8-2008

Essays on Urban Sprawl

Julie L. Marshall
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a dissertation written by Julie L. Marshall entitled "Essays on Urban Sprawl." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Economics.

William F. Fox, Major Professor

We have read this dissertation and recommend its acceptance:

Thomas P. Boehm, Donald J. Bruce, Matthew N. Murray

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

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Essays on Urban Sprawl

A Dissertation
Presented for the
Doctor of Philosophy Degree
The University of Tennessee, Knoxville

Julie Lynn Marshall
August 2008

Dedication

I dedicate this dissertation to my parents, Timothy Marshall and JoAnn Marshall, my brother, Scott Marshall, and my grandmother, Jean Altshuler.

Acknowledgements

This dissertation would not have been completed without the support of the many people who made this process possible. I am grateful to many of the faculty and staff at the University of Tennessee, my fellow students who made graduate school fun, and my friends, who provided much needed breaks.

First and foremost, I thank my committee who selflessly and patiently guided me through the process. In particular, I am deeply indebted to my chair, Bill Fox, who helped, encouraged, and guided my work with patience and wisdom. I cannot accurately express how much I have learned from Dr. Fox, both as a student of economics and as an employee of CBER. I benefited so much from my experiences as a research associate and from working with Dr. Fox over the last five years. I am grateful not only for his contributions to my dissertation, but also for helping me develop as a professional economist in CBER and being so instrumental in my development.

I am particularly appreciative of the experience of working with Matt Murray. I learned so much from him both about economics as well as life. He continually encouraged me not only during the dissertation process, but was a major reason I decided to even begin the dissertation. He believed in my potential even when I did not, and for that, I am forever grateful.

This dissertation would not have been possible without Don Bruce. I cannot express how many great ideas he would just toss out in casual conversation; ideas that have greatly improved my work. But my gratitude to Dr. Bruce goes beyond his contribution to my dissertation, or even my growth as a graduate student. Having had the opportunity to work with him has been invaluable to me as an economist and I cannot begin to state all the ways I have learned from him.

I thank Tom Boehm for agreeing to be on my committee and always being available to discuss ideas and ways to improve the work. He was very helpful in getting me to think about some of the issues and problems with my dissertation that I had not considered.

I would not have ended up taking the path I have had it not been for Dave Vogt, a research economist I worked for as a graduate student. Dave taught me how to be a research economist, from the very beginning when you are just forming the question to the many issues with data analysis, all the way to writing and presenting the work. Dr. Vogt was a true mentor in every sense, teaching and guiding, and continually presenting me with opportunities and challenges that helped me grow and learn.

I thank the staff of CBER who were so helpful and provided such a pleasant work environment. I am particularly grateful to Vickie Cunningham for her friendship as well as her expert assistance in all things data-related, and Betty Drinnen who was a tremendous help in so many ways. I also thank Joan Snoderly for her encouragement and positive attitude.

I would not be here without the support and encouragement of my family and friends. I thank my parents for their love and constant support and my brother for his endless encouragement, particularly since he knows the difficulties of this journey. Drs. Mark Tuttle, Laura Ullrich, and Tami Gurley-Calvez were all so helpful to me throughout graduate school, as well as being good friends. Finally, I would like to thank my friends: Alysson Sweet, Ana Preston, Toni Young, Rachel and John Cogburn, Mark and Danielle

Tuttle, Debbie and Gary Conrad, Brian Higgs, Stacia Couch, Deb Tracarella, Charlotte Mahan and Predrag Radulovic.

Abstract

Essay 1

Sprawl is an ill-defined and complex concept and this contributes to the difficulties in addressing it. Many studies and local policies are implemented without defining the very situation that is trying to be prevented. In this dissertation, I address this issue by computing and empirically testing a number of different measures that capture some of the elements of sprawl. While controlling for a number of other explanatory factors, I examine different fiscal factors that may contribute to the level of sprawl an area experiences. Because the property tax is the predominant source of local tax revenue, my main focus is on the impact that property tax rates have on sprawl in metropolitan areas. I next examine how the reliance on different types of revenue sources influence sprawl. I then offer insight into how local governments may use this information to look at their own sprawl issues. I find that higher property taxes are found in areas with lower degrees of sprawl, but that greater property tax differentials result in more sprawl.

Essay 2

The second essay of this dissertation addresses one of the inefficiencies often attributed to sprawl: the increase in the cost of delivering public services. Although this is one of the most common complaints concerning sprawl, there have been few studies examining how sprawl impacts public service costs. Using the same sprawl measures as in the first essay, I examine how differing levels of sprawl impact the costs of not only total public service expenditures, but also a number of local services important to residents. With this essay, I contribute to the debate on the relationship between sprawl and public service costs. The results of this study show that sprawl has a very limited relationship with most types of local public service expenditures.

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Part 1: General Introduction

People have been moving away from the cities in search of land, opportunity and a different way of life for many years. Perhaps one of the best-known examples of this is the settlement of the American West, where settlers left cities in the eastern U.S. and moved across the Great Plains to settle the western United States. However, this phenomenon is not unique to either those early times, or even the U.S.[1] While the reasons behind this movement of the population in the U.S. have most certainly changed since the 19th century, people still make choices as to where to live and how best to improve their quality of life through location decisions. As early as the 1930's, the patterns of development that described the location decisions of people began to take on a negative connotation, and the development of suburbs and the exodus of people from the central cities to these outlying areas was described with a new term: *sprawl*. Earle Draper, the Director of Planning at the Tennessee Valley Authority said in 1937, "Perhaps diffusion is too kind of a word. ... In bursting its bounds, the city actually sprawled and made the countryside ugly...uneconomic [in terms] of services and doubtful social value."

Since that time, the interest in sprawling development has not only grown, but has gained the attention of policymakers from the local level on up to a previous U.S. vice-president. There are a variety of proposed solutions to sprawl, the most common being growth management laws, urban containment policies, and zoning restrictions. The irony is that as policymakers are formulating new ways to either stop, slow, or reverse sprawl, people are continuing to move to outlying suburban areas in record numbers.

As with any important issue, there are (at least) two sides to sprawl; there is the argument that this is a natural process, and people are simply behaving as utility-

[1] See Richardson and Bae (2004) for a discussion of sprawl in Western Europe.

maximizing rational agents. One might expect that as incomes rise and people become accustomed to a higher standard of living, they will seek out new opportunities and often those opportunities are found away from central cities: larger houses on larger lots of land, open space, better public schools, and in general, a higher quality of life. The other side of the issue is that these development patterns contribute to a number of inefficiencies: fiscal, social, and otherwise.

The discussion regarding sprawl continues, however, as many of the main issues associated with sprawl are still debated. Perhaps the most natural question to ask when attempting to discuss sprawl is what do we mean by sprawl? Sprawl is an ill-defined and complex concept and this contributes to the difficulties in addressing it. Many studies and local policies are implemented without defining the very situation that is trying to be prevented. In this dissertation, I address this issue by computing and empirically testing a number of different measures that capture some of the elements of sprawl.

The next logical question then, is what are the causes of sprawl? Federal policies often cited as contributors to sprawl are the federal development of the interstate highway system and the deduction of mortgage interest from the federal income tax bill.[2] Other arguments maintain that sprawl is a product of lifestyles heavily reliant on automobiles.[3] While these may be contributors to sprawling development patterns, sprawl occurs at a local level, meaning it is prudent to examine local issues that may be impacting sprawl. While controlling for a number of other explanatory factors, I examine different fiscal factors that may contribute to the level of sprawl an area experiences. Because the

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[2] For a discussion on the impact of the federal highway system on sprawl see Rusk (1998); in their study Perskey and Kurban (2003) find that federal housing subsidies encourage sprawl.

[3] See Glaeser and Kahn (2004).

property tax is the predominant source of local tax revenue, my main focus is on the impact that property tax rates have on sprawl in metropolitan areas. I next examine how the reliance on different types of revenue sources influence sprawl. I then offer insight into how local governments may use this information to look at their own sprawl issues.

The second essay of this dissertation addresses one of the inefficiencies often attributed to sprawl: the increase in the cost of delivering public services. Although this is one of the most common complaints concerning sprawl, there have been few studies examining how sprawl impacts public service costs. There have been case studies and a few simulations where different population densities are employed to assess how costs are influenced. Using the same sprawl measures as in the first essay, I examine how differing levels of sprawl impact the costs of not only total public service expenditures, but also a number of local services important to residents. With this essay, I contribute to the debate on the relationship between sprawl and public service costs.

In the first essay, the dependent variable is the sprawl measure, and in the second essay the sprawl measure is one of the explanatory variables explaining local public service expenditures. Because of this interconnectedness, conceptually it is possible to model these questions in a simultaneous framework. However, a number of limiting factors make this particular type of modeling approach impractical, resulting in the separate analysis of these two particular questions. The first reason to look at these separately has to do with the fact that despite the potentially endogenous nature of the decisions being made (i.e. the decisions of choosing the property tax rate and the level of local public expenditure decisions), these are very much separate issues, and so I chose to treat them separately. The second reason is that there are no good instruments that will allow me to identify the equations in the system. The final reason to separate these two questions, is the limitation of appropriate and available data. If I were to set this up as a simultaneous system, in the first essay, most of the data, including the property tax and demographic variables come from the Decennial Census and are available for 1990 or 2000. A couple of the variables, however, are drawn from the Census of Governments, which to match up to the time frame I am analyzing, would use 1987 or 1997 data. When I move to the second equation, however, I am looking at how sprawl affects expenditures. Because of the availability of the expenditure data (which comes from the Census of Governments) the only expenditure years I could look at which would make sense are 1992 and 2002. (Although it could certainly be argued that areas choose their property tax rates and make their expenditure decisions simultaneously, the data from the Census of Governments prohibit examining this question. My sprawl measure is for 1990 or 2000, but expenditure data is available for either 1987/19987 or 1992/2002. Using the 1987/1997 measure would not make sense; it is not possible for a future level of sprawl to have an impact on some previous expenditure decision.) Because of this, I chose to separate these two questions so each could be analyzed thoroughly.

Part 2: Essay 1: The Influence of Property Tax Rates and Fiscal Structure on Urban Sprawl

1.A Introduction

> "The rapid spread of suburbs across the previously rural landscape is a common phenomenon in the United States today. Even the most casual observer cannot but be impressed with the magnitude of the changes. There has been much criticism, on aesthetic and other grounds, as to the kind of suburbs being built; they have also had their defenders, or at least those who say the results cannot be hopelessly bad because people still move in great numbers to the suburbs" (Clawson, 1962, p.99).

While this quote aptly describes the U.S. today, economist Marion Clawson made this observation about the changing landscape more than forty-five years ago. In the years since Clawson wrote about sprawl, the issue has continued to gain attention and is at the forefront of issues facing rapidly growing areas. Individuals, communities, planning commissions, state and local governments, and other groups have an interest in how communities and regions are growing and developing. Burchell et al. (1998) and Johnson (2001) note that some of the reasons for the interest in sprawl include: aesthetics of the developing area, excessive reliance on automobiles, decay of the central city, loss of open space, loss of agricultural or farmland, influence on community character, air and water pollution and other environmental impacts, health consequences for residents, and fiscal impacts on the community.

Many of the current definitions of sprawl found in the literature are either too subjective or too vague to be useful for empirical research. In order to examine causes of sprawl, it is necessary to operationally define the term *sprawl* in a way that is reasonably accurate and acceptable, yet still conducive to empirical research. One way this research contributes to the current literature is by testing a unique measure of sprawl, a spatial Gini coefficient. A Gini coefficient is a common way to measure concentration, most often the concentration of income, or wealth. In the current research, I construct a spatial Gini coefficient to measure how people are distributed across a given land area; where there is less concentration of people, there is a higher level of sprawl.

There are a number of ways local policy choices may contribute to sprawl; I focus on one key component of local fiscal policy, the property tax rate, and also gauge the relative reliance local governments have on different sources of revenue. Examining property tax rates is appropriate because they are the largest component of both local general revenue and local tax revenues. In 2005, local property tax revenue across the U.S. on average accounted for 72 percent of total local tax revenue; ranging from a high of 98 percent in New Hampshire local governments, to a low of 26 percent in the District of Columbia.[4] Brueckner and Kim (2003) theoretically examine the impact of property taxes on sprawl and find two separate (and opposing) impacts, so the net theoretical result is ambiguous. Although the reliance on different sources of revenue may also impact sprawl, the issue has received scant attention in the literature. Because theory does not provide a definite, clear answer, empirical research is needed to determine to what extent local property tax rates and reliance on different sources of revenue impact sprawl.

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[4] U.S. Census of Governments, 2005. http://www.census.gov/govs/www/estimate05.html

This study results in numerous contributions to the literature and is valuable in a number of ways. First, there are few recent empirical studies on the causes of urban sprawl and only a handful that examine the property tax and the fiscal variables of interest, so this research analyzes sprawl using more current data. Second, the research relies on different measures of sprawl than those previously used. In addition to the spatial Gini measure I use for sprawl, I also construct two additional measures of urban sprawl to use as robustness checks: an index of dissimilarity and a sprawl indicator. The index of dissimilarity is a common demographic measure examining the way groups are distributed across the component geographic areas that make up a larger area (i.e. how people are distributed among census tracts across a metropolitan area). The sprawl indicator measure is another way of analyzing how people are distributed across an area based on differing levels of high and low-density areas.

The different sprawl measures proposed in this study have not been used empirically before, and improve upon previous measures in a number of ways. First, these different measures of sprawl are based on very small units of geography (the census tract) allowing for a measurement of sprawl that is much richer in detail than those used in previous studies. Second, both the spatial Gini measure and the index of dissimilarity are well-regarded measures commonly used to analyze a number of different issues, including the distribution of wealth or the diversity of race in a community. Finally, by using three different, yet somewhat related measures of sprawl, I am able to assess how sensitive empirical results are to the measure of sprawl used.

Although the influence of many of the explanatory variables on sprawl has been studied, little attention has been paid to the reliance on property and sales taxes, and the effective property tax rate in an MSA. As local areas experience increasing sprawl it makes sense to examine local factors that may act as contributors. The results of my study indicate that after controlling for a number of factors that impact sprawl, higher effective property tax rates coincide with lower degrees of metropolitan sprawl. Likewise, a stronger reliance by metropolitan areas on property tax revenue as a share of total local tax revenue is found in areas with lower degrees of sprawl, and higher reliance on sales tax revenue slightly increases the level of sprawl. One possibility for these results is that in areas where the tax base is less mobile, higher property tax rates may be levied, these areas may also rely more heavily on property taxes as a source of revenue. Because sales and property taxes are the two largest components of total local tax revenues, an area with a higher reliance on property tax revenues would necessarily rely less heavily on sales tax revenues, so the results are consistent.

The structure of the chapter is as follows. Section 1.B describes the relevant literature, and Section 1.C contains the discussion of the measures of sprawl used. The theoretical structure and empirical methodology are discussed in Section 1.D, followed by descriptions of the data in Section 1.E. Results are presented in Section 1.F and Section 1.G concludes.

1.B Relevant Literature

Because this paper focuses on understanding and explaining the relationship between a variety of explanatory variables and sprawl; I examine three aspects of the literature. First, I discuss the theoretical treatment of sprawl in economics.[5] The second

[5] A number of fields address sprawl, including urban planning, transportation, and geography.

issue I address is the way that sprawl has previously been defined and quantitatively measured. Since there is a lack of consensus on the definition, it is necessary to assess how previous studies have estimated sprawl. Finally, the relationship between fiscal choice variables (i.e. property taxes and reliance on different sources of revenue) and sprawl is addressed.

Urban Economic Theory and Sprawl

Suburbanization (the term traditional economic theory uses to refer to sprawl) is the movement of residents and jobs away from the central city, and is a natural outcome based on the monocentric city model. The monocentric city model is a city with a central business district (CBD) where all employment is located surrounded by a residential ring where all housing is located. In the model, each of the homogenous households in the city receives utility from a numeraire good and their consumption of housing (where the lot size of their residence has an inverse relationship with the distance to the CBD). Taking into account rent and commuting costs, consumers choose their consumption of housing (i.e. location) in order to maximize utility. As one moves out from the CBD, rent falls thereby allowing for greater consumption of housing, while incurring greater commuting costs. Alonso (1964) first described this model and Muth (1969), Mills (1972), and Wheaton (1974) extended the basic model in a variety of ways.

Building upon the results of the monocentric city model, Mieszkowski and Mills (1993) discuss two theories of suburbanization that have emerged in urban economics: flight from blight and natural evolution. The natural evolution theory emphasizes the distance of residential sites to central work places, the effects of rising real incomes over time, the demand for new housing and land, and the heterogeneity of the housing stock.

Also included in and important to this theory are transportation costs, innovations of intra-urban transportation and changes over time in the comparative advantage of different income groups at commuting longer distances to work. The important result of the natural evolution theory is that suburbanization is a natural occurrence resulting from higher incomes and increasing population, improvements in transportation, and competition in the market for undeveloped land.

Rising real incomes encourage residents to increase their demands for new housing and more land; because of this desire for larger houses on larger lots, many residents choose to move out to suburbs. The heterogeneity of housing stock also encourages residents to move outward from the central cities, as the desire and demand for different types of housing is sought, in part due to rising incomes. In a similar fashion, the improvements in transportation infrastructure and the decrease in transportation costs have also influenced the movement of people away from the central cities. Both of these reduce the costs and difficulties in traveling further distances, making commuting longer distances not only more feasible, but less costly as well.

The flight from blight theory has its roots in Tiebout's (1956) "voting with the feet" hypothesis and stresses the fiscal and social problems of central cities such as high taxes, low quality public schools and other public services, racial tensions, crime, congestion, and low environmental quality as possible reasons city residents choose to relocate to suburban locations. Mieszkowski and Mills conclude that both the natural evolution and flight from blight approaches are important in explaining suburbanization.

Poor central city conditions have historically encouraged those citizens who were more affluent to flee for the suburbs. In the early development of urban economic theory, the central cities were the core of development, and therefore the first places to generally suffer from poor conditions. Higher tax rates encouraged those residents who were financially well off to move out to the suburbs where they can purchase larger homes, and because of lower tax rates in suburban areas, still have lower tax bills. Central cities have historically had higher rates of crime, minorities, and poor public services, all of which encouraged those residents who were capable of moving away to do so.

Brueckner and Fansler (1983) is one of the few empirical investigations of those factors that contribute to urban sprawl. Viewing sprawl as the result of market processes allocating land between urban and non-urban uses, the spatial sizes of urban areas are determined. Using a regression analysis of 40 Census-defined U.S. urbanized areas in 1970, the monocentric model is empirically tested. The authors find that nearly 80 percent of the variation in the size of urban areas is explained by variables of the monocentric model. Brueckner and Kim find that higher levels of population and personal income increase sprawl, while higher values of agricultural land decrease sprawl. The proxies for commuting cost are not statistically, significantly different from zero in either specification. Because the results are consistent with the predictions of the monocentric city model, the authors conclude that "the results of this paper justify a dispassionate view of sprawl, (p.481)" and therefore, in their view, sprawl should not be a cause of concern.

Defining Sprawl

The complexities surrounding urban sprawl may be most evident when attempting to define it. Every person with an interest in sprawl likely has their own definition (even if implicit), and while there are generally agreed upon components to sprawl, there is no consensus as to what it is. Malpezzi (2001) notes situations often associated with sprawl such as high reliance on automobiles/low incidence of public transportation, loss of farms and open space, and fiscal impacts. Malpezzi views these situations as consequences of sprawl, rather than as defining attributes of sprawl. However, as one begins to delve deeper into the issues surrounding sprawl, it becomes clear that the defining attributes and consequences of sprawl are not easily disentangled. Galster (2001) notes that this is one of the most common problems found in the definitions of sprawl in the literature: sprawl is described as both the cause *and* result of some urban process. The nature of this entanglement between causes and consequences makes any study of sprawl complicated- from the difficulty in defining sprawl to the challenge of appropriately testing potential causes and effects of sprawl.

A variety of definitions for sprawl are present in the economics literature; several are discussed below. A number of authors present good conceptual definitions and analyses of the many issues often associated with sprawl without providing a solution to the problem of how to measure sprawl. Nechyba and Walsh (2004) define sprawl as an "expanding urban footprint," and Brueckner (2000) notes that sprawl can accurately be thought of as "excessive suburbanization." While the ideas of both the *expanding urban footprint* and *excessive suburbanization* are common conceptualizations of sprawl, it is unclear as to how these concepts can be measured. Discussions of sprawl from the early economic literature such as Clawson (1962), and Harvey and Clark (1965) reveal that some of the early criticisms of the analyses of sprawl, most notably the lack of a clear and measurable definition, remain relatively unchanged today.

Defining a complex idea such as sprawl results in definitions that are difficult to measure and capture in an operational definition, while other definitions are more appropriately considered either a cause or a consequence of sprawl, and therefore not the definition of sprawl. The land area of the Urbanized Area is not a good measure of sprawl because it does not describe the distribution of population within its boundaries, a common (and useful) component of many sprawl definitions. It is possible that the distribution of population within two equally sized Urbanized Areas could be quite different, and for this reason, area may not be the best way to measure sprawl.[6] For example, in 2000, the Miami and Washington D.C. Urbanized Areas had similar areas,[7] 1,116 and 1,156 square miles, respectively. But Miami has nearly 1 million more inhabitants than Washington D.C., resulting in drastically different average densities. Miami's population of 4,919,036 results in a density (as measured by people per square mile) of 4,408, while Washington D.C.'s population of 3,933,920 results in a density of 3,403. So while these two areas contain similar land area, their differing populations give a much different picture as to the overall average density of these two areas. Another way to look at how the use of the size of Urbanized Areas may be a misleading measure of sprawl is to look at two areas that have similar average densities, yet different land areas. Portland, ME and Valdosta, GA have virtually identical average densities (1,519 people per square mile in Portland, 1,520 in Valdosta) yet Portland's population and land area are more than triple those of Valdosta. The use of land in the Urbanized Area would give identical sprawl measures for these two places.

[6] Another potential problem in using the Urbanized Area is that Census re-defined this geography in 2000, and earlier definitions are no longer comparable to the new definition, making comparisons across time impossible.
[7] See http://www.census.gov/geo/www/ua/ua2k.txt for data on Census-defined Urbanized Areas in 2000.

Wassmer (2006) uses the Urbanized Area to explore the expanding geographic footprints discussed in Nechyba and Walsh (2004), but does not consider this measurement sprawl and notes the problem discussed above. Using this measure as a proxy for sprawl could potentially be misleading; while this measure is capable of capturing the concept of the expanding areas, it doesn't lend any insight into the density or the distribution of the population within the urbanized area, as in the previous examples of Miami and Washington, DC. My proxy for sprawl, discussed in detail in the next section, improves on the urbanized area measure using detailed census tract data to analyze the distribution of the population within a given area.

Other proxies for sprawl measure the movement in population from the central city to the urban fringe. Carruthers (2003) uses the percentage of total population growth occurring at the urban fringe and Dye and McGuire (2000) measure the share of the population outside the urban core relative to the total population of the metro area. Measurement of population movement toward the suburbs captures the expanding footprint concept but fails to capture any associated density changes. As cities (or urban areas) develop, the natural process of city expansion usually consists first of outward expansion, and then as development progresses, the entire area undergoes increased density. Different measures of land use constitute other common measures of sprawl: Dye and McGuire (2000) use the share of urbanized land area relative to total metropolitan land area and the annual growth in urbanized land area. Carruthers (2003) and Fulton et al. (2001) calculate population density, dividing population by urbanized land area[8] as another possibility for measuring sprawl.

The Property Tax and Sprawl

Brueckner and Kim (2003) theoretically examine the connection between the property tax and urban sprawl. In their analysis, the property tax has two possible (and opposing) effects on urban spatial expansion. In the first effect, the property tax is viewed as a tax imposed equally on both land and capital improvements to the land. The tax on improvements to the land (the improvement effect) tends to lower the equilibrium level of improvements the developer chooses; this reduction in the intensity of land development results in the property tax increasing sprawl.

The second effect contradicts the previous result, and arises due to the impact the property tax has on the size of dwellings (the dwelling-size effect). If one argues that the tax on land and structures is passed on to consumers, then the price of housing increases, which leads to a decrease in the size of dwellings. Smaller dwellings imply an increase in population density thereby reducing the city's spatial area (and sprawl). The increase in density resulting from smaller dwellings may offset the decrease in density resulting from fewer improvements; the combined theoretical analysis reveals that the effect of the property tax is ambiguous. If the improvement effect is stronger, then the property tax may encourage sprawl; but if the dwelling size effect dominates, then the property tax may reduce sprawl. Assuming constant elasticity of substitution preferences in housing

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[8] Urbanized land area data are available from the USDA Natural Resources Inventory. Because of the sampling procedure used in obtaining the data, the county-level data may contain large errors, resulting in overestimating the amount of the urbanized land. The overestimation of this measurement of land area would likely result in overstating the degree of sprawl. More information on the NRI data can be found here: http://www.nrcs.usda.gov/TECHNICAL/NRI/1997/docs/1997CD-UserGuide.doc .

consumption (and an elasticity of substitution greater than or equal to one) results in higher-density, smaller, less-sprawled cities. However, the results of their numerical simulation indicate the likely influence of the property tax is a slight increase in sprawl. Because of the inconclusive theoretical results, empirical analysis is necessary.

Expanding the work of Brueckner and Kim (2003), Song and Zenou (2006) further develop the theoretical model, and are the first to empirically test the impact of property tax rates on sprawl. Theoretically, they use a log-linear utility function where the elasticity of substitution is variable (and greater than one), as opposed to the CES assumption of Brueckner and Kim. Song and Zenou's theoretical treatment shows that increasing the property tax rate decreases the size of the city, and therefore, they argue, sprawl. However, they use the land area of the Census-defined Urbanized Area as the measure of sprawl in their empirical analysis, which while not uncommon,[9] is not the best way to measure sprawl for the reasons noted above.

Using geographic information systems (GIS) methods, Song and Zenou (2006) calculate effective property tax rates for 448 Census-defined Urbanized Areas in 2000. McGuire and Sjoquist (2003) note that sprawl and property taxes may be endogenously determined; sprawl can affect property taxes through its impact on the property tax base and the property tax base may influence the choice of a property tax rate. It is also possible that the property tax rate influences the tax base, which in turn influences the degree of sprawl. One possibility is that areas with a less mobile tax base can implement a higher property tax rate. Previous empirical studies have not attempted to address the potentially endogenous nature of sprawl and property taxes, but Song and Zenou

[9] See Brueckner and Fansler (1983) and Nelson (1999).

incorporate an instrumental variables approach to address simultaneity bias. Using state aid to education as the instrument, and controlling for a number of factors, their two-stage least squares analysis reveals that higher property tax rates result in smaller urbanized areas, and in their view, less sprawl.

Prior to the work of Brueckner and Kim (2003) and Song and Zenou (2006), there was little exploration of the relationship between the property tax and sprawl. A few exceptions include Harvey and Clark (1965) who discuss how the real property tax results in discontinuous development, and Clawson (1962) who suggests raising property taxes as a way to decrease (or at least slow) development. In examining population growth at the urban fringe, Carruthers (2003) finds mixed results relating per capita property tax revenues and infrastructure investments to sprawl. His conclusion regarding the property tax is that it may not contribute as much to sprawl as previously thought, although this conclusion is based on property tax revenues rather than rates.

Fiscal Structure

I now turn my attention to fiscal structure and the impact it may have sprawl. The relationship between an area's fiscal structure and a number of topics has previously been explored. Fox, Herzog, and Schlottman (1989) look at the impact fiscal structure has on migration into and out of metropolitan areas. They examine a number of variables related to fiscal structure: the property, sales, and income tax revenues as a percent of local own-source revenues are measures of the tax structure of the metropolitan area. Other revenue sources include intergovernmental transfers, local own-source, and state own-source revenue per dollar of income, and they also include a mix of expenditure variables likely to influence migration are analyzed, as well. Gerking and Morgan (1998) look at the relationship between state and local fiscal structure and state economic development policies, and Fox and Murray (1990) look at how local public policies, including tax structure, influence business development decisions. A number of studies contained in Herzog and Schlottman (1991) discuss the relationship between business decisions and local policies, including taxes. There are not, however, many empirical studies of how public policies in general and tax structure specifically may influence an area's degree of sprawl. Further, to this author's knowledge, a theoretical analysis between the fiscal structure and the level of sprawl in an area does not exist.

There are a number of ways that metropolitan fiscal structure may influence the level of sprawl; Wassmer (2002) and (2006) examines these potential relationships on a subset of western metropolitan areas. Using the non-central place[10] dollar value of retail sales as his measure of sprawl, Wassmer (2002) examines how a state's reliance on different sources of revenue impacts sprawl. He examines how reliance on sales, property, and revenue from "other" taxes influences sprawl. Wassmer argues that greater reliance on a revenue source that is likely to generate a fiscal surplus (such as sales tax) is expected to increase the amount of retail sprawl, so a positive influence is expected from sales and other tax revenues. As discussed previously the property tax may have a positive or a negative impact on sprawl. Wassmer finds that the property tax revenue has no impact on non-central place retail sales, and state-wide sales tax and other taxes have the expected positive impact. Wassmer (2006) expands the sources of state-wide revenue he examines by adding income tax revenues to the different sources he examined in 2002.

[10] The non-central place (or to use terminology consistent with the monocentric, the central city) dollar value of retail sales is defined as follows. First, total retail sales for an entire Urban Area are calculated, and then the Census-designated central place dollar value of retail sales is subtracted. The remaining value is the value of retail sales occurring outside the central place.

Estimating a number of different specifications, he again finds that sales tax revenue is positive and significant, and in one specification revenue from other taxes is negative and significant; none of the other revenue sources are significant in any of the specifications.

The revenue sources I examine differ slightly from those used by Wassmer; he examines state-wide reliance, while I analyze the influence of metropolitan-level sales and property tax revenue as shares of local general revenue. Following the logic used with the effective property tax rate, the expected sign on the property tax share is ambiguous. Using the same reasoning as Wassmer, and assuming that areas that rely more heavily on sales tax revenue do so in order to benefit from the fiscal surplus that is generated, I expect the sign of the sales tax revenue to be positive.

1.C Sprawl

A spatial Gini coefficient, constructed from Census tract data,[11] is the main sprawl measured used in my paper. Using the equation below the sprawl Gini is:

$$\mathbf{G}_j = 1 - \sum_{i=0}^{n} (\alpha X_{ij} - \alpha X_{ij-1})(\alpha Y_{ij} + \alpha Y_{ij-1})$$

where

$\mathbf{G}_j$=is the spatial Gini measure for MSA j (j=1, 2, …306)

αX_{ij} =the cumulative tract population percentage of tract i in MSA j, and

αY_{ij}= the cumulative tract land area percentage of tract i in MSA j.

Examples of the calculation of the spatial Gini and a simple numerical example are shown in Tables 1-1 and 1-2 and Figures 1-1 and 1-2. Graphically, the Gini

[11] A number of authors have used census tract data to construct measures of sprawl; see Malpezzi and Guo (2001), and Brueckner and Largey (2006) for examples.

Coefficient is the area of concentration between the Lorenz curve and the line of perfect equality (denoted by area A), and the value is calculated as A/(A+B) in Figure 1-1. By definition, areas that are more sprawled will be closer to the line of perfect equality, as shown by scenario 2 in Figure 1-2. Areas with less sprawl will be closer to the line of perfect inequality, as shown by scenario 1 in Figure 1-2. (Figures and tables are located in the appendices.)

The Gini coefficient is commonly used to examine the distribution of income, but some authors have begun to use this measure in a spatial context (Tsai, 2005; Malpezzi and Guo, 2001). Recall that the Gini coefficient measures the degree of dispersion of a variable, most commonly income or wealth although it can easily be extended to gauge the population dispersion. The Gini coefficient has values between zero and one; a value of zero indicates that there is perfect equality in the variable being measured (no concentration) and a value of one indicates that there is perfect inequality (complete concentration). In the case of sprawl, the 45 degree line (the case of perfect equality) represents the case of "extreme" sprawl, where people are distributed equally across the land area of an MSA. Calculating the spatial Gini using the equation above resulted in a sprawl measure where higher values (i.e. closer in value to 1) were indicative of *lower* levels of sprawl. To make the sprawl Gini more intuitively pleasing, as well as to ease the interpretation of this measure, I subtract the value of the sprawl Gini from 1. Upon completing this transformation, the higher the value of the sprawl Gini (i.e. the closer in value to 1), the higher the degree of sprawl the MSA has.

This variable is chosen to approximate residential sprawl for MSAs for a variety of reasons. First, the lack of reliable, detailed data for different geographic areas is problematic when attempting to measure sprawl quantitatively. As discussed previously, the definitions of MSAs and Urbanized Areas can change, making comparisons over time problematic. The measure I use incorporates detailed land and population data at the census tract level; this data is available for all MSAs. Further, unlike other Census-defined regions, census tracts are relatively stable over time, so overall, they are a constant geographic entity. Second, the sprawl Gini relies on data that are consistently reported, whereas some data sources are either inconsistent over time, or not gathered on a regular basis. The data used to construct the index are from the 1990 and 2000 Decennial Censuses and consist of the county the tract is in, the population and the estimate of land area for each tract.

The Gini coefficient is a good measure of sprawl for a number of reasons. First, this type of measure is capable of capturing the distribution of people within an MSA, allowing greater insight into the spatial pattern of people than, say, an average density measure. Second, because of its design it is not necessary to make judgments as to the high-density/low-density cut-off points problematic in the work of Galster et al. (2001) and Lopez and Hynes (2003). In both of these studies, the degree of sprawl is determined by the decision of what is considered a high density tract and what is considered low density. The problem arises in choosing this cut-off point for high and low densities, Lopez and Hines (2001) use 3,500 people per square mile, which is a very high density. Even the density chosen by Galster et al. (2001) is somewhat high, in their study, they use the Urbanized Area minimum density of 1,000 people per square mile. Finally, because the sprawl Gini is constructed from a stable Census defined area, the census tract, it is possible to calculate the Gini over time for a number of different geographic areas including MSAs.

As with any measure attempting to capture sprawl, the Gini coefficient does have some limitations. The measure does not tell us where the inequality of people is (i.e. central city, suburbs, or exurbs). The Gini allows only a general statement of the sprawling condition of the MSA, and not specifically where more or less sprawl may be occurring. When examining sprawl, a more detailed measure is generally preferred, however, data limitations determine the detail available for a sprawl measure. Galster et al. (2001) chose an extremely detailed measure with very few observations (13 MSAs are included), while Song and Zenou (2006) chose a much simpler measure (land area of Urbanized Area) with more observations (448 Urbanized Areas).

The sprawl Gini is the primary sprawl measure of interest in my paper, however, for comparison, as well as to test the robustness of the econometric specification, two other measures are employed. Closely related to the Gini coefficient is the Index of Dissimilarity (ID) which is calculated using the following formula:

$$\mathbf{ID}_j = \mathbf{0.5}\, \mathbf{\Sigma}\, (\mathbf{X}_i - \mathbf{Y}_i),$$

where

$\mathbf{ID}_j$= the Index of Dissimilarity for MSA j (j=1, 2, …306)

$\mathbf{X}_i$= the percentage of population in tract i in MSA j, and

$\mathbf{Y}_i$= the percentage of land area in tract i in MSA j.

This measure[12] represents how dissimilar the population is from the line of perfect equality, and like the Gini Coefficient, is bounded by zero and one, with higher values (closer to 1) representing higher levels of sprawl. For a general discussion of the Index of Dissimilarity, see Sakoda (1981), Watts (1998) for a discussion of how the Index of Dissimilarity has been used to examine the segregation of the genders in different occupation, and Iceland, Weinberg and Steinmetz (2002) for a special report by the Census Bureau on racial and ethnic segregation in the U.S.

The final measure used in this paper is a sprawl indicator first proposed by Lopez and Hynes (2003) which also uses census tract data. The sprawl indicator is calculated using the following formula:

$$\mathbf{SI}_j = \mathbf{D}_j / \mathbf{M}_j$$

where

SI_j = the sprawl indicator for MSA j (j = 1,2…306)

D_j = population residing in low densities tracts in MSA j.

M_j =total population residing in MSA j.

In this paper, the cut-off point for the high-density/low-density tracts for the sprawl indicator is the land-weighted average density for the MSA. The cut-off point is an important choice as it will directly influence the degree of sprawl measured in an MSA. The indicator ranges from 0 to 1, where a score of 0 indicates that everyone in the MSA lives in a high-density tract, and a score of 1 indicates that everyone in the MSA lives in a low-density tract. Using this measure, the higher the value of the sprawl

[12] The Index of Dissimilarity was transformed in a similar fashion to the Gini, making it more intuitive and simplifying interpretation.

indicator (the closer in value to 1), the higher the degree of sprawl in the MSA; likewise, the closer the value to 0, the lower the degree of sprawl in the MSA.

As mentioned previously, this measure may be problematic because it requires a decision to determine the necessary condition for a high density tract versus a low density tract. By using the land-weighted average density for *each* MSA as the cut-off point, I attempt to take into account the uniqueness of each MSA. By land-weighting the average, I acknowledge the fact that the land areas of Census tracts are not equal and can vary widely, even within the same county.[13] If differences in land-weights are unaccounted for, this sprawl index treats each census tract as being essentially the same size, and for this reason, may introduce measurement error into the indicator. Although the three measures result in different values for a given area, the scale of each is the same; and the higher the value, the higher the level of sprawl.

These sprawl measures improve upon previous measures in a number of ways. First, the data used to construct each are publicly available for all MSAs allowing for a large number of observations. Second, although population changes impact the average density, it is not certain how the new population distributes itself throughout the MSA. The MSA is a grouping of counties designated by the U.S. Office of Management and Budget (OMB), based on a number of economic linkages, including work flow patterns. Because these counties are related to each other not only geographically, but also

[13] A census tract is a small subdivision of a county, and is designed to be relatively permanent. Census tracts do not cross county boundaries and generally contain between 2,500 and 8,000 people; they can vary widely in their size because they are delineated based on density. When first formed, tracts are designed to be as homogeneous as possible regarding characteristics of the population, however over time, census tracts do become more heterogeneous as their densities change. In rare cases, census tracts can be split or combined due to extreme changes in density from the initial formation. More detailed information about tracts can be found here: http://www.censusbureau.biz/geo/www/cen_tract.html.

economically, it makes sense to evaluate them as one unit. Using a continuous measure of sprawl, such as the measures proposed above is helpful because sprawl is not a dichotomous measure and therefore is properly gauged as a matter of degree. All three of the sprawl measures proposed allow measurement of the changes not only in the degree of sprawl in an MSA over time, but can also be reconstructed to conform to any future definitional changes of the MSA. Finally, by examining the values of each of the measures for a given area it is clear that each is different, and so may pick up different aspects of sprawl.

Table 1-3 contains the values for each of the three sprawl measures for all MSAs in 1990 and 2000. Table 1-4 contains the correlation coefficients between the three measures of sprawl used in this paper; there is a very strong positive relationship between the sprawl Gini, the Index of Dissimilarity, and the Sprawl Indicator.

In 1990, the average values for the Gini coefficient, Index of Dissimilarity, and the Sprawl Indicator are 0.259, 0.376, and 0.225, respectively. In 2000, the values are: 0.270, 0.388, and 0.227. Although the values between 1990 and 2000 are remarkably similar, the increase in the average values indicates a trend toward more sprawling populations, however of the 306 MSAs for which data were collected, 201 became less sprawled between 1990 and 2000, while 105 became more sprawled. This indicates the increase in sprawl, on average, was greater than the decrease in sprawl during this decade. Table 1-5 shows the three sprawl measures for the metropolitan areas with the lowest sprawl measurements in 1990 and 2000. It is important to note that all of the measures of sprawl used in this paper should be interpreted as a matter of *degree* rather than as an absolute measure. For example, in 1990, the Casper, WY MSA had a Gini coefficient of 0.042, where the low value is indicative of relatively low levels of sprawl; however by 2000, the Gini value had increased to 0.116, a substantial increase in the Gini, indicating that this MSA had become *more* sprawled during the 90s. (It is important to note in this case, that although the Casper, WY MSA experienced an increase in its sprawl based on it's Gini value, overall it maintains a relatively low degree of sprawl, much lower than the average MSA.) The Tucson, AZ MSA had a Gini value of 0.065 in 1990 and a value of 0.056 in 2000, indicating that this MSA had become less sprawled between 1990 and 2000.

Table 1-6 shows the sprawl values for the highest sprawl metropolitan areas in 1990 and how the measurement changed by 2000. Following the same logic as above, one can see that the Gadsden, AL MSA became more sprawled (increasing from a Gini value of 0.443 in 1990 to a value of 0.484 in 2000) and the Hickory-Morganton-Lenoir, NC MSA became less sprawled.

1.D Modeling Framework

Following the work of Brueckner and Fansler (1983), Mieszkowski and Mills (1993), and Song and Zenou (2006), and using the unique measures of sprawl discussed in the previous section, the degree of an area's sprawl is measured. I then assess the impact of property taxes, and a number of explanatory variables from the monocentric model, flight from blight and the natural evolution theories. A separate analysis gauges the impact of the reliance on sales and property tax revenues. As discussed in Brueckner and Kim (2003), the property tax may have two possible (and opposing) effects on the degree of sprawl in an area, and therefore the expected outcome is ambiguous.

The baseline model I estimate uses the instrumental variables approach in a fixed effects panel framework. In the first stage of the model, the endogenous explanatory variable of the equation (effective property tax rate) is regressed on all the exogenous variables in the reduced form, and fitted values are obtained. The first stage of the model is expressed in the equation below:

$$z_{jt}=\beta_0 + \beta \mathbf{x}_{jt} + \pi_1 \mathbf{V}_{jt} + e_{jt}$$

where z_{jt} is the endogenous property tax rate, $\mathbf{V}_{jt}$ is a vector of three instrumental variables, and $\mathbf{x}_{jt}$ are the exogenous explanatory variables (discussed in detail below).

The second stage of the model uses the predicted values of z ($\hat{z}_{jt}$), from the first stage regression to get unbiased estimates of the coefficients. This stage is shown in the equation below,

$$Y_{jt} = \alpha + \beta \mathbf{x}_{jt} + \delta \hat{z}_{jt} + e_{jt}$$

where j and t are MSA and time indices, Y_{jt} is the sprawl Gini; z_{jt} is the endogenous explanatory variable, the effective property tax rate; and $\mathbf{x}_{jt}$ is a vector of explanatory variables including: population of the MSA, percentage growth of the MSA population over the previous decade, land area of the MSA, the market value of agricultural land, central city share of non-white population, average home price in the MSA, state-level tax burden, MSA level of personal income, the share of the population under age 18 in public school, the standard deviation of the property tax rate, a dummy for the Census region[14] and e_{jt} is the error term. The instruments[15] chosen for this estimation are: the

[14] The Census regions and their component states are located in the Appendix.

state share of the state and local general revenue, the central city poverty rate, and the level of intergovernmental aid from the state to local areas. Statistically, these instruments are correlated with the effective property tax rate; yet do not appear to have a direct impact on sprawl.

If, as McGuire and Sjoquist (2003) suggest, the level of sprawl and the effective property tax rate are indeed endogenously determined, Ordinary Least Squares (OLS) results in coefficients that are biased and inefficient. The instrumental variables (IV) approach using two-stage least squares (2SLS) is an appropriate method to address the endogeneity of an explanatory variable. The key to successfully employing the IV approach is finding an appropriate instrument;[16] because sprawl is the dependent variable in the model I estimate, an appropriate instrument will be correlated with the property tax rate, yet have no effect on the sprawl measure.

A number of econometric issues must be taken into consideration in order to appropriately estimate the relationship between property tax rates and urban sprawl. In the presence of heteroskedasticity, the IV estimates of the standard errors are inconsistent; whereas the coefficients are consistent, yet inefficient.[17] Further, if heteroskedasticity is present, the common tests for endogeneity as well as overidentification of the model are not valid. If heteroskedasticity is deemed present, then

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[15] Some of the instrumental variables tested but not used in the analysis are: intergovernmental revenue from the state to local areas for education, educational attainment, the share of the population under age 18 in public school, state sales tax as a share of general revenue, MSA level tax burden, and state tax burden. These possibilities for instruments either did not explain the effective property tax, or were highly correlated with sprawl, and therefore inappropriate instruments.

[16] I use the Sargan-Hagan test to gauge the appropriateness of the instruments. The joint null hypothesis is that the instruments are valid, i.e. uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation. I fail to reject the null at the 1% significance level, indicating that the instruments are appropriate.

[17] See Baum, Schaffer, and Stillman (2003) for a detailed treatment of the instrumental variables approach.

an appropriate method to use is the Generalized Method of Moments (GMM); however if heteroskedasticity is not present, then the IV approach is appropriate. Therefore, the first step is running a test to determine whether heteroskedasticity may be present. The Bruesch-Pagan test is used to detect heteroskedasticity; the null hypothesis of homoskedasticity cannot be rejected at the 1% level of significance. These results imply that heteroskedasticity is unlikely to occur in the estimation, and IV is the appropriate methodology to use.

In addition to the structure of the variance, it is also necessary to address whether the theoretically endogenous regressor is truly endogenous. If the property tax rate is not endogenous to the model, then OLS is the appropriate model to use. Hausman test results indicate that the null hypothesis of exogeneity can be rejected at the 5% level of significance. This result confirms that the property tax rate is endogenous, and should be treated as such, therefore the IV approach is appropriate.

1.E Data

The data consist of two time periods,[18] 1990 and 2000; a number of models are run, and those results are discussed later in the chapter. The complete dataset includes 306[19] MSAs; covering the entire country except New England.[20] Because the county components of MSAs change over time, it was necessary to choose a period on which to

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[18] Because the data is a two-period panel, the fixed effects estimation produces identical results to a first-differenced model.

[19] Although data were collected for 306 MSAs, all multi-state MSAs were excluded from the analysis, because different states may have different tax structures.

[20] The New England MSAs are excluded because their counties are not comparable to the rest of the country, and in New England, townships are the primary local governments, and county governments have virtually no role. MSAs are aggregations of counties, so it was not appropriate to include New England.

base the definition, and the MSA definitions as of June 30, 1999 were chosen.[21] The MSAs were reconstructed for 1990 based on the 2000 definition. Because the definitions of MSAs change over time, if one consistent time period is not used, then a true analysis of how sprawl changes over time cannot be measured. For example, the Knoxville MSA had seven component counties in 1990: Anderson, Blount, Grainger, Jefferson, Knox, Sevier, and Union. By 1999, the Knoxville MSA had only six counties, but a number of the component counties had changed: Grainger and Jefferson were no longer part of the MSA, and Loudon county was added. If the definitions were not consistent across time, an analysis of the Knoxville MSA would include 7 counties in 1990 and 6 in 1999, of which only 5 are found in both years. There are a number of potential problems arising from definitional changes. The first, and potentially most problematic issue is that any changes in sprawl would not necessarily be due to changes in the location of people, but rather could arise due to the addition or removal of component counties. Choosing a base year as the definition allows for consistent comparisons across time. Additionally, the data on central cities are based on the June 30, 1999 definition.

Many of the explanatory variables are for the same year as the sprawl Gini, while the property tax information is reported for the previous year.[22] Table 1-7 contains the sources of data used in the analysis, a brief description and the expected effect on sprawl; descriptions of the instruments and the source notes are in Table 1-8. Summary statistics for the data are contained in Table 1-9. My empirical construct tests variables from four

[21] See http://www.census.gov/population/estimates/metro-city/99mfips.txt for a complete listing of MSAs and their component counties. This was the definition used for Census 2000.

[22] The Census long form questionnaire asked homeowners to report real estate taxes paid for the year prior to the Census; taxes in 2000 correspond to taxes paid in 1999, taxes in 1990 correspond to taxes paid in 1989.

theories: the flight from blight theory, the natural evolution theory, predictions of the monocentric city model, and the impact of property tax rates. Sprawl can be described as the spatial outcome of a number of different influencing factors, which fall into the four main categories described below.

Effective Property Tax Rate

The MSA average effective property tax rate is calculated from U.S. Census data; the long form of the Census questionnaire asked homeowners to report both the amount of real estate tax they paid as well as the value of their home in the year prior to the Census. The amount of the property tax paid divided by the reported value of the home aggregated to the MSA level is the effective property tax rate. Theory is unclear as to the expected sign of the property tax rate on sprawl, therefore, the predicted impact remains ambiguous. Since property tax rates are not levied at the MSA level, but rather at sub-MSA level jurisdictions the effective property tax rate reflects the average rate in the MSA.

In addition to the effective property tax rate I also gauge the impact of another related measure: the standard deviation of the property tax rate in each MSA. By incorporating the standard deviation of the property tax in each MSA, I am somewhat able to assess how differences of tax rates within an area may influence sprawl. Presumably, the larger the deviation, the more sprawl an area might experience.

Monocentric City Model

A number of variables described in the monocentric city model are also appropriately incorporated into a model explaining sprawl. The population level for the MSA is collected from Census files, and it is expected that higher populations will tend to increase the sprawl in an area.[23] There are a number of reasons for this assumption but the main idea is that as populations increase, central cities and suburbs will tend to be more heavily populated, and people will move further and further out, in search of more space and less congestion. The Census of Agriculture provides a variety of information on farms and agricultural land; I use the market value of agricultural land per acre as a proxy for the cost of converting land. This variable is prominent in urban economic theory and is expected to have an inverse relationship with sprawl; that is, the higher the value (price) of agricultural land, the lower the level of sprawl because less land will be converted into non-farm uses.

Natural Evolution Theory

The next group of variables in the empirical model fall under the natural evolution theory, which emphasizes the rise of real incomes, the demand for new housing, and the heterogeneity of the housing stock. The average home price in the MSA is calculated as the total value of homes (as reported by homeowners) divided by the total number of homes, and is expected to have an inverse relationship with sprawl. Higher average home prices may also capture the dwelling-size effect of Brueckner and Kim (2003), where higher property tax rates are passed on to consumers through higher home prices, and less sprawl is expected to result. Historically, people left central cities for suburbs because homes were not only cheaper in these areas, but residents were able to buy larger homes on larger plots of land. Total personal income in the MSA is expected to have a direct relationship with sprawl; as people's incomes increase, their tastes and demands change

[23] See Brueckner and Fansler (1983).

and not only are they more likely to demand larger homes and better schools, but they are also better able to afford their changing preferences.

Flight from Blight

Also called the fiscal-social choice theory, the flight from blight theory is an extension of Tiebout's model. The central city non-white population as a share of the total central city population is a direct test of the "flight from blight" theory and is expected to have a direct relationship with sprawl; the higher the percentage of the non-white population living in the central city, the more sprawl an area is expected to have. The number of municipalities is included as it directly relates to Tiebout's hypothesis that people move in response to greater choice in the number of possible jurisdictions when deciding where to locate. The expected sign of the number of municipalities is positive, that is, the more choices available to residents within an MSA, the greater the sprawl an area will experience.

Other variables are included in the empirical specification that do not clearly fall into one theoretical category, but intuition suggests that they may have an impact on sprawl. The variable measuring the share of the population under age 18 attending public school might be expected to increase the amount of sprawl in an area. As Tiebout suggests, different quality schools may influence where people choose to reside. More children in the public school system may result in congestion which may have an impact on the quality of education. This may induce parents to seek out schools where the quality is at least perceived to be better.

The monocentric city model includes a measure of the population level, however, it is possible that population growth might play a role in sprawl as well. For this reason, the population change during the previous decade is included. Because the sprawl measures used in this study focus on the distribution of people, rather than the absolute level of residents, it is unclear how population growth may influence the different sprawl measures, therefore the expected sign is ambiguous. I also include the land area of the MSA, in order to test whether geographic size has any influence on sprawl. However, the expected sign is ambiguous, because it is unclear how the Gini measure will be impacted by land area. A final variable included in the model is the state-level tax burden, which is total state taxes divided by total state personal income. With this variable, I attempt to capture the general tax climate of the state. The expected sign is ambiguous, as it is unclear how the state-wide tax burden impacts sprawl.

1.F Empirical Results

I estimate the baseline model using an instrumental variables approach in a fixed effects panel framework with the Gini sprawl measure as the dependent variable. A number of empirical specifications are estimated in order to determine the appropriate model to use to explain the relationship between sprawl and the explanatory variables discussed above. In addition to the baseline model, I estimate the IV separately for 1990 and 2000. The results for the first and second stage of the baseline model[24] are shown in Table 1-10 and the discussion follows. Elasticities from the fixed effects regression are in Table 1-11.

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[24] A customary way to determine whether a fixed or random effects model is appropriate is a Hausman specification test. The Hausman specification test compares the results of the consistent fixed effects model with the efficient random effects model. The null hypothesis is that the unobserved group-specific effects are uncorrelated with the other regressors. In the presence of such correlation the estimators from the random effect model will be biased, so the fixed effect model is preferred. I reject the null at the 1% level of significance, indicating that the fixed effect model is statistically the appropriate choice.

In this specification, a number of the explanatory variables are significant and of the expected sign. The primary variable of interest in the model is that of the effective property tax rate. Recall that because of the two possible and opposing effects, the expected sign of the effective property tax rate is ambiguous; the negative sign of the empirical results indicate that as the property tax rate increases, the value of the Gini coefficient decreases (which indicates a lower degree of sprawl in an area). The results of this variable indicates the dwelling-size effect of Brueckner and Kim (2003) has a stronger impact than the improvement effect, and confirms the theoretical extension and empirical test by Song and Zenou (2006), that is, that lower levels of sprawl occur in areas with higher property tax rates. This is a potentially important result to local governments concerned with the impact property taxes have on the degree of sprawl in local areas. For local areas interested in decreasing the extent of sprawl, property tax rates may be one fiscal policy choice worth examining.[25]

The standard deviation of the property tax displays a positive and statistically significant sign, indicating that greater variation of property tax rates within an MSA leads to increasing sprawl. It is not clear whether high tax rates attract or repel residents. It could be argued that residents flee high tax areas, in search of lower tax jurisdictions. On the other hand, the Tiboutian argument that people seek out the jurisdictions that best satisfy their demand for public services may be in play here. In this case, it may be

[25] Although the results of the Hausman test indicate that the property tax is endogenous and should be treated as such, I also estimated an OLS model to gauge the consequences of ignoring the endogeneity. Failure to account for the endogeneity of the effective property tax rate gives different results than the IV regression; many of the explanatory variables fail to be significant, including the average home price in the MSA and the total number of municipalities. Both the effective property tax rate and the standard deviation of the tax rate within the MSA fail to be statistically significant at any reasonable level. This is an important result; addressing the endogenous nature of the property tax is crucial to the outcome of the estimation.

possible that higher property tax areas attract residents, in part due to a possible perception that higher property tax rates are indicative of better quality public schools (or public services in general). Reinforcing the Tiebout idea is the positive and significant result of the number of municipalities in an MSA. This indicates that the more choices people have in where to live, the more sprawled an MSA will be.

The average home price is negative and statistically significant. This is the expected result; an area with a higher overall level of home prices may not supply enough incentive for residents move to suburban locations as is typical in a monocentric city framework. Recall, that in the monocentric model, residents who choose to live further out, are generally rewarded with lower home prices.

The population growth over the previous decade is negative and significant, indicating that the higher growth in the previous decade, the less sprawl an MSA experiences. While this result might seem counterintuitive, there is no reason to expect the sprawl Gini sprawl to be influenced by population growth, but rather by the distribution of people. The result of this variable shows that when areas experience higher population growth, the population tends to settle into more concentrated distributions across the MSA. The state-level tax burden has a negative and significant impact, meaning that the higher the state tax burden, the less sprawl there will be. This result may be working in a similar fashion to the property tax rate; because the state-level tax burden is constant across the state, there is no incentive to move elsewhere (within the state) to reduce these taxes.

Alternative Modeling Strategies

I next estimate the models separately for each year using the IV approach, to assess how looking at the relationship between property tax rates and sprawl change in a cross-section framework. Results from the regressions are in Table 1-12. Overall, the model does a better job of explaining sprawl in 2000 than 1990. This may be due to the artificial construction of the MSAs in 1990; it was necessary to use a definition for only one time period in order to have a consistent definition of MSAs over the two periods. Likewise, several central city designations changed between the two time periods, in most cases, an additional central city was added between 1990 and 2000. However in order to have comparable central cities and MSAs, it was necessary for them to be consistent over time. It is possible, though, that re-creating the definition in 1990 resulted in some measurement error at the MSA level.

Many of the variables remain significant in the cross-sectional IV framework, and no statistically significant variables change sign. The elasticities for the effective property tax rate in this specification are much larger than the fixed effects framework; in 1990 the elasticity is -0.360 and in 2000 is -0.630. In the fixed effects framework, the property tax elasticity is -0.070. Many of the variables are only significant in one of the time periods: in 1990 the state tax burden variable is positive and significant, while land area is negative and significant, while in 2000, population change is positive and significant while the average home price is negative and significant.

It is possible that the effective property tax rate (as well as the standard deviation of the property tax rate) have different influences on sprawl depending on the size of the MSA. I estimate the fixed effects model and break the MSAs into two population categories: placing all MSAs with populations of half a million or less into one category and all MSAs with populations over half a million into another. The regression results are shown in Table 1-13. When broken down by these population categories the property tax fails to be significant in the large MSAs, but is significant for the smaller MSAs. The standard deviation of the property tax rate fails to be significant for the small MSAs but is positive and significant for those MSAs with populations of greater than half a million.

The results of this partitioning suggest that Tiebout effects are likely in effect for the more populous MSAs; that is, areas that have greater populations also have greater choice as to where to live. This Tiebout-type effect is shown in the significance of the standard deviation of the property tax rate in large MSAs. The property tax rate may not be significant in large MSAs because high housing prices might prevent the property tax from being considered in the choice of where to live. The significance of the property tax rate for smaller MSA suggests that the dwelling size effect dominates for smaller areas, that is, higher property tax rates are taken in to consideration by residents who make their housing choices accordingly. The standard deviation of the property tax rate is not significant, likely because smaller areas contain fewer possibilities of where to live, so the tax differential does not matter as much. The remaining explanatory variables generally retain their significance from the baseline model, however, in many cases previously explanatory variables are no longer significant.

Robustness Checks

In order to check the robustness of the model, I re-estimate the baseline model but substitute the Index of Dissimilarity and the Sprawl Indicator for the sprawl Gini as the dependent variable. The results using the Index of Dissimilarity and the Sprawl Indicator do not perform as well in the fixed effects context as the estimation using the Gini. In each of the models, only three variables are significant, although they do display the expected signs. The effective property tax rate, the state-level tax burden, and the average home price in the MSA all display negative and significant signs. For the property tax rate and the average home price, the value of the coefficientsd with the sprawl Gini as the dependent variable are in the middle, with the Index of Dissimilarity as the lower bound coefficient estimate and the Sprawl Indicator as the upper bound estimate. This situation changes with the state tax burden, where the sprawl Gini specification results in the largest coefficient. The results of these regressions are in Table 1-14.

These results appear to indicate that when modeling the relationship between potential explanatory variables and sprawl, the choice of the sprawl variable matters. The fact that the effective property tax rate is significant and negative across all specifications is important, although the potential impact of the tax rate varies by the model and the specification.

Fiscal Structure

The final model I estimate is one where rather than looking at the influence property tax rates have on sprawl, the reliance on sales and property tax shares are analyzed. Using a similar model and panel structure as the baseline model, I estimate the impact of these two variables, the results are in Table 1-15. I find that when these two variables are estimated in separate regressions the share of the property tax is negative and significant while the share of sales tax revenue is positive and significant.

This is a potentially important finding, because it adds another dimension to the previous results based on property tax rates. Higher property tax rates coincide with lower areas of sprawl, and a higher *reliance* on property taxes as a major source of revenue also coincides with lower levels of sprawl. If one thinks of local revenue as a pie, then in most areas, sales tax revenue and property tax revenue would be the largest pieces of the pie. Holding the overall size of the pie constant, if one of these shares increases, then the other share must experience a decrease. In fact, if we look at the coefficients for the property tax share (-0.207) and the sales tax share (0.297), one can see that they nearly offset each other, and move in opposite directions.

The two variables cannot be estimated jointly, however, because the collinearity is too great between them. The results from this estimation may indicate that areas do actively pursue those types of activities that result in a fiscal surplus as Wassmer suggests, and the result of the reliance on property tax revenues may work in a similar fashion to property tax rates, that is, areas that rely more heavily on property tax revenues may experience Brueckner and Kim's (2003) dwelling-size effect. However, because the reliance on property and sales tax revenues are determined jointly, it may not be appropriate to model them in separate equations, and therefore, these results should be interpreted with caution. The model performance is fairly poor, with a low R^2 value and very few significant variables, although those that are significant are of the expected signs.

There are a couple of reasons that the analyses for the fiscal structure of an MSA do not produce significant results. First, it is possible that an area's fiscal structure has relatively little to do with the tendency to sprawl. On a somewhat related note, it is also possible that smaller areas than an MSA would need to be examined in order to find if there is a relationship between tax reliance and sprawl. Wassmer used the state-wide level, and this study used the metropolitan level and both resulted in similar results.

1.G Conclusions

The conclusions of this study provide evidence that the property tax does indeed influence sprawl. In the theoretical model of Brueckner and Kim (2003) this means that the dwelling-size effect dominates, and therefore higher property tax rates are often found in areas with lower degrees of sprawl. As most local government officials are well aware, the property tax is one of the least popular taxes,[26] and increasing rates to dampen the effect of sprawl would not only be an unpopular decision, but also not feasible since property taxes are assessed at city and/or county-levels, and not the MSA. It may be the case that areas with high property tax rates have higher taxes overall, providing residents not only with higher levels of public services but also perhaps with less variation of public services. Less variation in public services within a metropolitan area may reduce the need for residents to move in search of a different menu of public services, and therefore result in a lower degree of sprawl. The positive results of the measure of the standard deviation of the property tax indicate that property tax differentials may increase the level of sprawl an area experiences, as residents seek out the jurisdiction that best satisfies their preferences, and as residents sort themselves into these communities, the area will experience more sprawl.

[26] Kincaid and Cole (2005) analyze public opinion on multiple areas of federalism-related issues in 2005 comparing the results with findings from previous years. The local property tax is consistently identified as one of the top two worst taxes.

One issue of interest that arises from this research is the notion of how Tiebout sorting may impact the sprawl process. Greater differentials in the property tax rate increase sprawl so the efficiency gains of the market for public services may be offset (at least to some extent) by negative externalities associated with sprawl. Examples of possible externalities include: poor or reduced air quality, health impacts, and increased congestion. This result may be of particular interest to areas where there are large tax differentials in neighboring areas, or a large number of communities with different offerings of public services which may induce residents to sort themselves within an area according to their preferences and the services offered.

Links between sprawl and obesity, or public health in general could be analyzed using the sprawl measures developed here. Likewise, a number of environmental impacts, such as air and water quality, congestion, and traffic and commuting issues could be examined, in addition to other measures commonly used to gauge environmental health.

One additional avenue for research is updating this study once data from Census 2010 are available. Because the sprawl measures are based on stable geographic units, an additional year of data could be added maintaining consistency among the definitions of MSAs and central cities. The study would then span thirty years and perhaps give greater insight into those factors influencing sprawl.

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Essay 1: Appendices

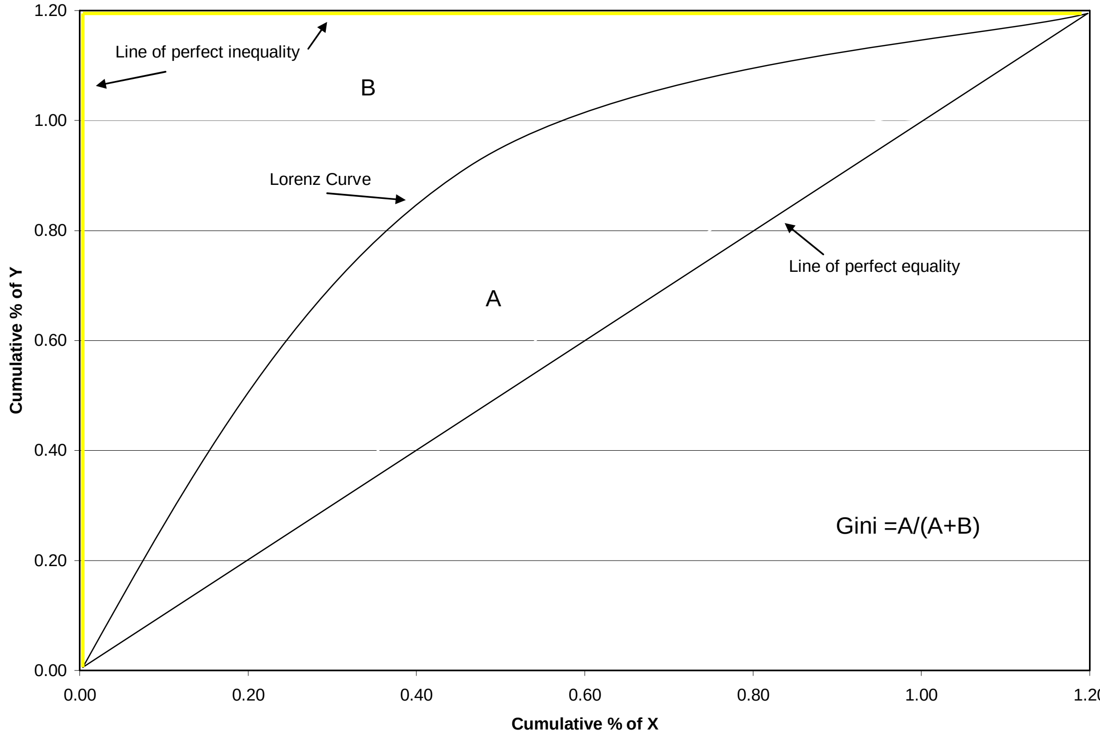

Figure 1-1: Example Gini Coefficient

Table 1-1: Scenario 1 Gini Example (low sprawl)

Tract	Tract Land Area (Y)	Tract Population (X)	Y%	X%	Cumulative Y%	Cumulative X%	($\alpha X_{ij} - \alpha X_{ij-1}$) (A)	($\alpha Y_{ij} + \alpha Y_{ij-1}$) (B)	A*B
1	200	100	0.38	0.07	0.38	0.07	0.07	0.38	0.03
2	150	200	0.28	0.13	0.66	0.20	0.13	1.04	0.14
3	100	300	0.19	0.20	0.85	0.40	0.20	1.51	0.30
4	75	400	0.14	0.27	0.99	0.67	0.27	1.84	0.49
5	5	500	0.01	0.33	1.00	1.00	0.33	1.99	0.66
Total	530	1500	1.00	1.00					
								Gini value=0.381 (low sprawl)	

Table 1-2: Scenario 2 Gini Example (high sprawl)

Tract	Tract Land Area (Y)	Tract Population (X)	Y%	X%	Cumulative Y%	Cumulative X%	($\alpha X_{ij} - \alpha X_{ij-1}$) (A)	($\alpha Y_{ij} + \alpha Y_{ij-1}$) (B)	A*B
1	200	500	0.38	0.33	0.38	0.33	0.33	0.38	0.13
2	150	400	0.28	0.27	0.66	0.60	0.27	1.04	0.28
3	100	300	0.19	0.20	0.85	0.80	0.20	1.51	0.30
4	75	200	0.14	0.13	0.99	0.93	0.13	1.84	0.25
5	5	100	0.01	0.07	1.00	1.00	0.07	1.99	0.13
Total	530	1500	1.00	1.00					
								Gini value=0.918 (high sprawl)	

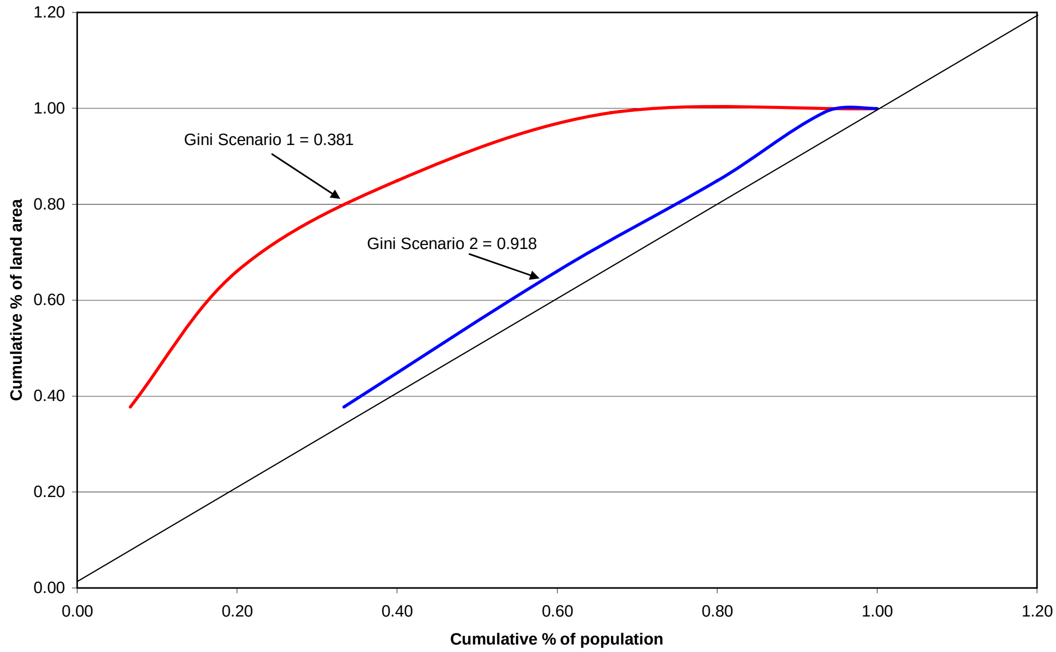

Figure 1-2: Example Sprawl Gini

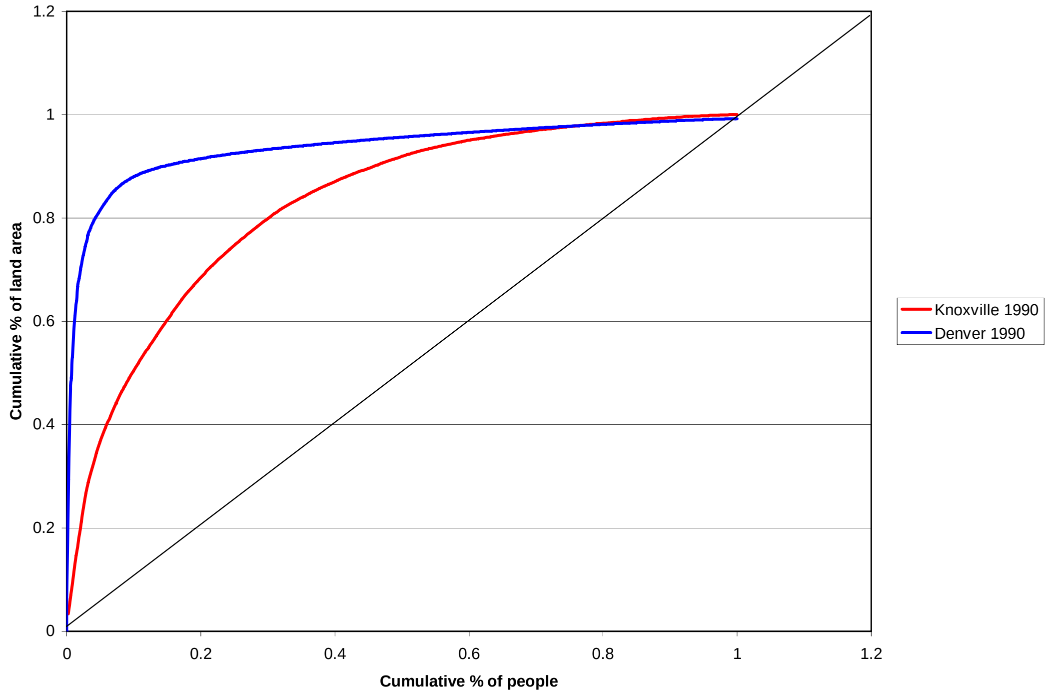

Figure 1-3: Graphical Representation of Sprawl Gini, 1990

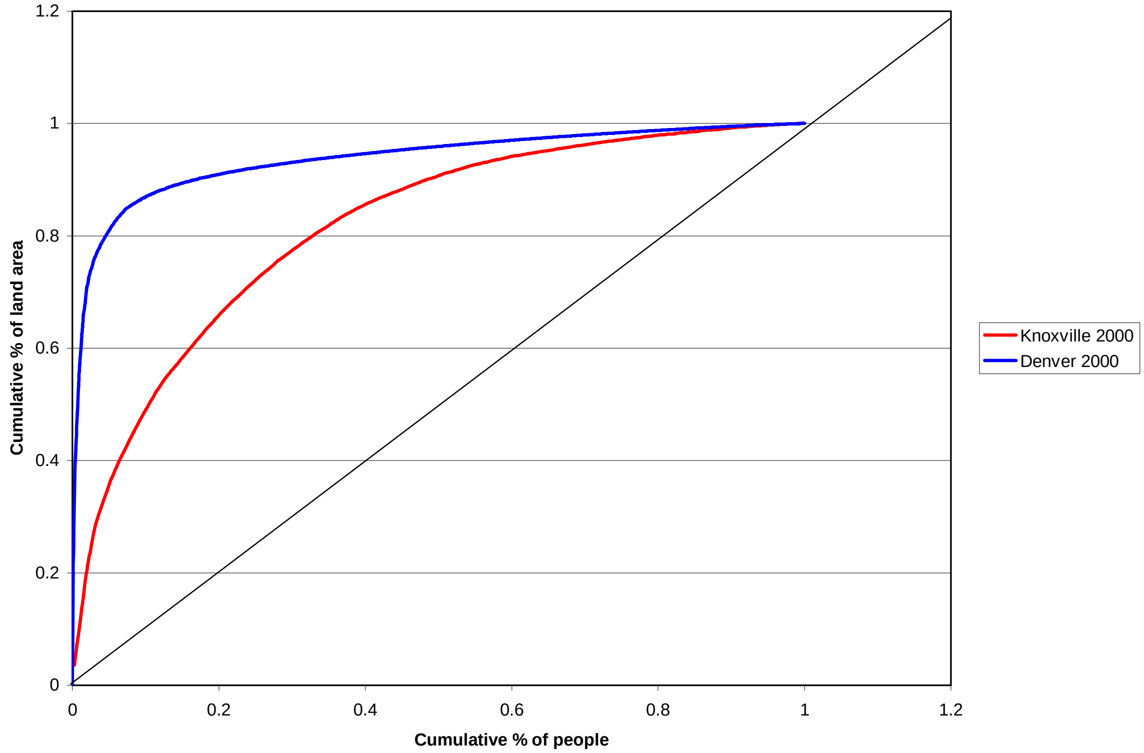

Figure 1-4: Graphical Representation of Sprawl Gini, 2000

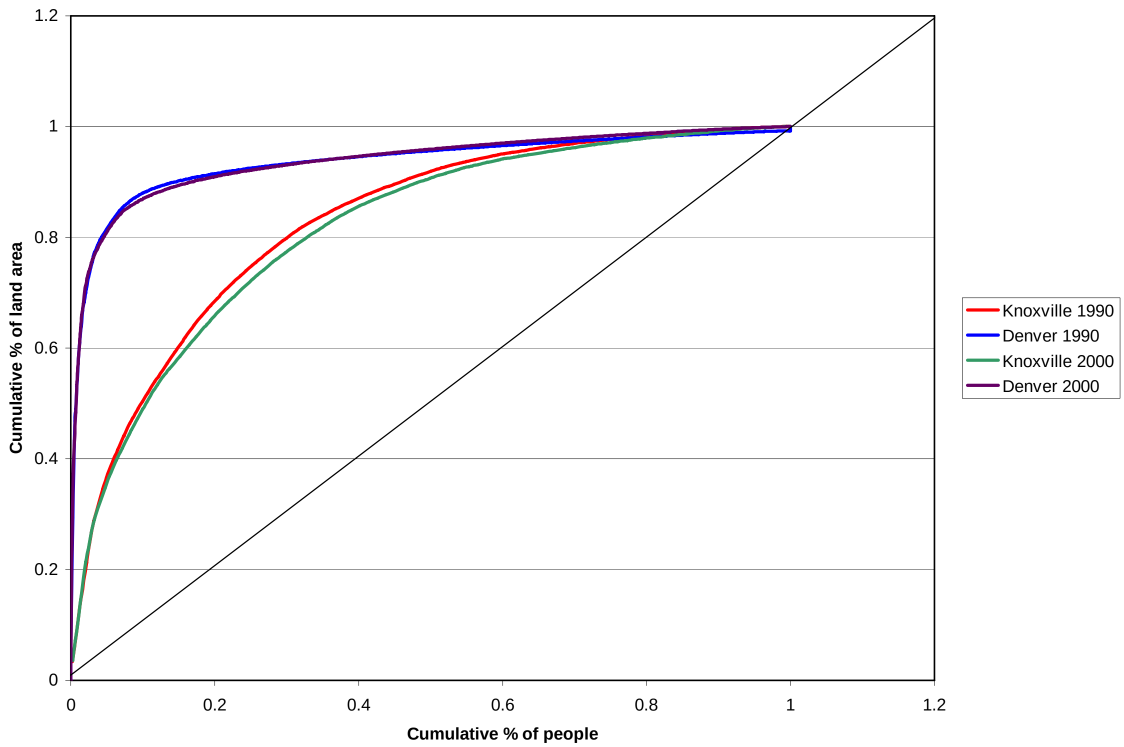

Figure 1-5: Graphical Representation of Sprawl Gini, 1990 and 2000

Table 1-3: Metropolitan Areas, Gini Coefficients, Index of Dissimilarity, and Sprawl Index Values, 1990 and 2000

MSA	Gini 1990	ID 1990	Sprawl Index 1990	Gini 2000	ID 2000	Sprawl Index 2000
Abilene, TX MSA	0.1562	0.2499	0.1904	0.1758	0.2432	0.1598
Albany, GA MSA	0.2318	0.3799	0.2654	0.2635	0.4027	0.2084
Albany--Schenectady--Troy, NY	0.2527	0.3853	0.2523	0.2616	0.3901	0.2534
Albuquerque, NM MSA	0.0773	0.1739	0.1064	0.07	0.1729	0.0928
Alexandria, LA MSA	0.301	0.4284	0.3294	0.3322	0.4646	0.3665
Allentown--Bethlehem--Easton,	0.3074	0.4402	0.2904	0.3175	0.4557	0.267
Altoona, PA MSA	0.3895	0.4968	0.4297	0.3738	0.4805	0.3492
Amarillo, TX MSA	0.0843	0.158	0.102	0.1031	0.194	0.1109
Anchorage, AK MSA	0.0884	0.1893	0.1174	0.0862	0.1725	0.105
Anniston, AL MSA	0.4389	0.5271	0.3314	0.4397	0.5386	0.343
Appleton--Oshkosh--Neenah, WI	0.2804	0.3771	0.2913	0.2827	0.3915	0.2632
Asheville, NC MSA	0.3774	0.5409	0.3071	0.4029	0.5638	0.2832
Athens, GA MSA	0.3541	0.5012	0.2784	0.3697	0.5072	0.2994
Atlanta, GA MSA	0.3398	0.4819	0.2491	0.3724	0.5107	0.248
Auburn--Opelika, AL MSA	0.3403	0.4544	0.2776	0.3729	0.484	0.2827
Austin--San Marcos, TX MSA	0.1969	0.3245	0.1973	0.2163	0.3475	0.189
Bakersfield, CA MSA	0.1306	0.2224	0.1738	0.1113	0.2003	0.1435
Baton Rouge, LA MSA	0.2904	0.4398	0.2317	0.3156	0.4631	0.2074
Beaumont--Port Arthur, TX MSA	0.1935	0.348	0.1447	0.2177	0.3744	0.1738
Bellingham, WA MSA	0.1553	0.2571	0.0332	0.1865	0.2622	0.0384
Benton Harbor, MI MSA	0.4169	0.5381	0.3652	0.4313	0.5509	0.3781
Billings, MT MSA	0.1416	0.1786	0.1545	0.1398	0.2106	0.1865
Biloxi--Gulfport--Pascagoula,	0.2495	0.3551	0.1902	0.2814	0.4084	0.2457
Binghamton, NY MSA	0.3397	0.4693	0.3618	0.3482	0.4685	0.3716
Birmingham, AL MSA	0.2942	0.413	0.2726	0.3266	0.4515	0.2916
Bismarck, ND MSA	0.1388	0.2369	0.1839	0.1297	0.1846	0.1088
Bloomington, IN MSA	0.3122	0.3984	0.2396	0.2879	0.3847	0.2308
Bloomington--Normal, IL MSA	0.2596	0.3183	0.2558	0.2298	0.3291	0.2621
Boise City, ID MSA	0.1642	0.2909	0.1705	0.1924	0.313	0.1616
Brownsville--Harlingen--San B	0.2537	0.395	0.2891	0.2632	0.3987	0.2785
Bryan--College Station, TX MS	0.2088	0.2531	0.1965	0.1979	0.2852	0.2009
Buffalo--Niagara Falls, NY MS	0.246	0.3772	0.2107	0.2681	0.4056	0.2183
Canton--Massillon, OH MSA	0.3011	0.4468	0.2253	0.3083	0.4434	0.209
Casper, WY MSA	0.0415	0.1233	0.0768	0.1157	0.1131	0.1016
Cedar Rapids, IA MSA	0.2258	0.3336	0.1853	0.2347	0.3386	0.1901
Champaign--Urbana, IL MSA	0.2268	0.2925	0.1912	0.2362	0.31	0.2085
Charleston--North Charleston,	0.2349	0.344	0.1958	0.2294	0.3535	0.1998
Charleston, WV MSA	0.3862	0.4996	0.3355	0.3922	0.5045	0.3163
Charlottesville, VA MSA	0.3556	0.474	0.3282	0.3679	0.4901	0.2995
Cheyenne, WY MSA	0.1171	0.1266	0.1068	0.1875	0.1568	0.1379
Chicago, IL PMSA	0.217	0.3644	0.1434	0.2393	0.3966	0.1596
Gary, IN PMSA	0.3302	0.4451	0.1679	0.3201	0.4506	0.1888
Kankakee, IL PMSA	0.3645	0.4722	0.3642	0.3752	0.4864	0.3788

MSA	Gini 1990	ID 1990	Sprawl Index 1990	Gini 2000	ID 2000	Sprawl Index 2000
Kenosha, WI PMSA	0.3088	0.4264	0.34	0.3406	0.4806	0.322
Chico--Paradise, CA MSA	0.2371	0.3748	0.262	0.2317	0.3632	0.2408
Hamilton--Middletown, OH PM	0.3409	0.4713	0.23	0.3669	0.5089	0.2169
Akron, OH PMSA	0.3697	0.5084	0.3075	0.3882	0.5335	0.2895
Cleveland--Lorain--Elyria,	0.2469	0.3811	0.1803	0.2668	0.4008	0.1796
Colorado Springs, CO MSA	0.1256	0.239	0.1359	0.1444	0.2507	0.1426
Columbia, MO MSA	0.3075	0.401	0.2502	0.3281	0.4228	0.2831
Columbia, SC MSA	0.3136	0.4289	0.2437	0.3467	0.4624	0.2595
Columbus, OH MSA	0.2293	0.3518	0.2076	0.2436	0.3677	0.1915
Corpus Christi, TX MSA	0.121	0.2103	0.0797	0.1365	0.2231	0.079
Corvallis, OR MSA	0.2077	0.2621	0.1451	0.2007	0.256	0.1372
Dallas, TX PMSA	0.1891	0.3083	0.1391	0.2032	0.3235	0.1378
Fort Worth--Arlington, TX P	0.2154	0.3389	0.1653	0.2361	0.3589	0.1728
Danville, VA MSA	0.3725	0.5002	0.367	0.4035	0.5393	0.4062
Dayton--Springfield, OH MSA	0.2978	0.4317	0.2073	0.3136	0.4454	0.2165
Daytona Beach, FL MSA	0.2324	0.3559	0.1583	0.2682	0.3951	0.1868
Decatur, AL MSA	0.4094	0.5504	0.3372	0.413	0.555	0.3418
Decatur, IL MSA	0.2731	0.3455	0.2485	0.2809	0.3602	0.2631
Boulder--Longmont, CO PMSA	0.1728	0.3104	0.1668	0.181	0.3234	0.1212
Denver, CO PMSA	0.1282	0.213	0.0814	0.1247	0.2284	0.075
Greeley, CO PMSA	0.1236	0.2835	0.1066	0.1415	0.2839	0.1069
Des Moines, IA MSA	0.1783	0.2951	0.1505	0.1904	0.327	0.1713
Ann Arbor, MI PMSA	0.3357	0.4719	0.3374	0.334	0.473	0.3217
Detroit, MI PMSA	0.2595	0.3845	0.1377	0.2838	0.4121	0.154
Flint, MI PMSA	0.3947	0.5184	0.2774	0.4145	0.5436	0.2785
Dothan, AL MSA	0.3657	0.5032	0.3404	0.4028	0.5375	0.4145
Dover, DE MSA	0.4231	0.5631	0.2783	0.4173	0.5424	0.3192
Dubuque, IA MSA	0.2456	0.3262	0.2508	0.2468	0.3407	0.2652
Eau Claire, WI MSA	0.3276	0.4202	0.3428	0.3272	0.4269	0.317
El Paso, TX MSA	0.1735	0.2634	0.1085	0.1956	0.3199	0.1306
Elkhart--Goshen, IN MSA	0.4169	0.5174	0.2389	0.4169	0.5202	0.2417
Elmira, NY MSA	0.3008	0.4174	0.2845	0.3149	0.4284	0.2929
Enid, OK MSA	0.2223	0.2537	0.2215	0.241	0.3597	0.2249
Erie, PA MSA	0.2555	0.3576	0.2485	0.2608	0.363	0.2582
Eugene--Springfield, OR MSA	0.141	0.2615	0.1462	0.1318	0.2489	0.1452
Fayetteville, NC MSA	0.3214	0.4477	0.1452	0.3402	0.4733	0.1687
Fayetteville--Springdale--Rog	0.3733	0.5092	0.3503	0.3606	0.4928	0.3117
Flagstaff, AZ--UT MSA	0.2265	0.3108	0.2858	0.1918	0.32	0.2795
Florence, AL MSA	0.3829	0.5287	0.3153	0.3899	0.5337	0.4007
Florence, SC MSA	0.4461	0.5597	0.3649	0.4464	0.5532	0.357
Fort Collins--Loveland, CO MS	0.095	0.2101	0.0932	0.1153	0.2284	0.1189
Fort Myers--Cape Coral, FL MSA	0.289	0.434	0.2247	0.3442	0.4951	0.2438
Fort Pierce--Port St. Lucie,	0.2039	0.3326	0.1139	0.2272	0.3399	0.1594
Fort Walton Beach, FL MSA	0.1762	0.2463	0.1422	0.1828	0.2576	0.1314
Fort Wayne, IN MSA	0.3027	0.4124	0.2705	0.3061	0.4112	0.2586
Fresno, CA MSA	0.1086	0.2369	0.1373	0.1092	0.2391	0.1553

MSA	Gini 1990	ID 1990	Sprawl Index 1990	Gini 2000	ID 2000	Sprawl Index 2000
Gadsden, AL MSA	0.443	0.5609	0.3094	0.4843	0.5993	0.3526
Gainesville, FL MSA	0.2967	0.3798	0.2294	0.2779	0.3722	0.2254
Glens Falls, NY MSA	0.3991	0.5681	0.4134	0.4211	0.5773	0.4227
Goldsboro, NC MSA	0.5041	0.615	0.5316	0.5417	0.671	0.4439
Grand Junction, CO MSA	0.1064	0.1874	0.1451	0.1117	0.1515	0.1069
Grand Rapids--Muskegon--Holla	0.3267	0.4507	0.2834	0.3381	0.4593	0.2835
Great Falls, MT MSA	0.14	0.1701	0.1404	0.1371	0.2031	0.1741
Green Bay, WI MSA	0.2566	0.3636	0.1741	0.2822	0.3895	0.201
Greensboro--Winston-Salem--Hi	0.3858	0.5248	0.3123	0.4022	0.5364	0.3163
Greenville, NC MSA	0.395	0.5036	0.2854	0.3723	0.4911	0.3023
Greenville--Spartanburg--Ande	0.4074	0.5489	0.3051	0.4367	0.5731	0.3315
Harrisburg--Lebanon--Carlisle	0.329	0.4699	0.3217	0.3239	0.4583	0.3168
Hattiesburg, MS MSA	0.3307	0.4698	0.2877	0.3448	0.4931	0.3695
Hickory--Morganton--Lenoir, N	0.4721	0.6036	0.3089	0.4619	0.5999	0.2713
Honolulu, HI MSA	0.2918	0.4244	0.2197	0.2579	0.4191	0.2039
Houma, LA MSA	0.3117	0.4549	0.3282	0.308	0.4278	0.2721
Brazoria, TX PMSA	0.3446	0.52	0.2146	0.3494	0.5043	0.2633
Galveston--Texas City, TX P	0.3314	0.4986	0.2632	0.3452	0.4802	0.2177
Houston, TX PMSA	0.2005	0.3117	0.1221	0.2102	0.3359	0.1403
Huntsville, AL MSA	0.3485	0.4595	0.3422	0.3722	0.4973	0.3399
Indianapolis, IN MSA	0.2578	0.3746	0.2212	0.2734	0.4005	0.2071
Iowa City, IA MSA	0.2574	0.3327	0.2541	0.3039	0.3852	0.3067
Jackson, MI MSA	0.4244	0.527	0.3048	0.4362	0.5503	0.3257
Jackson, MS MSA	0.2409	0.3594	0.2124	0.2537	0.3718	0.1966
Jackson, TN MSA	0.3382	0.4418	0.3545	0.332	0.4246	0.3101
Jacksonville, FL MSA	0.2332	0.3417	0.1616	0.2502	0.3657	0.1895
Jacksonville, NC MSA	0.3585	0.4225	0.282	0.3261	0.4443	0.2445
Jamestown, NY MSA	0.3947	0.5063	0.4138	0.4051	0.5217	0.4292
Janesville--Beloit, WI MSA	0.3142	0.4667	0.3962	0.3107	0.4625	0.3589
Johnstown, PA MSA	0.4117	0.565	0.4148	0.4315	0.5821	0.4158
Jonesboro, AR MSA	0.3713	0.4846	0.2583	0.3681	0.4686	0.2417
Joplin, MO MSA	0.3357	0.4489	0.3128	0.3441	0.458	0.3218
Kalamazoo--Battle Creek, MI M	0.3452	0.4818	0.2973	0.357	0.4909	0.3154
Killeen--Temple, TX MSA	0.2571	0.421	0.2277	0.2595	0.4107	0.2015
Knoxville, TN MSA	0.346	0.5009	0.2947	0.3692	0.5253	0.2858
Kokomo, IN MSA	0.3377	0.4549	0.3342	0.3443	0.4682	0.3478
Lafayette, LA MSA	0.2796	0.4378	0.2562	0.2769	0.4309	0.2478
Lafayette, IN MSA	0.2452	0.3294	0.251	0.2416	0.3351	0.2567
Lake Charles, LA MSA	0.2336	0.3488	0.2074	0.2663	0.404	0.2293
Lakeland--Winter Haven, FL MS	0.3048	0.424	0.2324	0.2849	0.4106	0.2015
Lancaster, PA MSA	0.4535	0.574	0.3929	0.4608	0.5819	0.3757
Lansing--East Lansing, MI MSA	0.2907	0.3812	0.265	0.3093	0.4011	0.2756
Laredo, TX MSA	0.058	0.0913	0.0785	0.135	0.1521	0.1299
Las Cruces, NM MSA	0.2448	0.398	0.3086	0.1641	0.3066	0.1726
Lawrence, KS MSA	0.2305	0.3064	0.1686	0.2257	0.3041	0.22
Lawton, OK MSA	0.2322	0.3585	0.2686	0.2561	0.3761	0.3016

MSA	Gini 1990	ID 1990	Sprawl Index 1990	Gini 2000	ID 2000	Sprawl Index 2000
Lexington, KY MSA	0.2401	0.3465	0.2318	0.2432	0.3526	0.201
Lima, OH MSA	0.353	0.4804	0.3199	0.3787	0.5007	0.3092
Lincoln, NE MSA	0.1349	0.1957	0.1106	0.1375	0.1991	0.1104
Little Rock--North Little Roc	0.2452	0.3959	0.2143	0.2609	0.4114	0.2305
Longview--Marshall, TX MSA	0.3623	0.4867	0.3037	0.3876	0.5155	0.3299
Los Angeles--Long Beach, CA	0.1935	0.3145	0.0741	0.1858	0.3092	0.0672
Orange County, CA PMSA	0.3788	0.5148	0.1425	0.3902	0.5311	0.1534
Riverside--San Bernardino,	0.0648	0.1646	0.0566	0.0597	0.156	0.0726
Ventura, CA PMSA	0.1292	0.2695	0.1092	0.1238	0.2658	0.1264
Lubbock, TX MSA	0.1438	0.2242	0.1206	0.1602	0.2522	0.1524
Lynchburg, VA MSA	0.3761	0.5097	0.3925	0.3911	0.5328	0.3849
Macon, GA MSA	0.2592	0.4195	0.2466	0.2736	0.4314	0.208
Madison, WI MSA	0.2348	0.3591	0.231	0.2469	0.3678	0.2066
Mansfield, OH MSA	0.3484	0.4761	0.254	0.3542	0.4869	0.2639
McAllen--Edinburg--Mission, T	0.2416	0.4067	0.1893	0.2561	0.407	0.1144
Medford--Ashland, OR MSA	0.1596	0.2853	0.1993	0.1506	0.2716	0.1854
Melbourne--Titusville--Palm B	0.2039	0.3413	0.0938	0.2397	0.3544	0.1157
Merced, CA MSA	0.2172	0.3705	0.2042	0.1663	0.3087	0.1806
Fort Lauderdale, FL PMSA	0.1999	0.3109	0.0336	0.2229	0.3136	0.0403
Miami, FL PMSA	0.128	0.2194	0.0479	0.1326	0.2293	0.0436
Milwaukee--Waukesha, WI PMS	0.2686	0.4072	0.2037	0.3032	0.4422	0.2199
Racine, WI PMSA	0.323	0.4252	0.2368	0.348	0.4543	0.2633
Missoula, MT MSA	0.1943	0.2637	0.2255	0.2252	0.3293	0.2575
Mobile, AL MSA	0.236	0.3862	0.2476	0.2824	0.4422	0.2577
Modesto, CA MSA	0.13	0.2315	0.1458	0.1199	0.2188	0.1247
Monroe, LA MSA	0.3331	0.4389	0.316	0.3656	0.4797	0.3571
Montgomery, AL MSA	0.2239	0.342	0.2402	0.2434	0.3783	0.2776
Muncie, IN MSA	0.3558	0.4589	0.3312	0.3677	0.4694	0.2952
Myrtle Beach, SC MSA	0.3737	0.4919	0.2928	0.3877	0.5016	0.3113
Naples, FL MSA	0.119	0.2122	0.0921	0.1208	0.2154	0.0712
Nashville, TN MSA	0.3032	0.432	0.2444	0.3226	0.449	0.2443
New Orleans, LA MSA	0.1194	0.2359	0.1242	0.1238	0.2421	0.1196
Bergen--Passaic, NJ PMSA	0.4199	0.5659	0.254	0.4164	0.5675	0.2661
Dutchess County, NY PMSA	0.405	0.5425	0.2924	0.4278	0.5645	0.3134
Jersey City, NJ PMSA	0.3703	0.496	0.1663	0.3776	0.503	0.1622
Middlesex--Somerset--Hunter	0.3464	0.469	0.2237	0.361	0.4924	0.2408
Monmouth--Ocean, NJ PMSA	0.379	0.5152	0.2126	0.3882	0.5281	0.2105
Nassau--Suffolk, NY PMSA	0.4166	0.5503	0.2055	0.4228	0.5557	0.2131
New York, NY PMSA	0.2109	0.3332	0.1181	0.1845	0.3305	0.1192
Newark, NJ PMSA	0.2445	0.3895	0.1914	0.2529	0.3955	0.1816
Trenton, NJ PMSA	0.3751	0.5092	0.2343	0.4186	0.5501	0.2608
Ocala, FL MSA	0.3893	0.5428	0.3116	0.4152	0.56	0.2668
Odessa--Midland, TX MSA	0.1252	0.1937	0.1118	0.1275	0.2206	0.1394
Oklahoma City, OK MSA	0.1759	0.2948	0.1718	0.1872	0.3096	0.189
Orlando, FL MSA	0.1933	0.3244	0.1363	0.2079	0.3443	0.1611
Owensboro, KY MSA	0.3489	0.4258	0.3012	0.3701	0.4395	0.2972

MSA	Gini 1990	ID 1990	Sprawl Index 1990	Gini 2000	ID 2000	Sprawl Index 2000
Panama City, FL MSA	0.2156	0.2902	0.1342	0.2541	0.3068	0.1507
Pensacola, FL MSA	0.2019	0.3343	0.1386	0.2271	0.3499	0.1695
Peoria--Pekin, IL MSA	0.2593	0.3751	0.2344	0.2747	0.3927	0.248
Atlantic--Cape May, NJ PMSA	0.3404	0.4894	0.3103	0.3563	0.5048	0.3236
Vineland--Millville--Bridge	0.3618	0.4924	0.3192	0.352	0.4919	0.3184
Wilmington--Newark, DE--MD	0.2906	0.428	0.2078	0.3251	0.4598	0.2141
Phoenix--Mesa, AZ MSA	0.0597	0.1387	0.0611	0.0664	0.1543	0.071
Pine Bluff, AR MSA	0.2176	0.381	0.227	0.2277	0.3939	0.1845
Pittsburgh, PA MSA	0.286	0.4264	0.2447	0.2978	0.4367	0.2528
Pocatello, ID MSA	0.1338	0.1939	0.1408	0.1407	0.1945	0.1429
Salem, OR PMSA	0.2203	0.3996	0.2209	0.1849	0.3541	0.1832
Provo--Orem, UT MSA	0.0671	0.1555	0.0841	0.077	0.1796	0.0704
Pueblo, CO MSA	0.0536	0.1328	0.0559	0.0854	0.1516	0.0927
Punta Gorda, FL MSA	0.2067	0.3026	0.1167	0.2193	0.3375	0.1484
Raleigh--Durham--Chapel Hill,	0.3332	0.4743	0.2871	0.3499	0.4964	0.2738
Rapid City, SD MSA	0.1295	0.157	0.1056	0.2521	0.2026	0.0965
Reading, PA MSA	0.3827	0.5156	0.38	0.3875	0.5253	0.38
Redding, CA MSA	0.186	0.2433	0.1584	0.1658	0.2324	0.1482
Reno, NV MSA	0.0498	0.1011	0.0385	0.0467	0.1118	0.0345
Richland--Kennewick--Pasco, W	0.097	0.2205	0.102	0.1054	0.224	0.101
Richmond--Petersburg, VA MSA	0.2256	0.3366	0.177	0.243	0.3535	0.1687
Roanoke, VA MSA	0.2077	0.3337	0.2238	0.2236	0.352	0.2172
Rochester, MN MSA	0.2671	0.381	0.1387	0.2256	0.3191	0.1901
Rochester, NY MSA	0.2865	0.3972	0.2822	0.2918	0.4053	0.2858
Rockford, IL MSA	0.2503	0.3641	0.2382	0.2604	0.3774	0.2488
Rocky Mount, NC MSA	0.4073	0.5231	0.3273	0.432	0.5574	0.3849
Sacramento, CA PMSA	0.1238	0.2451	0.1256	0.126	0.2417	0.1136
Yolo, CA PMSA	0.1475	0.2247	0.1565	0.1468	0.2238	0.1544
Saginaw--Bay City--Midland, M	0.352	0.4724	0.3654	0.3605	0.4915	0.3923
St. Cloud, MN MSA	0.3607	0.5015	0.3338	0.3771	0.5075	0.3655
St. Joseph, MO MSA	0.1925	0.3023	0.1899	0.2131	0.3156	0.2077
Salinas, CA MSA	0.1172	0.2604	0.1547	0.1009	0.2402	0.1346
Salt Lake City--Ogden, UT MSA	0.2067	0.3275	0.1428	0.2865	0.3211	0.1187
San Angelo, TX MSA	0.1599	0.1823	0.1299	0.225	0.1812	0.1041
San Antonio, TX MSA	0.1612	0.2495	0.1158	0.1863	0.2898	0.1476
San Diego, CA MSA	0.1332	0.238	0.0942	0.1207	0.2337	0.0935
Oakland, CA PMSA	0.2331	0.3687	0.1248	0.2472	0.3893	0.1386
San Francisco, CA PMSA	0.1448	0.2752	0.0898	0.1369	0.2725	0.0933
San Jose, CA PMSA	0.1572	0.2681	0.0753	0.1541	0.2603	0.0733
Santa Cruz--Watsonville, CA	0.2667	0.4233	0.2925	0.2451	0.3867	0.2362
Santa Rosa, CA PMSA	0.2547	0.4106	0.2143	0.2155	0.3725	0.2043
Vallejo--Fairfield--Napa, C	0.1382	0.253	0.1365	0.1416	0.2512	0.1389
San Luis Obispo--Atascadero--	0.1467	0.2452	0.1631	0.1574	0.2575	0.1464
Santa Barbara--Santa Maria--L	0.0766	0.1941	0.1276	0.0744	0.1795	0.1115
Santa Fe, NM MSA	0.2382	0.3487	0.2441	0.2472	0.3785	0.2493
Sarasota--Bradenton, FL MSA	0.171	0.2759	0.0727	0.1912	0.3054	0.0877

MSA	Gini 1990	ID 1990	Sprawl Index 1990	Gini 2000	ID 2000	Sprawl Index 2000
Savannah, GA MSA	0.239	0.3837	0.2175	0.2737	0.493	0.2673
Scranton--Wilkes-Barre--Hazle	0.2836	0.4136	0.2859	0.2953	0.4259	0.2844
Bremerton, WA PMSA	0.4023	0.5503	0.3745	0.4358	0.5791	0.3589
Olympia, WA PMSA	0.3557	0.4581	0.3029	0.3365	0.4559	0.2506
Seattle--Bellevue--Everett,	0.1379	0.261	0.1089	0.1459	0.2714	0.1081
Tacoma, WA PMSA	0.1651	0.3157	0.1225	0.1713	0.3108	0.1192
Sharon, PA MSA	0.439	0.5616	0.4229	0.4469	0.5715	0.4357
Sheboygan, WI MSA	0.3512	0.4927	0.2937	0.3508	0.4997	0.2704
Sherman--Denison, TX MSA	0.4345	0.5116	0.4088	0.4654	0.5579	0.455
Shreveport--Bossier City, LA	0.252	0.3868	0.288	0.2485	0.3805	0.2491
Sioux Falls, SD MSA	0.2228	0.3171	0.2818	0.2184	0.3272	0.2835
South Bend, IN MSA	0.2707	0.4061	0.2284	0.2832	0.4141	0.1786
Spokane, WA MSA	0.1435	0.2531	0.132	0.1592	0.2828	0.1311
Springfield, IL MSA	0.2502	0.3882	0.2758	0.261	0.4033	0.2577
Springfield, MO MSA	0.2845	0.4106	0.2496	0.2955	0.4078	0.2908
State College, PA MSA	0.3109	0.4397	0.3118	0.3036	0.4415	0.3141
Stockton--Lodi, CA MSA	0.1494	0.2494	0.1649	0.1496	0.2496	0.1509
Sumter, SC MSA	0.3333	0.4864	0.3046	0.3985	0.5289	0.4017
Syracuse, NY MSA	0.2848	0.4056	0.3023	0.3013	0.4235	0.3181
Tallahassee, FL MSA	0.3013	0.4091	0.3094	0.3178	0.4229	0.289
Tampa--St. Petersburg--Clearw	0.2885	0.41	0.1764	0.3038	0.4365	0.1758
Terre Haute, IN MSA	0.3345	0.4806	0.361	0.3364	0.4696	0.3297
Toledo, OH MSA	0.217	0.3382	0.1795	0.2299	0.3512	0.185
Topeka, KS MSA	0.2284	0.3746	0.1902	0.2671	0.4023	0.2083
Tucson, AZ MSA	0.0654	0.1524	0.0966	0.0563	0.1499	0.0784
Tulsa, OK MSA	0.1773	0.3171	0.2175	0.1745	0.3181	0.1968
Tuscaloosa, AL MSA	0.2684	0.3589	0.2396	0.2522	0.3902	0.2529
Tyler, TX MSA	0.3874	0.5223	0.3519	0.3992	0.529	0.3752
Utica--Rome, NY MSA	0.2375	0.4074	0.2899	0.2599	0.4326	0.3001
Victoria, TX MSA	0.2407	0.3441	0.3116	0.2638	0.3809	0.3483
Visalia--Tulare--Porterville,	0.131	0.2747	0.1348	0.1171	0.2632	0.1436
Waco, TX MSA	0.2686	0.3652	0.2664	0.2945	0.3904	0.2916
Baltimore, MD PMSA	0.2647	0.4016	0.209	0.2801	0.4187	0.1995
Hagerstown, MD PMSA	0.4176	0.5391	0.3835	0.4155	0.5405	0.381
Waterloo--Cedar Falls, IA MSA	0.2268	0.336	0.2291	0.2255	0.3483	0.2414
Wausau, WI MSA	0.3907	0.5075	0.3835	0.3922	0.5099	0.3499
West Palm Beach--Boca Raton,	0.1386	0.2581	0.085	0.1596	0.268	0.085
Wichita, KS MSA	0.1646	0.2711	0.1718	0.1696	0.2816	0.1801
Wichita Falls, TX MSA	0.14	0.2277	0.0849	0.1404	0.2222	0.1015
Williamsport, PA MSA	0.2448	0.4116	0.2915	0.2513	0.4208	0.3011
Wilmington, NC MSA	0.2997	0.4545	0.273	0.3124	0.4594	0.2913
Yakima, WA MSA	0.1585	0.2741	0.0987	0.1389	0.2723	0.1175
York, PA MSA	0.4601	0.5939	0.3794	0.462	0.5829	0.3608
Youngstown--Warren, OH MSA	0.3432	0.4567	0.2768	0.3598	0.4759	0.3016
Yuba City, CA MSA	0.233	0.3342	0.2151	0.2206	0.3298	0.2104
Yuma, AZ MSA	0.0382	0.1325	0.0584	0.0353	0.1178	0.0438

Table 1-4:Correlation Coefficients of the three sprawl measures

	GINI	ID	SI
GINI	1.000		
ID	0.969	1.000	
SI	0.846	0.831	1.000

Table 1-5: MSAs with the lowest sprawl values: 1990 and 2000

MSA	Gini 1990	Gini 2000	GID 1990	GID 2000	Sprawl Index 1990	Sprawl Index 2000
Yuma, AZ MSA	0.038	0.035	0.133	0.118	0.058	0.044
Casper, WY MSA	0.042	0.116	0.123	0.113	0.077	0.102
Reno, NV MSA	0.049	0.047	0.101	0.112	0.039	0.035
Pueblo, CO MSA	0.053	0.085	0.133	0.152	0.056	0.093
Laredo, TX MSA	0.058	0.135	0.091	0.152	0.079	0.129
Phoenix-Mesa, AZ MSA	0.059	0.066	0.139	0.154	0.061	0.071
Riverside-San Bernadino, CA MSA	0.065	0.059	0.165	0.156	0.057	0.073
Tucson, AZ MSA	0.065	0.056	0.152	0.150	0.097	0.078
Provo-Orem, UT MSA	0.067	0.077	0.156	0.179	0.084	0.070
Santa Barbara-Santa Maria-Lompoc, CA MSA	0.077	0.074	0.194	0.179	0.128	0.112

Table 1-6: MSAs with the highest sprawl values: 1990 and 2000

MSA	Gini 1990	Gini 2000	GID 1990	GID 2000	Sprawl Index 1990	Sprawl Index 2000
Goldsboro, NC MSA	0.504	0.542	0.615	0.671	0.532	0.444
Hickory-Morganton-Lenoir, NC MSA	0.472	0.462	0.604	0.600	0.309	0.271
York, PA MSA	0.460	0.462	0.594	0.583	0.379	0.361
Lancaster, PA MSA	0.453	0.461	0.574	0.582	0.393	0.376
Florence, SC MSA	0.446	0.446	0.559	0.553	0.365	0.357
Gadsden, AL MSA	0.443	0.484	0.561	0.599	0.309	0.353
Sharon, PA MSA	0.439	0.447	0.562	0.572	0.423	0.436
Anniston, AL MSA	0.439	0.439	0.527	0.539	0.331	0.343
Sherman-Denison, TX MSA	0.435	0.465	0.512	0.558	0.409	0.455
Jackson, MI MSA	0.424	0.436	0.527	0.550	0.305	0.326

Table 1-7: Variable Description and Source Notes

Variable	Expected Effect	Source	Definition
Gini Coefficient (G) Index of Disimilarity (ID) Sprawl Index (SI)	n/a	U.S. Census Gazetteer Files-2000 1990 Census of Population and Housing Public Law 94-171-1990	See text
MSA Effective property tax rate	+/-	U.S. Census Summary File 3-2000, 1990	The amount of property tax paid by the homeowner, divided by the reported value of their home, in the year prior to the Census.[27]
MSA population MSA area	+ +/-	U.S. Census Summary File 1-2000, 1990	Total population in the MSA, measured in 1000s, square miles in MSA
MSA agricultural land value/acre ($1000s)	-	U.S. Census of Agriculture, 1997, 1987	Value of agricultural land per acre, measured in $1000s
Central City non-white population share	+	U.S. Census Summary File 3-2000, 1990	The number of non-white people in the central city, divided by the total central city population
State-level Tax Burden	+/-	U.S. Census of Governments, Bureau of Economic Analysis, 1997, 1987	Total Tax Revenue divided by Total Personal Income in the State
Average home price in the MSA	-	U.S. Census Summary File 3-2000, 1990	Total value of homes in the MSA (as reported by homeowners), divided by the total number of homes
MSA personal income	+	Bureau of Economic Analysis, 1997, 1987	Total personal income in the MSA, measured in $1000s
Share of the population in public school	+	U.S. Census Summary File 1-2000, 1990	Share of the population under age 18 attending public school
Percent change in population, 10 year	+/-	Calculated from U.S. Census Summary File 1-2000, 1990	10 year population change in the MSA
Total number of municipalities in the MSA	+	U.S. Census of Governments, Bureau of Economic Analysis, 1997, 1987	Total number of municipalities in the MSA
Standard Deviation of property tax rate	+	See Gini, ID, Sprawl Index	MSA specific standard deviation of property tax rate

[27] The amount of property tax paid in 1989 was combined with several other fees and payments, making the isolation of the property tax paid impossible. In order to have an estimate of property taxes paid in 1989 to calculate an effective tax rate, I derived the amount of property taxes paid as a share of total property tax revenue, using the values from Census 2000 and the Census of Governments data for 1987 and 1997.

Table 1-8: Instrumental Variables Description and Source Notes

Variable	Expected Effect on Property Tax Rate	Source	Definition
Central City poverty rate	+/-	U.S. Census Summary File 3-2000, 1990	The number of people considered in poverty in the central city, divided by the total central city population
State share of state and local tax revenue	-	U.S. Census of Governments, Bureau of Economic Analysis, 1997, 1987	State portion of state and local tax revenue
MSA intergovernmental revenue from the state	-	U.S. Census of Governments, Bureau of Economic Analysis, 1997, 1987	Amount of intergovernmental revenue transferred from the state to the MSA

Table 1-9: Summary Statistics

	1990				2000			
Variable	**Mean**	**Std Deviation**	**Minimum**	**Maximum**	**Mean**	**Std Deviation**	**Minimum**	**Maximum**
Gini Coefficient	0.259	0.100	0.038	0.504	0.270	0.102	0.0352	0 .541
Index of Dissimilarity	0.376	0.115	0.913	0.615	0.388	0.117	0.112	0.671
Sprawl Index	0.225	0.093	0.033	0.532	0.227	0.093	0.035	0.455
MSA population (1000s)	612	1,048	57	8,863	700	1,174	58	9,519
MSA area (1000s square miles)	2.262	3.288	0.047	39.369	2.262	3.288	0.047	39.369
Central City non-white population share	0.25	0.17	0.02	0.93	0.311	0.186	0.035	0.993
Average home price in the MSA ($1000s)	91.47	53.75	31.82	353.44	138.067	64.463	66.759	547.206
State share of state and local tax revenue	0.608	0.067	0.491	0.803	0.635	0.058	0.536	0.821
MSA Effective property tax rate	0.095	0.062	0.007	0.314	0.112	0.051	0.025	0.264
MSA agricultural land value/acre ($1000s)	5.25	14.18	0	169.10	8.12	21.735	0	320.082
MSA personal income ($1000s)	10,127	19,769	792	176,272	17,938	33,609	1,247	299,412
Municipalities	93.49	125.78	4	1278	99.95	133.36	1	1456
Share of population in public school	0.646	0.076	0.177	0.947	0.707	0.043	0.256	0.810
Standard deviation of property tax rate	0.080	0.0155	0	0.139	0.069	0.0102	0	0.0653
Property taxes as share of total tax revenue	0.756	0.162	0.242	0.994	0.739	0.159	0.253	0.989
Sales taxes as share of total tax revenue	0.174	0.149	0	0.608	0.186	0.155	0	0.642
State-level Tax Burden	0.060	0.011	0.045	0.102	0.0644	0.011	0.047	0.0999
Central City poverty rate	0.183	0.068	0	0.580	0.177	0.057	0.059	0.469
State share of state and local tax revenue	0.608	0.067	0.491	0.803	0.635	0.058	0.536	0.821
MSA intergovernmental revenue from the state	0.337	0.872	0.016	9.534	0.634	1.559	0.041	17.03

Table 1-10: Fixed Effects IV Regression Model-sprawl-Gini sprawl measure

	First stage Effective Property tax rate	Second Stage Gini Measure
MSA Effective property tax rate	-	**-0.188**** (0.078)
MSA population	0.008 (0.029)	0.013 (0.015)
MSA agricultural land value/acre ($1000s)	-0.0004 (0.0002)	-0.00007 (0.0001)
Central City non-white population share	**0.064*** (0.037)	-0.020 (0.021)
State-level Tax Burden	**-0.694**** (0.293)	**-1.062***** (0.180)
Average home price in the MSA	**0.479***** (0.081)	**-0.142***** (0.054)
MSA personal income	**1.068***** (0.319)	0.036 (0.201)
Share of the population in public school	**-0.057*** (0.029)	-0.023 (0.016)
Percent change in population, 10 year	**-0.084***** (0.024)	**-0.023*** (0.015)
Total number of municipalities in the MSA	-0.014 (0.203)	**0.186*** (0.110)
Standard Deviation of property tax rate	**0.005***** (0.002)	**0.002*** (0.001)
Central City poverty rate	**0.003***** (0.001)	-
State share of state and local tax revenue	**-0.317***** (0.075)	-
MSA-level of intergovernmental revenue from the state	**-0.014**** (0.006)	-
Constant	**0.393***** (0.064)	**0.377***** (0.028)
R-squared within	0.458	0.282

N=269
Regression includes year fixed effects
Standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 1-11: Elasticities-Dependent variable-sprawl Gini

	Fixed Effects
MSA Effective property tax rate	**-0.073**
MSA population	0.029
MSA agricultural land value/acre ($1000s)	-0.002
Central City non-white population share	-0.022
State-level Tax Burden	**-0.252**
Average home price in the MSA	**-0.063**
MSA personal income	-0.002
Share of the population in public school	-0.060
Percent change in population, 10 year	**-0.012**
Total number of municipalities in the MSA	**0.066**
Standard Deviation of property tax rate	**0.006**
MSA area	**-**

Table 1-12: IV Regression results, 1990 and 2000, Gini sprawl measure

	1990-IV First Stage	1990-IV Second Stage	2000-IV First Stage	2000-IV Second Stage
MSA Effective property tax rate	**--**	**-0.982*** (0.286)**	**--**	**-1.519*** (0.387)**
MSA population	0.004 (0.002)	-0.012 (0.053)	0.005 (0.0001)	-0.033 (0.041)
MSA agricultural land value/acre ($1000s)	**-0.0004*** (0.0002)	**-0.001***** (0.0004)	**-0.0004**** (0.0002)	**-0.001***** (0.0004)
Central City non-white population share	-0.012 (0.025)	0.034 (0.037)	0.008 (0.016)	0.032 (0.031)
State-level Tax Burden	**1.937***** (0.420)	**1.497***** (0.516)	**1.076**** (0.414)	0.229 (0.581)
Average home price in the MSA	-0.001 (0.001)	-0.210 (0.157)	**-0.0002***** (0.0001)	**-0.286**** (0.126)
MSA personal income	0.035 (0.017)	0.721 (2.836)	0.0001 (0.0003)	1.698 (1.650)
Share of the population in public school	-0.002 (0.015)	0.019 (0.027)	0.013 (0.012)	0.029 (0.030)
Percent change in population, 10 year	-0.014 (0.026)	-0.034 (0.044)	**0.051**** (0.025)	**0.125*** (0.066)
Total number of municipalities in the MSA	-0.0001 (0.0004)	-0.081 (0.064)	-0.0001 (0 .00003)	-0.074 (0.065)
Standard Deviation of property tax rate	0.007 (0.002	0.003 (0.004)	**0.007***** (0.003)	0.003 (0.007)
MSA area	-0.001 (0.001)	**-0.006**** (0.003)	-0.001 (0.001)	-0.008 (0.002)
Central City poverty rate	**-0.004*** (0.005)	**--**	**-0.001*** (0.004)	**--**
State share of state and local tax revenue	**-0.414***** (0.071)	**--**	**-0.387**** (0.074)	**--**
MSA-level of intergovernmental revenue from the state	-0.0001 (-0.0002)	**--**	**-0.008*** (0.0004)	**--**
Constant	**0.258***** (0.037)	**0.381***** (0.061)	**0.388***** (0 .030)	**0.642***** (0.106)
Adjusted R-squared	0.478	0.411	0.601	0.489

N=269
Regressions include dummies indicating Census region
Standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 1-13: Elasticities from IV estimation, sprawl Gini

	1990-elasticity	2000-elasticity
MSA Effective property tax rate	**-0.360**	**-0.630**
MSA population	-0.027	-0.081
MSA agricultural land value/acre ($1000s)	**-0.021**	**-0.032**
Central City non-white population share	0.033	0.038
State-level Tax Burden	**0.349**	0.055
Average home price in the MSA	-0.075	**-0.148**
MSA personal income	0.025	0.103
Share of the population in public school	0.050	0.076
Percent change in population, 10 year	-0.019	**0.059**
Total number of municipalities in the MSA	-0.028	-0.027
Standard Deviation of property tax rate	0.008	0.008
MSA area	**-0.048**	-0.062

Table 1-14: Fixed Effects results by population groupings

	First Stage Population less than 500,000	Second Stage Population less than 500,000	First Stage Population 500,000 and above	Second Stage Population 500,000 and above
MSA Effective property tax rate	--	**-0.134*** (0.076)	**--**	0.015 (0.209)
MSA population	**0.0003*** (0.0002)	0.0002 (0.0001)	**-0.002*** (0.001)	0.0001 (0.0002)
MSA agricultural land value/acre ($1000s)	-0.001 (0.002)	-0.001 (0.001)	-0.004 (0.003)	0.002 (0.002)
Central City non-white population share	**0.068*** (0.038)	-0.029 (0.024)	-0.207 (0.179)	0.111 (0.085)
State-level Tax Burden	-0.3369 (0.383)	**-1.107***** (0.239)	**-1.523**** (0.531)	**-0.725**** (0.288)
Average home price in the MSA	**-0.001***** (0.0001)	**-0.0002***** (0.0001)	**0.001***** (0.0003)	-0.0001 (0.0001)
MSA personal income	0.043 (0.038)	0.009 (0.043)	0.048 (0.025)	0.008 (0.033)
Share of the population in public school	-0.070 (0.037)	-0.030 (0.022)	-0.046 (0.268)	**-0.436***** (0.128)
Percent change in population, 10 year	**-0.057**** (0.029)	-0.012 (0.018)	0.057 (0.074)	-0.013 (0.139)
Total number of municipalities in the MSA	0.0001 (0.0003)	0.002 (0.002)	-0.0002 (0.0004)	-0.0001 (0.0001)
Standard Deviation of property tax rate	0.002 (0.002)	0.001 (0.003)	0.0001 (0.009)	**0.009*** (0.005)
Central City poverty rate	**0.003***** (0.001)	--	**0.002*** (0.001)	--
State share of state and local tax revenue	**-0.386***** (0.092)	--	0.127 (0.141)	--
MSA-level of intergovernmental revenue from the state	**-0.0002***** (0.0001)	--	0.0001 (0.0003)	--
Within R-squared	0.496	0.304	0.934	0.826
N=	198		110	

Regressions include year fixed effects
Standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 1-15: Fixed Effects IV Regression results-Index of Dissimilarity and Sprawl Indicator measures

	First Stage Index of Dissimilarity	Second Stage Index of Dissimilarity	First Stage Sprawl Indicator	Second Stage Sprawl Indicator
MSA Effective property tax rate	--	**-0.142*** (0.084)	**--**	**-0.277**** (0.112)
MSA population	0.00008 (0.00002)	-0.00001 (0.00002)	0.00008 (0.00003)	-0.00007 (0.00002)
MSA agricultural land value/acre ($1000s)	-0.00004 (0.0002)	-0.00004 (0.0001)	-0.00004 (0.0002)	-0.00004 (0.0002)
Central City non-white population share	**0.064*** (0.037)	-.021 (0.023)	**0.064*** (0.037)	0.024 (0.030)
State-level Tax Burden	**-0.694**** (0.293)	**-0.771***** (0.195)	**-0.694***** (0.293)	**-0.649**** (0.258)
Average home price in the MSA	**-0.001***** (0.0001)	**-0.146**** (0.058)	**-0.0005***** (0.0001)	**-0.241***** (0.076)
MSA personal income	**0.0001**** (0.002)	0.133 (0.217)	**0.0001**** (0.001)	0.347 (0.288)
Share of the population in public school	**-0.057*** (0.029)	0.011 (0.018)	**-0.057*** (0.029)	-0.047 (0.023)
Percent change in population, 10 year	**-0.084***** (0.024)	-0.016 (0.015)	**-0.084***** (0.024)	-0.029 (0.021)
Total number of municipalities in the MSA	-0.00001 (0.0002)	0.169 (0.119)	-0.00001 (0.0002)	-0.019 (0.157)
Standard Deviation of property tax rate	**0.005***** (0.002)	0.001 (0.001)	**0.005***** (0.002)	0.002 (0.001)
Central City poverty rate	**0.003 ***** (0.001)	--	**0 .003***** (0.001)	--
State share of state and local tax revenue	**-0.317***** (0.075)	--	**-0.317***** (0.075)	--
MSA-level of intergovernmental revenue from the state	**0.0001***** (0.0006)	--	**-0.0001***** (0.0006)	--
Within R-squared	0.458	0.265	0.459	0.051

N=269
Regressions include year fixed effects
Standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 1-16: Fixed Effect revenue shares regression results

	First Stage Sprawl Gini-property share	Second Stage Sprawl Gini-property share	First Stage Sprawl Gini-sales share	Second Stage Sprawl Gini-sales share
MSA Property Tax Share	--	**-0.207**** (0.088)	**--**	--
MSA Sales Tax Share	--	--	**--**	**0.297**** (0.139)
MSA population	0.0004 (0.00005)	0.00001 (0.00002)	0.0005 (0.00005)	0.00008 (0.00002)
MSA agricultural land value/acre ($1000s)	-0.0002 (0.0003)	-0.0001 (0.0001)	0.0002 (0.0003)	-0.0001 (0.0001)
Central City non-white population share	0.046 (0.061)	-0.020 (0.024)	-0.001 (0.058)	-0.029 (0.025)
State-level Tax Burden	0.194 (0.489)	**-0.882***** (0.169)	-0.313 (0.466)	**-0.828***** (0.186)
Average home price in the MSA	-.0002 (0.0001)	**-0.0001*** (0.0001)	0.0001 (0.0001)	-0.0001 (0.0001)
MSA personal income	0.0008 (0.0007)	0.0006 (0.0003)	0.0007 (0.0004)	0.0008 (0.0003)
Share of the population in public school	0.043 (0.049)	-0.003 0.019)	-0.049 (0.047)	0.003 (0.022)
Percent change in population, 10 year	0.045 (0.040)	0.001 (0.015)	-0.061 (0.038)	0.010 (0.018)
Total number of municipalities in the MSA	-0.00002 (0.0003)	0.0002 (0.0001)	-0.00006 (0.0003)	0.0002 (0.0001)
Standard Deviation of property tax rate	0.003 (0.003)	0.002 (0.001)	-0.002 (0.003)	0.002 (0.001)
Central City poverty rate	**0.003**** (0.001)	--	**-0.002** (0.001)	--
State share of state and local tax revenue	**-0.283**** (0.126)	--	**0.199** (0.120)	--
MSA-level of intergovernmental revenue from the state	-0.00007 (0.0001)	--	-0.00004 (0.0001)	--
Within R-squared	0.174	0.093	0.109	0.039

N=269
Regressions include year fixed effects
Standard errors in parentheses
*significant at 10%, ** significant at 5%, ***significant at 1%

Table 1-17: Census Regions and Component States[28]

Census Region	States
New England	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
Middle Atlantic	New Jersey, New York, Pennsylvania
East North Central	Indiana, Illinois, Michigan, Ohio, Wisconsin
West North Central	Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota
South Atlantic	Delaware, D.C., Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia
East South Central	Alabama, Kentucky, Mississippi, Tennessee
West South Central	Arkansas, Louisiana, Oklahoma, Texas
Mountain	Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming
Pacific	Alaska, California, Hawaii, Oregon, Washington

[28] www.census.gov/geo/www/us_regdiv.pdf

Part 3: Essay 2: The Fiscal Impacts of Sprawl: The Impact on Local Public Service Expenditures

2.A Introduction

As early as the 1930's, the patterns of development that described the location decisions of people began to take on a negative connotation, and the development of suburbs and the exodus of people from the central cities to these outlying areas was described with a new term: sprawl. Earle Draper, the Director of Planning at the Tennessee Valley Authority said in 1937, "Perhaps diffusion is too kind of a word. ... In bursting its bounds, the city actually sprawled and made the countryside ugly...uneconomic [in terms] of services and doubtful social value." While it may be true that sprawling development is indeed ugly, with questionable social value, the work in this chapter focuses on a different outcome of sprawl.

There are a number of consequences commonly linked to urban sprawl, and the list continually grows. Some of the most commonly noted outcomes of sprawl are negative, and although there are positive outcomes associated with sprawl, those are not discussed in this chapter.[29] Such social ills as poor physical health (Sturm and Cohen, 2003); obesity (Plantinga and Bernell, 2007); environmental consequences (Kahn, 2000); and the decrease in a sense of community (Brueckner and Largey, 2006) have all been evaluated as possible consequences of sprawl.

Among various negative outcomes of sprawl are purported effects on local public services. The common perception is that expenditures on a number of different public services including waste management, sewer, roads and utilities are expected to increase in the presence of higher levels of sprawl, although is no clear theoretical reasoning for

[29] For examples of some of the benefits of sprawl, see Gordon and Richardson (1998), Glaeser and Kahn (2003), and Burchell et al. (2005).

this and little empirical support. The response of local governments and planners to the notion that higher degrees of sprawl results in higher expenditures is to encourage smaller, more dense development to decrease public service expenditures. Despite these claims, it is not clear that more densely developed areas are necessarily more cost-efficient in terms of public services.

Sprawl is neither a density nor a population measure, and the possible effects it may have are ambiguous. There are two possible (and opposing) ways that sprawl might influence local public service expenditures. First, sprawl's possible influence on local public services will depend on the service in question. There is no reason to believe that all local public services are impacted similarly and can be lumped together because each service may experience its own unique production, cost, and demand functions. When discussing possible influences on public services, it is best to discuss the different impacts sprawl might have on different types of local public services. For public services where we believe that economies of density[30] might come in to play, we might expect areas with lower levels of sprawl (indicating higher concentrations of people) to experience decreasing per capita expenditure costs.

Although density and the distribution of people are not identical, it is likely that for some public services, where there are greater concentration of residents, we will see lower per capita expenditures. Examples of public services where this hypothesis might prevail include sewer, utilities, and highways. It may be more cost-effective to provide

[30] Economies of density occur where there are cost savings due to higher average density levels; this is the basis for encouraging more densely populated developments. It is also possible, however that diseconomies of density exist, and that public service expenditures rise with higher density levels. Because the presence of economies/diseconomies of density will depend on the type of public service in question, it is necessary to analyze different services separately.

these types of services to areas where the population is more highly concentrated, or in other words, where there is a tighter distribution of people. An area with a low sprawl value might see higher per capita expenditures in other categories of local public services: examples include police and possibly fire. In these two categories of services, areas with high concentrations of residents (and therefore lower sprawl values) may be subject to some of the social conditions often seen in areas with high densities, i.e. higher crime rates, higher poverty rates, etc. To achieve some given, desired level of safety, areas with low sprawl might require more in the way of police and fire expenditures vis-à-vis areas with higher sprawl (or less concentration of people). The opposite effect is also possible, however, if we believe that areas with lower concentrations of residents are more geographically distant from areas of higher concentrations of residents, then we might expect to see higher per capita expenditures for higher levels of sprawl. It may cost more per resident to provide police services to an area that is further out, and where the population is more spread out.

The literature in economics (as well as other fields) has not really examined the question of how sprawl impacts public service expenditures. To my knowledge, there has been no theoretical treatment of the possible relationship between sprawl and expenditures on local public services. Most previous studies have used some measure of average density as a proxy for sprawl. Although there have been case studies and simulations resulting in cost projections based on differing (often hypothesized) levels of sprawl, only a handful of studies have examined how actual sprawl levels (as proxied by average density) impact local public service expenditures.

In this chapter, I examine how sprawl influences different local public service expenditures, distinguishing between current operating and capital expenditures because sprawl may influence these two broad categories differently. Using the three unique measures of sprawl constructed and discussed in detail in the previous chapter (with the sprawl Gini being the main focus), I use publicly available data to empirically test whether sprawl has any influence on expenditures using a cross-sectional approach, in addition to a fixed effects panel model. In addition to sprawl, I also test how average density and population growth influence local public service expenditures.

There are a number of issues requiring clarification and further discussion when addressing the potential impact of sprawl on public services. First, it is necessary to precisely define what is meant by public service expenditures. Because the concept can take on different meanings, and in fact does so within the literature, it is necessary to clarify the concept. It is also necessary to outline the conceptual model illustrating how sprawl (in addition to population growth and average density) may work to influence public service expenditures. Much of the literature does not explicitly define sprawl, but rather uses an average density measure, which proxies not only for sprawl but also for the "harshness" of the environment in which the public service is provided. I provide a discussion of how sprawl may influence different public services with clear links to the previous literature.

Despite the potentially important consequences, there have been very few studies examining the impacts of sprawl on the costs of public services; even fewer have been undertaken with a broad-focus on a large number of areas (in contrast to case studies) using actual data (as opposed to simulations). An important motivation for this chapter is that despite increasing interest, very little is known about how variables related to development patterns such as population, population change, density and sprawl influence public expenditures in the local sector.

The work in this chapter contributes to the existing literature in a number of ways. There is no reason to presume (as is the common belief) that sprawling development patterns result in costlier public services vis-à-vis less sprawled development. In this chapter, I focus on the empirical question of the relationship between sprawl and local public service expenditures, using three unique measures of sprawl, and incorporating two broad theories of explaining public service expenditures in a fixed effects panel framework. In addition to using average density and population measures, I gauge how sprawl influences a number of different public service expenditures, separated into both current operating and capital expenditures. Using data available from the Census of Governments, I am able to assess how sprawl actually impacted expenditures, as opposed to previous studies that hypothetically examine how expenditures might be affected.

Because of the lack of research and the contradictory nature of previous empirical work, more research on how population growth, average density, and sprawl impact public service expenditure decisions is necessary. The nature of this research is twofold: the first component will add to the current knowledge on local public service expenditures, in particular how sprawl, density, and changing population may influence these decisions. The second part of this research speaks to the relevant policy question, that is, does sprawl make any difference in local public expenditure decisions. Based on the unique measures of sprawl used in this analysis, I find that for many categories of public expenditures, sprawl has no impact, while both population and average density have varying degrees of influence on different categories of expenditures.

The structure of the chapter is as follows. Section 2.B describes the conceptual model and related literature. Section 2.C contains a brief description of the sprawl measures used in this study as well as descriptions of the data and empirical methodology. Results are presented in Section 2.D and Section 2.E concludes.

2.B Conceptual Model and Relevant Literature

The conceptual framework described below is drawn from Ladd (1994), who examines the impact that population (as opposed to sprawl) may have on spending, so extension of her conceptual model to include sprawl is required. Because population growth does not necessarily mean sprawl, in this section I attempt to distinguish between the different ways that sprawl, density, and population may influence the expenditure on public services and tie that discussion to the relevant literature.

I first clarify the term *costs*, and it's meaning in the context of this chapter. As in Bradford et. al (1969) and Ladd (1992), in discussing the output of the local public sector I distinguish between the final outputs of value to residents and the direct inputs required to produce a given level of output by the local public sector. For example, if fire protection is the local public service of interest most residents are likely concerned with the response time and proximity of fire departments rather than the number of firehouses or fire personnel employed.

Ladd (1992) notes that the use of the term cost, particularly when discussing local public services can be confusing, due to the failure of many authors to distinguish between the costs of direct outputs and the final outputs of value. The failure to make this distinction often results in opposing expectations when discussing the possible effects of density on public service costs. On the one hand, in the presence of economies of density, higher average density results in lower production costs, while on the other hand, it is also possible that higher density may cause the cost of providing the final output to rise. Throughout this chapter, when referring to local public service costs, I refer to the cost of providing final outputs of value to residents. Available data, however, do not provide the cost of providing final outputs, so in this chapter, costs are proxied by the amount of the local expenditure for each service.

Local Public Service Expenditures

Local public services are provided to residents through local public expenditures. Per capita spending for a given level of local public expenditures (e) is described using the relationship below, where (S) is the service level for each resident, (C) is the unit cost of providing services to each resident, and (SD) represents the division of responsibility for these services between state and local governments.

$$e=S*C*SD$$

There is an extensive literature explaining the public service expenditure decisions of local governments. These studies typically fall into two broad categories: estimating cost functions and estimating determinants of demand. Cost studies generally focus on scale economies, production technologies, and other related aspects,[31] while demand studies assess the role of choice and a number of explanatory variables that are expected to influence residents' demands for local public services.

[31] See Hirsch (1970) for a general discussion of local public services and cost functions.

The research in this chapter builds on previous work examining the relationship between population, average density and public service costs. Two separate studies by Ladd (1992; 1994) assess the relationship between a number of explanatory variables, and population-change and density variables. Although she focuses on population rather than sprawl, Ladd (1992; 1994) are examples of one of the best attempts to gauge the impact of population growth on the cost of public services. Her conceptual examines the impact that population growth has on local per capita public spending and finds the net results ambiguous. Because of the ambiguity found in the conceptual model, she notes that empirical work is necessary to determine the direction and magnitude of the impacts of population growth.

Focusing on measures of population, population growth, and average density, Ladd (1992) estimates the demand relationship for per capita current operating, public safety, and capital expenditures in a cross-section of counties. A number of explanatory variables are incorporated, representing different tastes and preferences that may influence demand. In addition to the usual income, population and tax price variables, she uses the educational attainment of the population, the poverty rate, per capita public school enrollments, manufacturing and non-manufacturing jobs, and the average wage. Additionally, she uses what she terms intergovernmental relations variables which represent the degree to which states divide responsibilities among state and local governments. She uses local share variables to control for the differences in responsibility among different areas. For each category of spending, the local share is the ratio of local government spending divided by state and local total spending. Other variables incorporated to represent intergovernmental relations are the per capita amount of intergovernmental aid from federal and state government.

Ladd finds that most public services exhibit a U-shaped cost curve, and that in general, higher average densities typically result in higher per capita expenditure costs; while many of the planning results find higher average densities associated with lower per capita costs. There are a number of possible reasons for the discrepancies between Ladd's work and many of the planning studies. First, the planning literature generally focuses on capital costs of development, while Ladd uses current costs, and current costs tend to be larger than capital costs. This fact, combined with the failure to make a distinction between what precisely is meant by public service costs may lead to the differing results. The differences in these results can be attributed to both the different definitions of costs used in the studies, and very different methodologies.

Ladd (1994) uses two separate regression models to examine the fiscal impacts of local population growth (measuring population change rather than a measure of sprawl). In the first, Ladd regresses the percent change in per capita spending in county *i* on the percent change in population in county *i*, and the percent change in population in county *i,* squared. In the second specification, Ladd expands the model and explores three separate dependent variables (all are percent changes): spending on current operations plus assistance and subsidies (general and utilities), capital outlays (general and utilities), and interest payments (general purpose). Explanatory fiscal variables used in the model include the change in ratio of local spending to state and local spending, by state in the following areas: public safety, social services (including welfare, wealth, and hospitals), housing and community development, and transportation.

Ladd (1994) again finds a U-shaped cost curve, and her results reinforce those in her 1992 paper, suggesting that larger populations are associated with higher per capita public service expenditures. Using a different methodology, Ladd and Yinger (1991) find that the cost of services may rise with density, results which again contradict the commonly expected perception that lower density results in higher public expenditure costs. Both of these studies however, appear to be studies of economies of *size*, rather than sprawl. Fox and Gurley (2006) discuss how often, when analyzing public service delivery, the measure of economies of size is more relevant than economies of scale. Economies of size are analyzed by noting changes in the jurisdiction size, which includes both population and geographic changes, and the proportionate increase in input requirements.

Costs of public services

Continuing with Ladd's exposition of the costs of providing public services, the costs are expected to be a function of the direct outputs, population level, and the environment in which the services are provided. The equation below shows this relationship.

$C_s = f\,(Cq, N, X)$

where *Cq* is the cost of the input, N is the population, and X is a vector of variables describing the environment in which the public services are provided.

The different components that make up the cost of providing a public service are discussed briefly below. Cost per unit of input (*Cq*) can be impacted by numerous things, but perhaps one of the most important attributes to explain the differences in public service costs is the idea of economies vs. diseconomies of scale. Public services where large fixed costs can be spread over larger numbers of people often result in economies of scale; examples of this type of public service would be highway systems and roads, and utility lines. Diseconomies of scale may be found in those public services where increases in population result in higher average costs; possible examples include fire and police protection, as well as education. With these types of services, there are no cost savings with increasing levels of population.

The influence of the population (*N*) of a local area on the costs of output depends on the degree of publicness (*p*) of the good. Many empirical studies estimate that *p* is typically very close to 1 for local government expenditures. The implications of this finding are that these goods are affected by congestion, in a similar manner to the way private goods are impacted.[32] When a public service is congestible, then the cost of providing that service is likely to rise with increased congestion. To maintain some given level of service (or service quality), more inputs may be necessary, resulting in a higher level of expenditures.

Finally, the environment (*X*) in which local public services are provided will impact the cost of the outputs in the following way. As discussed previously, costs will increase when the inputs needed increase, and the increase in inputs is due to the harshness of the environment. A number of ways of measuring the harshness of the environment have been explored in the literature; examples include: population density, poverty, and per capita number of students.[33] In the econometric model discussed in the

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[32] Oates (1988) contains an excellent discussion of the congestion effects associated with local public goods.

[33] See Bradbury et al. (1984), and Ladd and Yinger (1991) for more details on studies focusing on harshness of the environment.

next section, sprawl is added to a number of other measures to proxy for harshness of the environment.

Service Levels

The next component in the conceptual model is that of service levels and how different service levels are achieved. Service levels are typically defined as those services that voters place value on, such as educational attainment for education or level of safety for police protection. If Q is the total amount of direct inputs, the equation below describes the production function for S.

$$S=f(Q, N, \mathbf{X})$$

where N represents the population, and X is a vector of explanatory variables indicative of the environment in which the services are provided.

The environment of service provision is first discussed in Bradford et al. (1969) and proposes that harsher environments may require more inputs to produce a given level of public services. Differing input requirements in harsher environments to produce a given level of service is best explained using an example of the possibility of different requirements for public safety in low population vs. high population environments. A low population area may require fewer police officers to achieve a given level of public safety per person than a higher population area. Because the more highly populated area would require more police officers to achieve a certain level of safety per capita, the "environment" in which the public service is being delivered is considered more harsh.[34]

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[34] Sprawl could easily be considered as the environment in which public services are provided. Because the focus of this study, however, is on sprawl's impacts, sprawl is evaluated separately from other factors that may be indicative of the harshness of the environment.

Population may affect public service levels in a number of ways, but will depend on the level of publicness of the services (or goods) in question. The degree of publicness ranges in value from zero to one; a value of one indicates that the services are private, and a value of zero indicates that the services are purely public.[35] If a good is purely public, then the benefit residents receive is not influenced by population levels. In the case of private goods, in order to maintain a constant level of the public service, the intermediate outputs would need to vary proportionally with changes in the population.

Demand for Services

The next step in formulating the analysis of providing public services in local areas is to examine the demand for public services. The demand equation for locally provided services can be expressed as:

$S^D = f(Y, L, T),$

where Y refers to income, L refers to local preferences, and T is representative of the tax price. The variables in the demand equation represent those characteristics of the deciding or median voter.

The median voter hypothesis (MVH) is one of the most common models in the public finance literature for estimating the determinants of demands for the services offered by state and local governments. While the median voter model has some weaknesses, it remains the predominant framework in which to model demand for government services, and provides the foundation upon which my empirical model is built.

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[35] A purely public good or service here is one that is both non-rival and non-excludable. The non-rival condition means that consumption of the good (or service) by one individual does not diminish another's consumption, and the non-excludability condition means that no one can be excluded from consuming the good. See Samuelson (1954) for further discussion of public and private goods.

The foundation of the MVH is the assumption that each household faces a maximization problem to find its desired level of public services. Because available government data do not include information on service prices or output, but rather on expenditures, the dependent variable in the median voter model is per capita expenditures for each public service category of interest. The other explanatory variables in the model are income, property values and tax price, supply price of the service in question, and a vector of taste parameters. The MVH framework is built around that of the decisive, or median voter, and therefore, whenever possible, explanatory variables are chosen in order to be representative of the median voter. The choice of explanatory variables in the econometric model and their relationship to the MVH is discussed further in section 2.D.

Borcherding and Deacon (1972) and Bergstrom and Goodman (1973) are the seminal papers estimating the demand for local public goods. Estimating the demand function for a variety of output categories, Borcherding and Deacon (1972) utilize the median voter model framework. Using a cross-section, state-level model, demand functions for eight separate categories of public services in 1962 were estimated: local education, higher education, highways, health and hospitals, police, fire, sewers and sanitation, and parks and recreation. The explanatory variables used include population, tax price, income, a measure of divisibility of the service, land area, and a measure of urbanization.

The price elasticity of demand is negative and significant as expected; as the price for a particular service increases, the demand will decrease. The price elasticity of income displays the expected positive sign, one would expect as the income of the average citizen increases, the greater they would demand in terms of public services. It is possible that an increase in income may increase the demand for quality, rather than quantity of public services. However, given the availability of public expenditure data (and the general lack of data on public service quality), it is not possible to disentangle the quality versus quantity question. Borcherding and Deacon find that the population level has a negative influence on public service expenditures, while land area in general has a positive effect. The urbanization variable which simply measured the percent of the state's residents living in urban areas is positive yet significant in two equations: police and fire protection. This result can be explained by considering the differences between areas that are highly urbanized and those with less urbanized, more rural populations. Generally, higher levels of urbanization are also associated with higher densities and also higher levels of crime; these characteristics might result in a need to spend more on certain public services, as Borcherding and Deacon find.

Bergstrom and Goodman (1973) estimate demand functions of individuals for sub-state level services in the median-voter framework. Using a cross-section of muncipalities for a single year, the demand for expenditures in three different categories (police, parks and recreation, and total municipal expenditures) are estimated. The explanatory variables in their analysis are: the population in a municipality, the tax price for the resident with median income, median income level in a municipality, percent population change, percent non-white, density, percent of the population over age 65. Following theoretical expectations, the price elasticity of demand is expected to be negative, while the income elasticity is expected to positive; both variables display the expected signs and are significant. In their pooled analysis,[36] population change had a negative and significant elasticity, possibly because there is a lag between population change and a corresponding change in public service expenditures. The population elasticity has a positive and significant effect in all expenditure categories, while density has a negative and significant impact, but only in the equation estimating general expenditures.

It is necessary to point out that despite its popularity, the median voter model is also subject to much criticism, mainly due to its simplistic nature. Several recent papers have addressed the simplicity of the median voter model, and have evaluated what level of aggregation is most appropriate for analysis, its predictive power for specific public services as well as aggregate government activity.[37] However, despite continued criticism, the median voter model remains one of the most frequently used models in public finance.

Thus, local public expenditure decisions are explained by three equations: the cost function, the service demanded equation, and the division of spending responsibilities between state and local governments. I do not explicitly estimate a cost function, but variables that will proxy for costs are incorporated in the analysis. I now turn my attention to the way that population and average density might influence expenditure decisions and then expand the discussion to include sprawl.

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[36] In addition to the pooled analysis, Bergstrom and Goodman also estimated separate regressions for each of the states in their sample. However, the results are generally quite similar to the pooled results so the individual state results are not discussed here.

[37] See Turnbull and Djoundourian (1994), Gouveia and Masia (1998), Turnbull (1998), and Turnbull and Mitias (1999) for recent examples of studies based around the median voter model.

Population Growth, Density, Sprawl, and Local Public Service Expenditures

Given the conceptualization described above, I now broaden the framework described by Ladd (1994) to include a discussion of how sprawl, density, and population growth might influence per capita local expenditures. Recall that the general form of the cost function is:

$C_s = f(Cq, N, X)$.

While Ladd focuses primarily on density and population, the main focus of my research is the sprawl component. In order to appropriately attribute the impacts that sprawl might have, I must control for density, population level, and population growth. Table 2-1 shows the correlation coefficients between the sprawl Gini, population, population change, and average density. It is clear there is not strong collinearity between these measures, allowing them to be tested in an econometric specification. Referring back to the conceptual framework, the primary variables of interest here are *N* and *X*, because population, density and sprawl are proxies for the harshness of the environment in which the service is provided.

Sprawl

Although the impact of sprawl on the cost of providing public services appears to be a natural place for economics to contribute to this ongoing debate, the literature lacks studies addressing this issue. As previously mentioned, one of the most common arguments used as a basis for curbing sprawl is its high cost; the lower population densities associated with sprawl are generally expected to lead to higher expenditures on public services. This idea of lower density development patterns leading to higher expenditures on public services is an oft-cited, yet unsubstantiated argument against sprawl. Low-density, spatially expansive development patterns are expected to lead to greater costs because of the potentially large investments required to extend roadways and other types of infrastructure that bring water, sewer, electricity, and other services long distances to reach fewer numbers of people. It is further argued that urban sprawl may undermine economies of scale for other services, including police protection and public education, by lowering the density of individual consumers.

Despite the common perception that sprawl increases public expenditures, there have been few discussions of the mechanism through which sprawl might influence local public expenditure decisions using a conceptual framework, rather than an *ad hoc* approach. The sprawl Gini measure I use, described in detail in the previous chapter, focuses on the distribution of people, and therefore is capturing different characteristics of an area than population and density. The distribution of people is a different characteristic than the average density of people; for example, an area with its population evenly spread out over the land, or an area with its population all living in the exact same spot would yield identical average density measurements. (Although this example is conceptually impossible, it is not possible for everyone in an MSA to live in the exact same spot, theoretically it is possible, and illustrates a weakness with using the average density measure.) It is possible, however, for two areas with vastly different populations and densities to have similar Gini values. Take for example Glen Falls, NY and Bergen-Passaic, NJ, whose Gini values are 0.423 and 0.422, respectively. These are both relatively sprawled areas, yet if one looks at their population and density values, we see a much different picture. Glen Falls, NY has a population of 110,993 and an average density of 188 people per square mile, whereas Bergen-Passaic, NJ has 2.8 million people and is one of the more densely inhabited MSAs at 2,297 people per square mile. Because both population levels and density can impact local public service expenditures, we must take those two attributes into account, especially in light of how vastly different these values can be, even with a similar Gini value. Separately accounting for density and population allows the isolation of the impact of a different attribute of an area; the distribution of population.

There are two possible ways that sprawl might impact per capita local expenditures. First, it is possible that higher concentrations of people (i.e. lower levels of sprawl), might experience decreasing per capita expenditures, in a manner similar to the way areas might experience economies of density. If, however, we believe that areas with lower concentration of people results in higher per capita expenditures, then higher levels of sprawl would result in higher expenditures. Because the impacts of sprawl conceptually are ambiguous, and not likely to be the same across different types of local public services, empirical analysis is necessary to distinguish not only the different ways density, population, and sprawl, might impact local public service expenditures, but how these effects might differ across public service types.

The one relevant study in the economics literature is Carruthers and Ulfarsson (2003), where they examine the relationship between alternative development patterns and expenditures on public services for 283 metropolitan counties, observed over the ten year period, 1982-1992.

Carruthers and Ulfarsson use a number of variables to attempt to characterize the spatial structure of urban areas. Their measure of sprawl is composed of multiple variables including: the average number of jobs and people per acre of urbanized land essentially an average density measure); the spatial extent of urbanized land area in a county, given by the total number of developed acres; and property value, expressed as the total locally assessed property value per acre of urbanized land. The authors argue that using jobs and people are a better way to calculate density because the amount of developed land depends both on residential land use and on nonresidential land use.

Using a fixed effects model, the authors estimate expenditures for a variety of public services. Expenditures are expected to be a function of several broad sets of variables, including: characteristics of the built environment which includes density, urbanized land area, and the property value; political characteristics of the area such as per capita municipal governments, per capita special districts, an indicator of whether the county contains the central city; and revenue sources including local tax and intergovernmental transfers. Equations are estimated using twelve different dependent variables: per capita total expenditure, per capita spending on capital facilities, per capita spending on roadways, per capita spending on other transportation, per capita spending on sewerage, per capita spending on trash collection, per capita spending on housing, per capita spending on police, per capita spending on fire, per capita spending on parks, per capita spending on education, and per capita spending on libraries.

Carruthers and Ulfarrson's parameter estimates for density appear to create economies of size for: total direct expenditure, capital facilities, roadways, police, and education. For each of these services, the per capita cost decreases as densities increase, with the greatest savings realized in areas with very high densities. The spatial extent of urbanized land is positive and significant in most of the models, indicating that the spread of a metro area plays an important role in determining public service expenditure.

Property value is significant in 5 of the 12 equations and positively correlated with per capita spending for all services except for other transportation and sewers. Political characteristics are significant in most of the equations, suggesting that the formation of small general and special purpose governments may work to lower per capita spending.

Carruthers and Ulfarsson's results indicate that public service expenditures are influenced by the physical pattern of development; average density, urbanized area and property value all influence the per capita amount spent on service provision. The political structure of metropolitan counties is also found to have an effect; with greater fragmentation being associated with lower expenditure.

Population Growth and Density

There are two possibilities for the way that population growth might influence local public expenditure decisions. On the one hand, large increases in population might increase the congestion in the services provided; increased congestion may result in higher local per capita expenditures to maintain some desired level of service. If however, there are economies of scale in service production, then increasing the population works to lower the per capita expenditure costs, as spreading cost among a larger number of people will lower the amount spent per capita. Of course, in the presence of diseconomies of scale, the opposite effect prevails. A decrease in per capita public expenditures may also take place if areas are slow to respond to fast population growth; the decline in per capita expenditures may be indicative of decreased service levels and/or quality.

Population changes may influence the demand function as well; as population changes the income, tastes, and preferences of local area residents may be changing. If the preferences of residents change, they might demand not only higher levels or quality of services, but a greater variety of public services as well. Of course, it is also possible that despite the increased demands for services, local governments are unable to meet this demand, and service quality and/or the variety of services provided may fall resulting in lower per capita expenditures.

Density influences expenditures in a similar manner to population, either through the congestion mechanism, or economies of density. Recall that economies of density occur when there are cost savings due to higher average density levels. Diseconomies of density exist, resulting in rising public service expenditures coinciding with higher density levels. In the case of congestion, higher density may lead to increased congestion in the provision of public services, resulting in higher expenditures. However, if there are economies of density in the production of local services, then costs can be expected to fall with increased densities. Because the possibility for either economies or diseconomies of density exists, the influence of the density variable on local public services is ambiguous and empirical work is necessary to determine the net impact on per capita expenditures.

Buettner, Schwager, and Stegarescu (2004) examine how population and density impact public service costs in German states. They estimate cost functions for a large number of government expenditure categories for each of the states. There are two main contributions from their work: first, the authors distinguish between the different impacts of population and density in their empirical framework. Their second contribution is disaggregating public expenditures into a large number of categories[38] and analyzing the relationship between density and population for each expenditure. Although the impacts of density and population differ across the different expenditure categories (as would be expected), in the aggregate they find that the per capita cost of public services is constant. In other words, they find no fiscal advantage (or disadvantage) for areas of either high or low density. They argue that there is no basis for preferential treatment of German states based on the cost of providing public services.

2.C Data and Empirical Model

I estimate the baseline relationships using a cross-sectional model[39] of the following form, where all variables are expressed in logarithmic form:

$$e_i = \alpha + \beta \boldsymbol{DC_i} + \gamma \boldsymbol{SD}_i + \delta \boldsymbol{X}_i + \varepsilon_i \,,$$

where $i = 1, \ldots, 273$ and represents the MSAs used in the analysis. The regression is run separately for each time period. I first focus the analysis on different categories of current operating expenditures, and then turn my attention to capital expenditures. e_i is the per capita expenditure of a particular public service, α is a constant, $\boldsymbol{DC_i}$ is a vector of explanatory variables representative of the demand, cost, and taste variables from the conceptual framework, $\boldsymbol{SD}_i$ is a vector of intergovernmental relationship variables and represents the division of responsibilities in the conceptual framework, $\boldsymbol{X}_i$ is a vector containing the Gini sprawl measure, population (or in one specification, population

[38] A total of 40 expenditure categories are examined, ranging from police protection, housing, and education to prisons, sports and recreation and welfare.
[39] Although I estimate per capita total expenditures, I follow the previous literature that estimates different public services separately.

change), and the average density measure, and ε_i is the residual term. These variables are discussed in greater detail below.

The relationship between sprawl and the cost of providing a public service is likely lagged; that is, expenditures at time *t* are more likely to be influenced by the level of sprawl in a previous time period opposed to the sprawl in the same time period, *t*. Any fiscal response or consequence to changing urban form would not be expected to occur instantaneously, and therefore there is more likely to be a lag. Building the lag into the model is possible due to the different availability of the data sources. The expenditure data is drawn from Census of Governments data and is available for years ending in 2 and 7 (e.g. 1992 and 2002) while the sprawl Gini, and many of the other explanatory variables are available from decennial Census reports (e.g. 1990 and 2000). This data availability allows the sprawl Gini in 1990 (or 2000) to impact the outcome of the expenditure variables in 1992 (or 2002). Table 2-2 contains the source notes for the variables and Table 2-3 contains the source notes for capital expenditures. The descriptive statistics for current operating expenditures and explanatory variables are in Table 2-4 and Table 2-5 contains the descriptive statistics for capital expenditures.

The data consist of two periods, covering 273 MSAs[40] in all areas of the country except New England.[41] Because the county components of MSAs change over time, it was necessary to choose a period on which to base the definition, and the MSA

[40] Although data were collected for 306 MSAs, all multi-state MSAs were excluded from the main analysis.

[41] The New England MSAs are excluded because their counties are not comparable to the rest of the country. MSAs are aggregations of counties, so it was not appropriate to include New England.

definitions as of June 30, 1999 were chosen.[42] The MSAs were reconstructed for 1990 based on the 2000 definition. Because the definitions of MSAs change over time, if one consistent time period is not used, then a true analysis of how sprawl changes over time cannot be measured. For example, the Knoxville MSA had 7 component counties in 1990: Anderson, Blount, Grainger, Jefferson, Knox, Sevier, and Union. By 1999, the Knoxville MSA had only 6 counties, but a number of the component counties had changed: Grainger and Jefferson were no longer part of the MSA, and Loudon county was added. If the definitions were not consistent across time, an analysis of the Knoxville MSA would include 7 counties in 1990 and 6 in 1999, of which only 5 are found in both years. A number of potential problems arise from definitional changes. The potentially most problematic issue is that any changes in sprawl would not necessarily be due to changes in the location of people, but rather could arise due to the addition or removal of component counties. Choosing a base year as the definition allows for consistent comparisons across time.

Explanatory Variables

The explanatory variables I use are discussed below; I separate them into meaningful categories in order to discuss them in more detail. Following the conceptual framework discussed above, I use per capita expenditures for a number of different public services as the dependent variables, a vector of explanatory variables that are representative of cost, demand and taste variables, a vector of variables representing the harshness of the environment, and a vector containing variables representing

[42] See http://www.census.gov/population/estimates/metro-city/99mfips.txt for a complete listing of MSAs and their component counties. This was the definition used for Census 2000.

intergovernmental relations. Wherever possible, the explanatory variables are chosen to be representative of the median voter. A unique aspect of the model is the incorporation of the sprawl measure into a fully-specified model of local expenditure decisions. In addition to the sprawl measure, I also incorporate average density, population, and population change, to separately assess their potential impact.

The Gini measure of sprawl is based on decennial Census data for 1990 and 2000; so the sprawl measure in addition to the majority of the explanatory variables are also reported for those years. The numerous expenditure variables are from the Census of Governments data for 1992 and 2002. The expenditure categories that I focus on are: per capita current operations, per capita education current operations, per capita fire protection current operations, per capita police protection current operations, per capita highway current operations, per capita waste management current operations, and per capita sewer current operations. In addition to the current operating costs, I also gauge the influence sprawl has on the costs of capital for selected categories of expenditures.

Sprawl, Density, Population and Population Change

The primary relationships of interest to this study are between per capita expenditures and sprawl, density, population, and the percent population change. These variables are all proxies for the harshness of the environment, or, in terms of the conceptual model presented earlier, are part of the environmental vector, *X*. Based on the earlier discussion of the possible ways sprawl may impact public service costs, I have no clear expectation of the sign of the sprawl variable. As discussed previously, the impact of sprawl is likely to vary across different public services.

In addition to the sprawl variable, the importance of the average density of the MSA is also assessed. Higher average density may increase per capita spending because more public goods might be required to provide some predetermined given level of output. However, if there are economies of density in the production of public services, then per capita costs might fall. According to Ladd (1992; 1994) higher densities generally result in higher levels of local public expenditures. Because there are two possible outcomes for average density, the expected sign is ambiguous. I calculate the 10-year population change over the previous decade for each MSA in order to gauge the impact of population growth. High population growth may increase per capita public expenditures if the population growth increases the marginal cost of providing the services. Another possibility is that a surge in population might decrease per capita spending if areas are slow to accommodate their new, larger populations. The expected sign of the population level is ambiguous, as well. It is unclear how population may impact the spending on public services; there are two possible effects the population level can exert. For a purely public good, it could reasonably be expected that higher populations would result in lower per capita expenditure costs. On the other hand, diseconomies of scale could occur, where higher populations may result in higher per capita expenditures.

One difficulty that arises when discussing local public services and sprawl is that local public service expenditure decisions and the distribution of people in an area occur at different geographic levels. For example, sprawl can appropriately be conceptualized at the MSA level, however, there are no public services delivered at the MSA level. MSAs can have numerous governments providing public services, and the responsibilities of these governments vary widely among the MSAs. To reconcile the difference between the level at which we typically observe sprawl and the level at which local public services are provided, I incorporate an MSA-specific measure of the average size of local governments.[43] While the population level serves as a proxy for the total size of the MSA, the average size of local governments approximates the responsibility of the average government within an MSA. The purpose of this variable is two-fold: on the one hand it contributes additional information on how the "size" of an area affects local public service expenditures. Second, though not an exact measure, this variable proxies for the presence of economies or diseconomies of scale for each type of local public service.

Demand, Cost, and Taste Variables

The next set of variables are used to fully account for the demands, taste, and costs that may influence local expenditure decisions. The two variables of primary interest here are the per capita income of MSA residents, and the tax price. The tax price is the ratio of the average home price to the total value of homes in the MSA.[44] The income elasticity is expected to be positive, while the price elasticity is expected to be negative. The expectations of these signs are consistent through the literature. The average wage in the MSA is included as a direct proxy for the input cost of providing public services. This variable is the average wage for all non-government jobs, and represents the wage that governments would have to pay its employees. Presumably, the higher the wage, the higher the cost of an input to the public service, and the higher the

[43] The types of governments this variable includes are: county, municipal, township, school district, and special districts.
[44] The value of homes is obtained from the long-form Census questionnaire, that asks homeowners to report the value of their home for the year prior to the Census.

per capita expenditure is expected to be. The per capita number of jobs is used as a proxy for the “daytime population” in an area. In other words, the number of jobs relative to the population may exert some influence on the expenditures on public service, perhaps in a similar manner to the way density may influence expenditures.

Intergovernmental Relations Variables

In each local expenditure equation, a measure of the extent to which local areas are responsible for each type of expenditure is included. For each service category, I include the state share of spending which is defined as the ratio of state spending to the total spending of state and local governments in the state. This variable accounts for the relative responsibility of the state government vis-à-vis local governments, and is expected to exert a negative effect on local government expenditures. The larger the state share, the lower the local responsibility, and therefore the lower the local expenditure. I also include the per capita intergovernmental aid from the state and federal government. It is expected that the more aid local governments receive the more likely local governments are to increase local per capita spending.

2.D Results

I first estimate the current operating expenditure decision of local governments for six different categories of services: education, police, fire, sewer, highways, and waste management. The final dependent variable estimated is total current operating expenditures. I estimate a fully-specified expenditure model in a cross-sectional framework expanding upon the median voter framework; the results from the regression for 1992 are found in Table 2-6; results for 2002 are in Table 2-7. I begin with the discussion of the results of the primary variable of interest, the sprawl Gini measure. This variable is negative and significant in 2 of the 7 expenditure equations (police and fire) in 1992, and 3 of the 7 equations in 2002 (highways, police, and fire). These results indicate that for fire and police protection, more sprawled areas tend to spend less per capita on police and fire protection than areas with a lower sprawl value. At first glance, these results may seem to run counter to what is known about the service delivery of these two services. There are, however, a couple of possible explanations for these results. For police, it may be that areas where the population is less concentrated (i.e. more sprawl) provide fewer opportunities for crime, and therefore expenditures per resident tend to be lower than areas with higher concentrations of its population. Throughout the country, many large municipalities support their own police force, while smaller cities and rural areas may be served by state police, part-time forces or even volunteer officers. So while the cost per resident of police services may fall for more sprawled areas, service quality may also be falling.

The results for how sprawl impacts the expenditures on fire services are a bit trickier than public safety, and not as straightforward. First, there is the difference in the way areas staff their fire departments. Most often, large cities are protected by paid fire departments. Medium-sized cities and areas are often protected by some combination of paid and volunteer forces. Rural areas and small communities are usually served by volunteer departments. Each of these different types of fire departments are funded differently, with the larger departments usually funded out of a municipal budget, volunteer departments supported by either special governments or subscription fees, and medium sized departments drawing support from some combination of the above. To further complicate matters, many departments outside of large cities rely on uncompensated assistance from other fire departments to deal with some calls. This makes service quality look better and costs look lower than they actually are. There are also major differences between central city and suburban fire responses. Central cities tend to have higher call volume and more major incidents (due to among other factors, higher concentration of people and more multi-unit housing) but because they are served by full-time paid firefighters the service there tends to be better. Outlying areas tend to have fewer fires, but service is typically of lower "quality" because the fire departments are broadly dispersed and depend much more heavily on volunteers. For these reasons, the results of both police and fire services should be interpreted with caution.

The elasticity sprawl value for per capita highway expenditures in 2002 is -0.131. This result may indicate that in areas where there is less sprawl, the roads do not take as much abuse as in areas where there are greater concentrations of people on the roads.

Sprawl has a positive and significant impact on waste management expenditures in both 1992 and 2002, with elasticities of 0.417 and 0.460, respectively. This result indicates that more sprawled areas spend more per capita on waste management vis-à-vis less sprawled areas, perhaps due to increased driving to pick up waste. The positive impact of sprawl on waste management expenditures is also found in Carruthers and Ulfarsson (2003), although the authors do not calculate elasticities so the magnitude of the impact cannot be compared.

Previous empirical studies have not examined a sprawl measure, but rather used an average density measure, often as a proxy for sprawl. As discussed above, however, sprawl and average density are expected to exert separate influences on local public expenditures, and so should be analyzed separately. Average density is negative for highway current operations in both time periods, positive for fire in both time periods, and positive for sewer expenditures in 2002. The sign for the highway equation indicates that in areas with higher average densities, per capita expenditures are lower than in areas where densities are lower. While at first, this result may seem to contradict the results for sprawl and highway expenditures, recall that sprawl and average density are not accounting for the same phenomenon in an area. This result, in fact, shows that it is important to account for both average density and sprawl in the analysis of local public expenditures, as each measure can exert a different effect. Areas with higher average densities spend more per person on sewers vis-à-vis areas with lower average densities. This result may come about because it may be costlier to provide sewer services to areas that have more people per square mile than areas with fewer people per square mile, perhaps because of greater system use and higher costs to maintain the system. Carruthers and Ulfarsson (2003) did not find average density to have any impact, and Buettner et al (2004) did not look at sewer services.

Another variable of interest to the current study is the average size of governments within an MSA; this variable is significant in five equations in 1992 and in all seven equations in 2002. As expected, the signs of the elasticities vary depending on the category of service, but results are consistent across categories for each year. Economies of scale are found for the following services: per capita highway expenditures, per capita education expenditures, and sewers (but only for 1992). The results for highways and sewers are consistent with the results discussed in Fox and Gurley (2006) and Hirsch (1970). The result for education is a bit surprising, however, in a review of several studies Hirsch finds that education expenditures are found to be either U-shaped or with constant returns to scale. The elasticities for education for 1992 and 2002 are relatively small (-0.046 and -0.047), respectively, and do not likely indicate large cost savings. One possible explanation for this result is that in general, many MSAs are in the downward-sloping portion of the average cost curve for education.

Diseconomies of scale are found for: total per capita expenditures, fire, police, and waste management. The elasticities for total per capita expenditures are small in 2002 (0.029). Labor intensive public services such as fire and police can reasonably be expected to have increasing costs as the number of people increase. Compared to sewer systems or highways, waste collection is also fairly labor intensive which likely results in the large elasticities for each year (0.385 in 1992 and 0.389 in 2002.)

The share of the population age 25 and over with at least a bachelor's degree and the average wage both are generally positive, and the average number of jobs in an MSA is negative although only in a few equations. MSAs with a greater share of their population who have at least a bachelor's degree have higher per capita total expenditures in both 1992 and 2002, higher per capita expenditures on fire services and sewers in 2002, and higher per capita police expenditures in 1992. The results for this variable conform to the idea that higher levels of education in a population influence the taste for public services; the positive (yet small) elasticities confirm this theory. The average number of jobs is negative for total current operations, fire, and highways, with small elasticities compared to many of the other variables. Ladd (1992) finds that the number of jobs has a negative impact in a few of her specifcations, as well.

Most of the variables chosen to represent the median voter behave as expected. The state share of state and local total current operating expenditures is negative and statistically significant in four of five regressions in both 1992 and 2002, with elasticities ranging from –0.213 to -0.794.[45] This result indicates that the greater the reliance on the state portion of the state and local total, the less the responsibility local areas have and the lower the dollar amount spent per capita. The tax price is negative and significant in two of the seven equations in 1992 and negative and significant in only one equation in 2002. The elasticities for tax price range from -0.096 (for education) to -0.760 (for sewers). The tax price variable was not significant in Ladd (1992; 1994); and the ad hoc approaches of Carruthers and Ulfarsson (2003) and Buettner et al (2004) do not use a tax price variable.

Per capita personal income is positive and significant in 4 of the 7 equations in 1992, and in 3 of the 7 equations in 2002. The elasticities range from 0.212 (total current operating expenditures) to 0.918 (fire services). Other than the relatively low elasticity for total current operating expenditures, the elasticities for the income variable are consistent with previous surveys of empirical studies of the median voter model. The intergovernmental aid variable is positive and significant in five equations in 1992 and six equations in 2002. The elasticities for the aid variable are generally lower than those for per capita personal income; indicating that although grant money received by the MSA from both state and federal governments does increase local spending, on average it has less of an effect than an equal increase in personal income. However, in 1992, the

[45] No state money is given to local areas for fire services, so the state share of the total is not included for fire. Several areas did not have reliable data for the state portion of waste management services in 1992, so the state share is not included in this equation for either year.

elasticity of the aid variable exceeds the elasticity of the personal income variable, lending some evidence that the flypaper effect is at work.[46]

The MSA population level is not significant in any equation in 1992 and negative in only one equation in 2002 (sewer). This result might indicate that as population increases areas experience economies of scale in sewer services, as costs are spread out over a greater number of people, and mirrors the result obtained by Borcherding and Deacon (1972). Because this variable is only significant in one equation in one time period, in the next section I examine how population change rather than the level impacts local spending decisions.

Capital Expenditures

The focus thus far has been on operating expenses. However, sprawl may also potentially impact capital outlays; as people spread out geographically and residential areas become less concentrated, local areas may have to increase expenditures to ensure sufficient capital facilities. The data on capital outlays from the Census of Governments is a measure of gross investment, not the annual cost of capital. Therefore, the results below should be used with caution, as the estimates are not meant to be interpreted as the annual cost of using capital, but rather how the explanatory variables described above influence gross capital investment in a number of service categories during a given year.

I examine three categories of capital expenditures in addition to the total. The categories I focus on are: education, sewer, and waste management. I choose sewer and waste management these are capital expenditure categories where one might expect

[46] The flypaper effect represents the idea that grants to local governments tend to increase local expenditures more than an equivalent increase in per capita personal incomes. See Fisher (1982) and Turnbull (1997) for more on flypaper effects on local expenditures.

sprawl to have an impact. Capital education expenditures are included because, as a general rule, education is the largest category of local expenditures and the one residents are most likely to be concerned with. I generally find that the median voter model is not a good predictor of capital expenditures, with relatively few significant variables in each time period. This is not terribly surprising, as the theoretical model is less appropriate for annual capital expenditures than current operating expenditures. The results for capital expenditures in 1992 are found in Table 2-8 for 1992 and in Table 2-9 for 2002. The variables that are significant, however, generally display the expected signs and are of reasonable magnitude. As with current operating expenditures, the primary variable of interest is the sprawl Gini. In 1992, the sprawl Gini is negative for sewer capital and positive in 2002 for education. These results appear to indicate that higher levels of sprawl increase per capita spending on education facilities, perhaps because as people locate further out, in less concentrated areas, the need for educational facilities increases. The opposite result occurs for sewers, which may show that sprawl does not increase the capital outlays for sewer systems. However, because these statistically significant results occur in only one time period, caution should be used before making policy recommendations based on these results. Average density is negative in both years for total capital expenditures, a result that somewhat mirrors Ladd's (1992) results, although the empirical approaches differ. Despite the results showing that more sprawled areas spend less per capita in a couple of service categories, these results should be interpreted cautiously. Because this data measures gross investment, if instead the annual cost of capital were used instead, the results could differ from those discussed above.

Robustness

To check the robustness of the results, I make a number of changes in the next set of regressions. First, I replace the sprawl Gini with different proxies for sprawl; the Index of Dissimilarity and the Sprawl Indicator discussed at length in the previous chapter. The results of each of these in each of the regression equations are quite similar to those using the sprawl Gini. The Index of Dissimilarity is negative for fire and police in 1992. In 2002, the elasticity for fire and police is negative, while the elasticity for education is positive. The results using the sprawl indicator are remarkably similar in both time periods to those obtained using the Index of Dissimilarity in 2002. The results for these regressions are in Tables 2-10 through 2-13. Comparisons of the elasticities of the different sprawl measures for 1992 and 2002 are found in Table 2-14 and Table 2-15, respectively. The elasticities for the Index of Dissimilarity are slightly higher than for the sprawl Gini, while the sprawl index is slightly lower than the sprawl Gini. In all cases, however, the results are reasonable compared to the Gini measure indicating that the results of the model are robust to different sprawl measures.

I next estimate the original equations using the sprawl Gini, but replaced the population level with the population change. It is possible that while the level itself does not exert much influence on public service expenditures, population change may have an influence. As discussed above, large increases in population may increase the congestion in the provision of services; more congestion may result in higher local per capita expenditures to maintain the desired level of service. If this is the case, then per capita expenditures will rise as population increases. In the presence of economies of scale in service production, increases in population lower per capita expenditure costs, as spreading cost among a larger number of people lowers the amount spent per capita. Of course, in the presence of diseconomies of scale, the opposite effect prevails. A decrease in per capita public expenditures may also take place if areas are slow to respond to fast population growth; the decline in per capita expenditures may be indicative of decreased service levels and/or quality.

The variable of interest here is the population change variable, the results for this specification are found in Tables 2-16 and 2-17. In 1992 this variable is positive and significant in three equations (highway, police, and sewers) and in 2002 positive and significant for police. The elasticities tend to be small (ranging from 0.047 for highways to a high of 0.116 for sewers), particularly compared to the elasticities of per capita income, per capita aid, and the average wage. Except for very slight changes in the coefficients, the sprawl results remain unchanged from the baseline results.

Alternative Modeling Strategies

Although there are only a few empirical studies examining per capita local public service expenditures, most are estimated in a cross-sectional framework. Only one previous paper, Carruthers and Ulfarsson (2003), estimates per capita expenditures in a panel framework, and to my knowledge, no previous study has employed a panel framework using anything other than an *ad hoc* approach. In this section I test the conceptual model drawn from the median voter model outlined above using a fixed-effects panel model.

The results of the fixed-effects panel model are in Table 2-18.[47] The results of the fixed-effects framework in general are similar to the cross-section results, many of the median voter variables behave as expected, although with limited significance. The sprawl measure is only significant in the sewer equation, and is negative. Average density is negative and significant in two equations, education and police; the elasticity for expenditures on police is comparable to the result found in 1992. These results may indicate that despite the supposedly negative fiscal impacts, sprawl does not have quite as much influence as is commonly perceived, especially when examined in the context of a multi-year panel, rather than in a cross-section.

Sprawl and Density Interaction

Although the specifications discussed above address the separate influences that density and sprawl may have on local public service expenditures, it is also possible that the interaction between sprawl and density may exert an impact not picked up by these two variables alone. Using the sprawl Gini, I estimate the baseline model for current operating expenditures from above, incorporating the density/sprawl interaction term. The results for these regressions are in Tables 2-19 and 2-20. The results indicate that the inclusion of the interaction term causes both density and the sprawl Gini fail to be significant in a number of public service categories, while many of the other variables retain their explanatory power. In joint significance tests, I fail to reject the null at the 1% level, indicating that sprawl, average density, and the interaction of the two are jointly

[47] The Hausman specification test is the accepted test to compare the results of the consistent fixed effects model with the efficient random effects model. The null hypothesis is that the unobserved effects with the other regressors. In the presence of such correlation, the estimators from the random effects model will be biased, so the fixed effects model is preferred. I reject the null at the 1% level of significance, indicating that the fixed effects model is statistically the appropriate choice.

significant for fire, police, sewer and highway expenditures. These variables are jointly insignificant, however, for total current operating expenditures and education current expenditures. This outcome further illustrates that the impact of sprawl depends on the particular public service

2.E Conclusions

Several conclusions can be reached from the results of this research. First, for a number of expenditure categories, neither sprawl nor average density play a role in raising public service expenditures. The lone exception is in the case of per capita expenditures on waste management, where higher levels of sprawl lead to higher expenditures. This result mirrors that of Carruthers and Ulfarsson (2003) and shows that, perhaps, in the case of certain types of services, the distribution of people in a local area does matter, and greater concentration of residents within an area may lead to cost savings. However, the main conclusions of this research is that other than for waste management services, sprawl’s impact on local public service expenditures is rather small, especially when compared to a number of other factors.

In addition to sprawl, I have tested how a number of factors may influence local public service expenditure decisions, and have found the common perception that sprawl raised expenditures to be unsubstantiated. Even in the cases where sprawl does influence expenditures, the elasticities tend to be quite small; exerting a much smaller influence than a number of other factors.

The variables representing cost, taste and demand have varied impacts, but overall conform to predictions from the literature. The important result of this work, is that for nearly all categories of expenditure variables, sprawl has either no or very limited influence on per capita local public spending. This is potentially an important conclusion, in particular for local areas and policy-makers; it is possible that attention can be directed to other possible outcomes of sprawl not addressed in this research.[48] This conclusion, however, should be interpreted with caution; this research was performed at the aggregate level, and perhaps sprawl does play a role when local public services are disaggregated to a sub-MSA level. Also, despite my attempts at addressing the robustness of the results to different measures of sprawl, the concept of sprawl can mean different things to different people. It is possible that a different set of proxies for sprawl could have potentially different results.

Attempting to capture the different impacts of average density and sprawl is another important component of this research; these two variables were found to have different impacts on fire expenditure categories, and sprawl was found to be a significant factor while average density had no influence in a number of categories: police, waste management, highways, and sewers. Previous studies have found that either in general, average density doesn't matter (Carruther and Ulfarsson (2003); Buettner et al (2004)), or that it increases expenditures but only at very high densities (Ladd (1992)). The current research falls into the former category; for the majority of local public expenditures, average density has no influence. The results of this research contribute to the ongoing debate as to whether sprawl increases local public expenditures; and my results tend to suggest that sprawl has limited influence on local public service expenditures.

[48] Examples include the potential relationships between sprawl and health, air and water quality, and perhaps other qualitative outcomes that were not the focus here.

There are a number of possibilities for future research. Reconciling the different levels of geography at which sprawl and local public services are delivered should be a priority of future research. As noted previously, sprawl takes place at the MSA level, while local public services are delivered at a sub-MSA level. It is possible that some of the impacts on local public services may be masked when aggregated to the MSA level.

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Essay 2: Appendices

Table 2-1: Correlation Coefficients between Sprawl, Density and Population

	Gini	Average Density	Population	Percent Population Change
Gini	1.000			
Average Density	0.091	1.000		
Population	-0.132	0.455	1.000	
Percent population change	-0.342	-0.108	0.031	1.000

Table 2-2:Variable Description and Source Notes

Variable	Expected Effect	Source	Definition
Per capita current operating expenditures-total	n/a	Census of Governments 1992, 2002	Total current operating expenditures for the MSA, divided by the MSA population
Per capita current operating expenditures -education	n/a	Census of Governments 1992, 2002	Current operating expenditures on education for the MSA, divided by the MSA population
Per capita current operating expenditures-police	n/a	Census of Governments 1992, 2002	Current operating expenditures on police for the MSA, divided by the MSA population
Per capita current operating expenditures-fire	n/a	Census of Governments 1992, 2002	Current operating expenditures on fire for the MSA, divided by the MSA population
Per capita current operating expenditures-sewer	n/a	Census of Governments 1992, 2002	Current operating expenditures on sewer for the MSA, divided by the MSA population
Per capita current operating expenditures-highway	n/a	Census of Governments 1992, 2002	Current operating expenditures on highways for the MSA, divided by the MSA population
Per capita current operating expenditures-waste management	n/a	Census of Governments 1992, 2002	Current operating expenditures on waste management for the MSA, divided by the MSA population
Gini Coefficient Index of Dissimilarity Sprawl Index	+/-	U.S. Census Gazetteer Files-2000 1990 Census of Population and Housing Public Law File 94-171-1990	
MSA population (1000s)	+/-	U.S. Census Summary File 1-2000, 1990	Total population in the MSA measured in 1000s

Variable	Expected Effect	Source	Definition
Average Density	+/-	U.S. Census Summary File 1-2000, 1990	Total population in the MSA divided by the square miles in the MSA
MSA area (1000s square miles)	+/-	U.S. Census Summary File 1-2000, 1990	Square miles in the MSA
Percent population change	+/-	Caluclated from U.S. Census Summary File 1-2000, 1990	10 year population change in the MSA
Per capita personal income (1000s)	+	BEA, 2000, 1990	Total personal income in the MSA divided by total MSA population
Per capita aid	+	Census of Governments 1992, 2002	Total intergovernmental revenue from Federal and State source, divided by the MSA population
State share of state and local expenditures-total	-	Census of Governments 1992, 2002	State share of total state and local total expenditures for each state.
State share of state and local expenditures-education	-	Census of Governments 1992, 2002	State share of total state and local expenditures on education for each state.
State share of state and local expenditures-police	-	Census of Governments 1992, 2002	State share of total state and local expenditures on police for each state.
State share of state and local expenditures-highway	-	Census of Governments 1992, 2002	State share of total state and local expenditures on highway for each state.
State share of state and local expenditures-sewer	-	Census of Governments 1992, 2002	State share of total state and local expenditures on sewer for each state.
State share of state and local expenditures-wastemanagement	-	Census of Governments 1992, 2002	State share of total state and local expenditures on waste management for each state.
Average government size in the MSA	+/-	Census of Governments 1992, 2002	MSA population divided by total government entities in MSA, including county, municipality, township, school district, and special district.
Percent of the population with at least a bachelor's degree	+	Census Summary File 3- 2000, 1990	Percent of the population over age 25 who has attained at least a bachelor's degree.
Average Wage	+		Total amount paid in salaries divided by total number of jobs in the MSA

Table 2-3: Capital Expenditures: Definitions and Source Notes

Variable	Expected Effect	Source	Definition
Per capita expenditures-total capital	n/a	Census of Governments 1992, 2002	Total expenditures on capital divided by total MSA population
State share of state and local total capital expenditures	-	Census of Governments 1992, 2002	State share of total state and local expenditures on total capital for each state.
Per capita expenditures-education capital	n/a	Census of Governments 1992, 2002	Total expenditures on education capital divided by total MSA population
State share of state and local education capital expenditures	-	Census of Governments 1992, 2002	State share of total state and local expenditures on education capital for each state.
Per capita expenditures-waste management capital	n/a	Census of Governments 1992, 2002	Total expenditures on waste management capital divided by total MSA population
State share of state and local waste management capital expenditures	-	Census of Governments 1992, 2002	State share of total state and local expenditures on total waste management capital for each state.
Per capita expenditures-sewer capital	n/a	Census of Governments 1992, 2002	Total expenditures on sewer capital divided by total MSA population
State share of state and local sewer capital expenditures	-	Census of Governments 1992, 2002	State share of total state and local expenditures on total sewer capital for each state.

Table 2-4: Descriptive Statistics

	1990				2000			
Variable	**Mean**	**Std Deviation**	**Minimum**	**Maximum**	**Mean**	**Std Deviation**	**Minimum**	**Maximum**
Per capita current operating expenditures-total	1879.412	524.1671	912.5828	4164.291	2887.055	759.0596	1107.013	5934.045
Per capita current operating expenditures-education	.8394435	.2060185	0	1.670014	1.284616	.3068018	0	2.484893
Per capita current operating expenditures-police	.1014347	.040849	.0086379	.2779249	.1612206	.0563142	.0604458	.4279159
Per capita current operating expenditures-fire	.0515462	.0216698	.0006907	.1385231	.0790971	.031714	.0009122	.2166426
Per capita current operating expenditures-sewer	.0439044	.0215373	0	.1421782	.0682446	.0331101	.0085275	.3417383
Per capita current operating expenditures-highway	.0665334	.0288275	.0064737	.1936409	.0918047	.039779	.0104306	.2151594
Per capita current operating expenditures-waste management	.0351595	.023735	7.56e-06	.1693706	.0503584	.0303273	.0002121	.1594961
Gini Coefficient	0.259	0.100	0.038	0.504	0.270	0.102	0.0352	0.541
Index of Dissimilarity	0.376	0.115	0.913	0.615	0.388	0.117	0.112	0.671
Sprawl Index	0.225	0.093	0.033	0.532	0.227	0.093	0.035	0.455
Percent population change	0.145	0.164	-0.098	0.947	0.125	0.109	-0.081	0.507
MSA population (1000s)	612	1,048	57	8,863	700	1,174	58	9,519
Average Density	378.653	909.244	4.501	11,846.96	424.616	999.174	5.412	13,043.78
MSA area (1000s square miles)	2.262	3.288	0.047	39.369	2.262	3.288	0.047	39.369
Per capita personal income (1000s)	14.536	2.513	6.726	24.941	22.762	3.907	11.007	40.669

	1990				2000			
Variable	**Mean**	**Std Deviation**	**Minimum**	**Maximum**	**Mean**	**Std Deviation**	**Minimum**	**Maximum**
Per capita aid	0.584	0.227	0.139	1.691	0.955	0.337	0.171	2.178
State share of state and local expenditures-total	0.403	0.064	0.306	0.606	0.426	0.065	0.328	0.785
State share of state and local expenditures-education	0.280	0.070	0.166	0.471	0.278	0.076	0.169	0.999
State share of state and local expenditures-police	0.849	0.0548	0.627	0.936	0.849	0.07	0.623	0.985
State share of state and local expenditures-fire	0	0	0	0	0	0	0	0
State share of state and local expenditures-highway	0.443	0.148	0.198	0.873	0.438	0.146	0.162	0.891
State share of state and local expenditures-sewer	0.009	0.021	0	0.120	0.020	0.039	0	0.262
State share of state and local expenditures-waste management	0	0	0	0	0.106	0.103	0	0.689

Table 2-5 Capital Expenditure Descriptive Statistics

	1992				2002			
Variable	**Mean**	**Std Deviation**	**Minimum**	**Maximum**	**Mean**	**Std Deviation**	**Minimum**	**Maximum**
Per capita capital expenditures-total	0.312	0.164	0.039	1.425	0.515	0.229	0.082	1.519
Per capita capital expenditures-education	0.089	0.054	0	0.256	0.181	0.095	0	0.672
Per capita capital expenditures-utilities	0.049	0.068	0	0.682	0.065	0.079	0	0.568
Per capita capital expenditures-waste management	0.006	0.011	0	0.077	0.005	0.007	0	0.046
Per capita capital expenditures-sewer	0.029	0.035	0	0.246	0.035	0.043	0	0.422
State share of state and local capital expenditures-total	0.405	0.070	0.288	0.601	0.436	0.064	0.348	0.777
State share of state and local capital expenditures-education	0.281	0.070	0.166	0.472	0.278	0.076	0.169	0.999
State share of state and local capital expenditures-utilities	0.069	0.204	0	0.812	0.074	0.201	0	0.904
State share of state and local capital expenditures-waste management	0.098	0.100	0	0.594	0.106	0.104	0	0.689
State share of state and local capital expenditures-sewer	0.009	0.021	0	0.120	0.020	0.039	0	0.263

Table 2-6: Regression results, 1992

	Per Capita Current Operations	Per Capita Education Current Operations	Per Capita Highway Current Operations	Per Capita Fire Current Operations	Per Capita Police Current Operation	Per Capita Sewer Current Operations	Per Capita Waste Management Current Operations
State share of state and local total	**-0.467***** (0.070)	**-0.274***** (0.039)	**-0.794***** (0.070)	---	**-0.332***** (0.043)	-0.002 (0.038)	---
Tax Price	0.036 (0.063)	**-0.096*** (0.013)	-0.154 (0.118)	0.131 (0.138)	0.080 (0.086)	**-0.760***** (0.285)	0.030 (0.221)
Per capita personal income	**0.212**** (0.100)	-0.048 (0.120)	**0.626***** (0.182)	**0.918***** (0.272)	**0.790***** (0.171)	1.210 (0.916)	0.661 (0.526)
Per capita aid	**0.397***** (0.037)	**0.394***** (0.030)	0.071 (0.066)	**0.326***** (0.083)	**0.231***** (0.043)	0.209 (0.167)	**0.475***** (0.174)
Average size of local government	0.025 (0.016)	**-0.047***** (0.014)	**-0.065**** (0.030)	**0.151***** (0.036)	**0.157***** (0.022)	0.030 (0.075)	**0.389***** (0.069)
MSA population	0.059 (0.067)	-0.099 (0.067)	-0.143 (0.125)	0.140 (0.142)	0.097 (0.091)	-0.908 (0.306)	0.031 (0.265)
Average density	-0.009 (0.025)	-0.017 (0.025)	**-0.112**** (0.043)	0.080* (0.050)	-0.011 (0.035)	0.185 (0.110)	0.012 (0.129)
Gini	0.020 (0.025)	0.007 (0.029)	-0.056 (0.063)	**-0.338***** (0.067)	**-0.171**** (0.045)	-0.333 (0.240)	**0.417**** (0.168)
Percent with at least bachelor's degree	**0.098**** (0.050)	0.034 (0.038)	-0.048 (0.083)	0.043 (0.111)	0.104* (0.064)	0.094 (0.179)	-0.100 (0.237)
Average wage	**0.326**** (0.150)	0.121 (0.143)	**0.786***** (0.219)	-0.040 (0.377)	0.086 (0.200)	-0.222 (0.744)	-0.658 (0.594)
Number of Jobs	**-0.046*** (0.025)	0.032 (0.024)	**-0.122***** (0.045)	**-0.154***** (0.058)	-0.022 (0.037)	0.032 (0.744)	0.039 (0.179)
constant	**-2.750**** (1.261)	-1.811 (1.190)	**-11.310***** (1.884)	-4.710 (3.058)	**-6.657***** (1.583)	-9.119 (6.437)	-1.949) (4.685)
Adjusted R square	0.526	0.594	0.599	0.307	0.569	0.351	0.137
n	273	272	273	273	273	156	273

Robust standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 2-7: Regression results, 2002

	Per Capita Current Operations	Per Capita Education Current Operations	Per Capita Highway Current Operations	Per Capita Fire Current Operations	Per Capita Police Current Operation	Per Capita Sewer Current Operations	Per Capita Waste Management Current Operations
State share of state and local total	**-0.619***** (0.082)	**-0.252***** (0.042)	**-0.689***** (0.072)	---	**-0.213***** (0.046)	-0.004 (0.038)	---
Tax Price	0.081 (0.081)	-0.113 (0.022)	-0.183 (0.138)	-0.019 (0.151)	0.112 (0.104)	**-0.578***** (0.173)	0.510 (0.322)
Per capita personal income	0.125 (0.109)	0.032 (0.122)	**0.273**** (0.265)	**0.896***** (0.269)	**0.712***** (0.149)	-0.259 (0.458)	0.752 (0.618)
Per capita aid	**0.335***** (0.035)	**0.366***** (0.034)	-0.096 (0.076)	**0.364***** (0.111)	**0.154**** (0.064)	**0.209*** (0.115)	**0.258*** (0.144)
Average size of local government	**0.029*** (0.016)	**-0.047***** (0.015)	**-0.081**** (0.036)	**0.161***** (0.045)	**0.090***** (0.021)	**-0.094*** (0.051)	**0.385***** (0.091)
MSA population	0.122 (0.083)	0.036 (0.096)	-0.192 (0.148)	-0.034 (0.162)	0.126 (0.108)	**-0.690***** (0.203)	0.538 (0.361)
Average density	-0.002 (0.023)	-0.009 (0.022)	**-0.120***** (0.046)	**0.142**** (0.064)	0.019 (0.037)	**0.224***** (0.082)	0.036 (0.124)
Gini	0.019 (0.035)	0.048 (0.029)	**-0.131*** (0.074)	**-0.314***** (0.074)	**-0.197***** (0.045)	0.001 (0.094)	**0.460**** (0.208)
Percent with at least bachelor's degree	**0.086*** (0.050)	-0.034 (0.040)	-0.080 (0.099)	**0.195*** (0.106)	0.007 (0.066)	**0.326*** (0.172)	-0.118 (0.260)
Average wage	**0.273*** (0.146)	0.165 (0.133)	**0.627**** (0.316)	-0.541 (0.369)	-0.065 (0.180)	0.185 (0.447)	-0.643 (0.578)
Number of Jobs	**-0.060**** (0.027)	-0.005 (0.022)	-0.011 (0.059)	**-0.135**** (0.064)	0.027 (0.035)	0.052 (0.072)	0.028 (0.130)
constant	-1.816 (1.235)	-1.6630 (1.147)	**-10.066***** (2.770)	-0.696 (3.171)	**-4.773***** (1.540)	-6.679 (4.050)	0.525 (5.428)
Adjusted R square	0.520	0.597	0.463	0.246	0.592	0.292	0.162
n	273	272	273	273	273	156	273

Robust standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 2-8: Regression results for Capital Expenditures, 1992

	Per Capita Capital Expenditures-Total	**Per Capita Capital Expenditures-Education**	**Per Capita Capital Expenditures-Sewer**	**Per Capita Capital Expenditures-Waste Management**
State share of state and local total	**-0.806***** (0.210)	**-0.476***** (0.139)	-0.014 (0.061)	---
Tax Price	0.083 (0.153)	-0.207 (0.173)	-0.388 (0.626)	0.167 (0.472)
Per capita personal income	0.256 (0.260)	0.006 (0.382)	2.711 (1.892)	**3.146*** (0.877)
Per capita aid	0.132 (0.089)	**0.289**** (0.114)	-0.452 (0.425)	0.236 (0.297)
Average size of local government	**0.118***** (0.038)	0.046 (0.060)	-0.158 (0.221)	**0.413***** (0.150)
MSA population	0.177 (0.158)	-0.165 (0.191)	-0.367 (0.752)	-0.039 (0.525)
Average density	**-0.141***** (0.046)	-0.111 (0.076)	0.029 (0.399)	-0.267 (0.184)
Gini	-0.007 (0.071)	0.027 (0.109)	**-1.731**** (0.634)	0.351 (0.285)
Percent with at least bachelor's degree	**0.305***** (0.114)	0.192 (0.197)	-0.002 (0.698)	-0.327 (0.419)
Average wage	-0.378 (0.294)	**-1.234***** (0.471)	0.480 (1.926)	-4.250 (1.131)
Number of Jobs	**0.098*** (0.058)	**0.202***** (0.091)	0.369 (0.374)	**0.607*** (0.260)
constant	0.021 (2.499)	5.986 (3.838)	-23.871 (17.801)	**20.318*** (9.052)
Adjusted R square	0.300	0.136	0.287	0.099
n	273	272	156	273

Robust standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 2-9: Regression results for Capital Expenditures, 2002

	Per Capita Capital Expenditures-Total	Per Capita Capital Expenditures-Education	Per Capita Capital Expenditures-Sewer	Per Capita Capital Expenditures-Waste Management
State share of state and local total	**-0.576****	**-0.477*****	0.030	---
	(0.238)	(0.140)	(0.051)	
Tax Price	-0.183	-0.263	0.456	0.678
	(0.152)	(0.201)	(0.634)	(0.569)
Per capita personal income	0.020	-0.423	-2.071	1.891
	(0.271)	(0.445)	(1.811)	(1.193)
Per capita aid	**0.148***	**0.304****	-0.563	0.353
	(0.091)	(0.144)	(0.405)	(0.367)
Average size of local government	0.061	**-0.121****	-0.231	**0.339***
	(0.041)	(0.058)	(0.233)	(0.173)
MSA population	-0.086	-0.080	0.952	0.687
	(0.164)	(0.211)	(0.693)	(0.655)
Average density	**-0.104****	**-0.134***	-0.052	0.006
	(0.051)	(0.071)	(0.259)	(0.263)
Gini	-0.030	0.191*	-0.268	-0.231
	(0.075)	(0.103)	(0.329)	(0.339)
Percent with at least bachelor's degree	0.359	0.127	0.732	0.209
	(0.104)	(0.175)	(0.763)	(0.528)
Average wage	0.193	0.279	1.394	-2.230-
	(0.317)	(0.466)	(1.777)	(1.292)
Number of Jobs	0.093	**0.216*****	-0.028	-0.168
	(0.059)	(0.082)	(0.274)	(0.287)
constant	**-5.371***	**-6.719***	-8.753	13.046
	(2.842)	(3.857)	(16.380)	(11.984)
Adjusted R square	0.300	0.259	0.171	0.044
n	273	272	156	273

Robust standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 2-10: Regression results Alternative Sprawl Measure, Index of Dissimilarity, 1992

	Per Capita Current Operations	Per Capita Education Current Operations	Per Capita Highway Current Operations	Per Capita Fire Current Operations	Per Capita Police Current Operation	Per Capita Sewer Current Operations	Per Capita Waste Management Current Operations
State share of state and local total	**-0.470***** (0.070)	**-0.275***** (0.039)	**-0.794***** (0.070)	---	-0.332 (0.043)	-0.003 (0.039)	---
Tax Price	0.037 (0.062)	-0.109 (0.068)	-0.153 (0.119)	0.127 (0.138)	0.082 (0.088)	**-0.762**** (0.291)	0.032 (0.218)
Per capita personal income	**0.211**** (0.100)	-0.048 (0.121)	**0.627***** (0.181)	**0.925***** (0.267)	0.794 (0.173)	1.234 (0.925)	0.652 (0.525)
Per capita aid	**0.396***** (0.036)	**0.393***** (0.030)	0.076 (0.065)	**0.343***** (0.079)	0.244 (0.043)	0.225 (0.174)	**0.451**** (0.175)
Average size of local government	0.026 (0.016)	**-0.046***** (0.014)	-0.064** (0.029)	**0.147***** (0.035)	0.158 (0.022)	0.034 (0.077)	**0.393***** (0.067)
MSA population	0.059 (0.067)	-0.098 (0.067)	-0.139 (0.123)	0.152 (0.142)	0.108 (0.093)	**-0.899***** (0.309)	0.012 (0.261)
Average density	0.012 (0.024)	-0.019 (0.025)	**-0.120***** (0.040)	**0.093*** (0.049)	-0.012 (0.035)	0.171 (0.109)	0.010 (0.123)
ID	0.038 (0.044)	0.014 (0.042)	-0.055 (0.081)	**-0.504***** (0.084)	**-0.200***** (0.056)	-0.424 (0.338)	0.580 (0.213)
Percent with at least bachelor's degree	**0.102**** (0.050)	0.035 (0.039)	-0.046 (0.084)	0.012 (0.109)	0.102 (0.064)	0.074 (0.193)	-0.074 (0.239)
Average wage	**0.329**** (0.151)	0.122 (0.143)	**0.786***** (0.220)	-0.059 (0.364)	0.081 (0.202)	-0.247 (0.730)	-0.637 (0.590)
Number of Jobs	**-0.043*** (0.025)	0.034 (0.024)	**-0.118***** (0.043)	**-0.166***** (0.058)	-0.017 (0.038)	0.042 (0.128)	0.045 (0.182)
constant	-2.767 (1.264)	-1.820 (1.189)	**-11.310***** (1.897)	-4.616 (2.946)	-6.638 (1.598)	-9.072 (6.403)	-2.041 (4.636)
Adjusted R square	0.527	0.594	0.598	0.323	0.566	0.350	0.139
n	273	272	273	273	273	156	273

Robust standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 2-11: Regression results Alternative Sprawl Measure, Index of Dissimilarity, 2002

	Per Capita Current Operations	Per Capita Education Current Operations	Per Capita Highway Current Operations	Per Capita Fire Current Operations	Per Capita Police Current Operation	Per Capita Sewer Current Operations	Per Capita Waste Management Current Operations
State share of state and local total	**-0.622***** (0.080)	-0.256 (0.042)	**-0.691***** (0.073)	---	-0.211 (0.045)	-0.004 (0.011)	---
Tax Price	0.082 (0.079)	-0.003 (0.091)	-0.176 (0.136)	-0.001 (0.147)	0.131 (0.100)	**-0.562***** (0.168)	0.493 (0.314)
Per capita personal income	0.128 (0.110)	0.036 (0.123)	**0.256***** (0.264)	**0.856***** (0.263)	0.691 (0.151)	-0.270 (0.454)	0.816 (0.626)
Per capita aid	**0.335***** (0.035)	0.365 (0.034)	-0.098 (0.076)	**0.362***** (0.111)	0.154 (0.064)	**0.212*** (0.115)	**0.264*** (0.144)
Average size of local government	**0.029*** (0.016)	-0.047 (0.015)	**-0.082**** (0.035)	**0.161***** (0.452)	0.090 (0.020)	**-0.092*** (0.050)	**0.388***** (0.092)
MSA population	0.122 (0.081)	0.034 (0.093)	-0.176 (0.144)	0.004 (0.157)	0.158 (0.103)	**-0.670***** (0.196)	0.492 (0.346)
Average density	-0.005 (0.024)	-0.013 (0.022)	**-0.116***** (0.045)	**0.148**** (0.062)	0.015 (0.037)	**0.205**** (0.079)	-0.055 (0.131)
ID	0.033 (0.044)	**0.054*** (0.034)	-0.184 (0.097)	**-0.431***** (0.099)	**-0.249***** (0.062)	0.069 (0.134)	**0.663**** (0.278)
Percent with at least bachelor's degree	**0.088*** (0.051)	-0.031 (0.040)	-0.090 (0.099)	**0.173*** (0.105)	-0.002 (0.066)	**0.335*** (0.170)	-0.081 (0.258)
Average wage	**0.271*** (0.145)	0.163 (0.133)	**0.644***** (0.316)	-0.498 (0.365)	-0.038 (0.181)	0.207 (0.453)	-0.703 (0.577)
Number of Jobs	**-0.058**** (0.027)	0.002 (0.023)	**-0.015***** (0.059)	**-0.143**** (0.062)	0.027 (0.034)	0.064 (0.071)	0.046 (0.131)
constant	-1.805 (1.230)	-1.618 (1.144)	**-10.178***** (2.779)	-0.968 (3.154)	-4.935 (1.553)	**-6.792*** (4.074)	0.930 (5.434)
Adjusted R square	0.520	0.598	0.464	0.251	0.591	0.294	0.167
n	273	272	273	273	273	156	273

Robust standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 2-12: Regression results, Alternative Sprawl Measure, Sprawl Indicator, 1992

	Per Capita Current Operations	Per Capita Education Current Operations	Per Capita Highway Current Operations	Per Capita Fire Current Operations	Per Capita Police Current Operation	Per Capita Sewer Current Operations	Per Capita Waste Management Current Operations
State share of state and local total	**-0.463***** (0.073)	**-0.278***** (0.039)	**-0.794***** (0.071)	---	**-0.316***** (0.041)	0.010 (0.038)	---
Tax Price	0.036 (0.063)	-0.108 (0.067)	-0.155 (0.118)	0.130 (0.142)	0.077 (0.084)	**-0.746**** (0.283)	0.018 (0.222)
Per capita personal income	**0.211**** (0.100)	-0.048 (0.121)	**0.626***** (0.182)	**0.923***** (0.276)	**0.791***** (0.172)	1.122 (0.895)	0.653 (0.523)
Per capita aid	**0.394***** (0.036)	**0.393***** (0.030)	0.077 (0.065)	**0.364***** (0.086)	**0.250***** (0.042)	0.191 (0.161)	**0.417**** (0.175)
Average size of local government	0.024 (0.016)	**-0.044***** (0.014)	**-0.068**** (0.030)	**0.148***** (0.035)	**0.150***** (0.021)	0.025 (0.072)	**0.373***** (0.066)
MSA population	0.056 (0.067)	-0.097 (0.067)	-0.143 (0.123)	0.157 (0.145)	0.098 (0.089)	**-0.858***** (0.308)	-0.014 (0.264)
Average density	-0.002 (0.021)	-0.021 (0.022)	**-0.117***** (0.036	-0.020 (0.044)	0.016 (0.030)	0.138 (0.114)	0.144 (0.125)
SI	0.006 (0.029)	0.022 (0.023)	-0.066 (0.056)	**-0.296***** (0.060)	**-0.198***** (0.040)	-0.188 (0.184)	0.186 (0.151)
Percent with at least bachelor's degree	**0.094*** (0.048)	0.037 (0.038)	-0.048 (0.083)	0.071 (0.108)	**0.106*** (0.060)	0.111 (0.185)	-0.177 (0.238)
Average wage	**0.324**** (0.151)	0.125 (0.143)	**0.782***** (0.220)	-0.051 (0.391)	0.074 (0.197)	-0.125 (0.794)	-0.667 (0.611)
Number of Jobs	**-0.049*** (0.025)	0.039 (0.024)	**-0.130***** (0.045)	**-0.168***** (0.063)	-0.046 (0.038)	0.024 (0.136)	-0.009 (0.198)
constant	**-2.744**** (1.270)	-1.885 (1.195)	**-11.170***** (1.889)	-4.129 (3.145)	**-6.215***** (1.567)	-9.354 (6.699)	-2.207 (4.839)
Adjusted R square	0.526	0.560	0.600	0.309	0.583	0.341	0.124
n	273	272	273	273	273	156	273

Robust standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 2-13: Regression results, Alternative Sprawl Measure, Sprawl Indicator, 2002

	Per Capita Current Operations	Per Capita Education Current Operations	Per Capita Highway Current Operations	Per Capita Fire Current Operations	Per Capita Police Current Operation	Per Capita Sewer Current Operations	Per Capita Waste Management Current Operations
State share of state and local total	**-0.635***** (0.083)	**-0.256***** (0.041)	**-0.803***** (0.072)	---	**-0.210***** (0.042)	-0.005 (0.010)	---
Tax Price	0.088 (0.079)	0.005 (0.093)	-0.195 (0.130)	-0.006 (0.143)	0.131 (0.099)	**-0.553***** (0.172)	0.477 (0.308)
Per capita personal income	0.128 (0.109)	0.037 (0.123)	0.281 (0.266)	**0.877***** (0.279)	**0.705***** (0.152)	-0.261 (0.455)	0.774 (0.624)
Per capita aid	**0.330***** (0.035)	**0.359***** (0.034)	-0.084 (0.076)	**0.398***** (0.109)	**0.175***** (0.060)	**0.204*** (0.114)	0.209 (0.146)
Average size of local government	**0.031*** (0.016)	**-0.045***** (0.015)	**-0.076**** (0.037)	**0.153***** (0.044)	**0.087***** (0.020)	**-0.087*** (0.052)	**0.394***** (0.092)
MSA population	0.128 (0.081)	0.044 (0.094)	-0.137 (0.148)	-0.005 (0.151)	0.156 (0.101)	**-0.661***** (0.199)	0.478 (0.339)
Average density	-0.006 (0.020)	-0.012 (0.019)	**-0.168***** (0.039)	0.101 (0.071	0.015 (0.030)	**0.208***** (0.071)	0.037 (0.112)
SI	0.037 (0.029)	**0.053**** (0.021)	-0.044 (0.062)	**-0.318***** (0.061)	**-0.177***** (0.043)	0.064 (0.083)	**0.431**** (0.184)
Percent with at least bachelor's degree	**0.086*** (0.050)	-0.036 (0.039)	-0.063 (0.099)	**0.216**** (0.105)	0.022 (0.064)	**0.325***** (0.173)	-0.152 (0.255)
Average wage	**0.278*** (0.145)	0.169 (0.131)	**0.648**** (0.316)	-0.523 (0.373)	-0.051 (0.182)	0.212 (0.449)	-0.675 (0.584)
Number of Jobs	**-0.052*** (0.028)	0.011 (0.022)	0.011 (0.060)	**-0.166**** (0.071)	0.016 (0.036)	0.074 (0.073)	0.059 (0.136)
constant	-1.918 (1.234)	-1.751 (1.136)	**-10.049***** (2.758)	-0.224 (3.196)	**-4.515***** (1.565)	**-6.971*** (4.076)	-0.094 (5.425)
Adjusted R square	0.521	0.602	0.456	0.258	0.594	0.295	0.165
n	273	272	273	273	273	156	273

Robust standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 2-14: Elasticities for Sprawl Gini, ID, SI, 1992

	Per Capita Current Operations	Per Capita Education Current Operations	Per Capita Highway Current Operations	Per Capita Fire Current Operations	Per Capita Police Current Operation	Per Capita Sewer Current Operations	Per Capita Waste Management Current Operations
Sprawl Gini	0.020 (0.025)	0.007 (0.029)	-0.056 (0.063)	**-0.338***** (0.067)	**-0.171**** (0.045)	-0.333 (0.240)	**0.417**** (0.168)
ID	0.038 (0.044)	0.014 (0.042)	-0.055 (0.081)	**-0.504***** (0.084)	**-0.200***** (0.056)	-0.424 (0.338)	0.580 (0.213)
SI	0.006 (0.029)	0.022 (0.023)	-0.066 (0.056)	**-0.296***** (0.060)	**-0.198***** (0.040)	-0.188 (0.184)	0.186 (0.151)

Table 2-15: Elasticities for Sprawl Gini, ID, SI, 2002

	Per Capita Current Operations	Per Capita Education Current Operations	Per Capita Highway Current Operations	Per Capita Fire Current Operations	Per Capita Police Current Operation	Per Capita Sewer Current Operations	Per Capita Waste Management Current Operations
Sprawl Gini	0.019 (0.035)	0.048 (0.029)	-0.131* (0.074)	-0.314*** (0.074)	-0.197*** (0.045)	0.001 (0.094)	0.460** (0.208)
ID	0.033 (0.044)	0.054* (0.034)	-0.184 (0.097)	-0.431*** (0.099)	-0.249*** (0.062)	0.069 (0.134)	0.663** (0.278)
SI	0.037 (0.029)	0.053** (0.021)	-0.044 (0.062)	-0.318*** (0.061)	-0.177*** (0.043)	0.064 (0.083)	0.431** (0.184)

Table 2-16: Regression results with Population Change Variable, 1992

	Per Capita Current Operations	Per Capita Education Current Operations	Per Capita Highway Current Operations	Per Capita Fire Current Operations	Per Capita Police Current Operation	Per Capita Sewer Current Operations	Per Capita Waste Management Current Operations
State share of state and local total	**-0.395***** (0.083)	**-0.324***** (0.042)	**-0.878***** (0.090)	---	**-0.280***** (0.041)	-0.002 (0.059)	---
Tax Price	-0.004 (0.020)	-0.012 (0.015)	-0.028 (0.039)	**-0.027***** (0.052)	-0.031 (0.031)	0.069 (0.110)	-0.009 (0.082)
Per capita personal income	0.203 (0.105)	-0.064 (0.122)	**0.682***** (0.191)	**0.936***** (0.291)	**0.815***** (0.170)	**2.796***** (0.946)	0.664 (0.528)
Per capita aid	**0.411***** (0.039)	**0.375***** (0.031)	0.063 (0.066)	**0.329***** (0.084)	**0.267***** (0.043)	0.040 (0.247)	**0.394***** (0.210)
Average size of local government	0.001 (0.016)	**-0.072***** (0.015)	-0.051 (0.032)	0.126 (0.039)	**0.119***** (0.022)	-0.081 (0.089)	**0.308***** (0.076)
Population Change, 10 year	0.018 (0.015)	-0.006 (0.011)	**0.047**** (0.023)	0.060 (0.043)	**0.058**** (0.026)	**0.116***** (0.061)	0.019 (0.073)
Average density	0.036 (0.028)	0.014 (0.021)	**-0.124**** (0.050)	0.068 (0.057)	0.0002 (0.037)	0.136 (0.229)	0.110 (0.187)
Sprawl Gini	-0.011 (0.035)	-0.021 (0.028)	-0.021 (0.062)	**-0.294***** (0.070)	**-0.135***** (0.044)	-0.537 (0.355)	**0.322*** (0.181)
Percent with at least bachelor's degree	0.036 (0.052)	-0.026 (0.039)	-0.087 (0.089)	0.017 (0.125)	0.012 (0.065)	-0.148 (0.245	-0.339 (0.265)
Average wage	**0.375**** (0.162)	0.166 (0.154)	**1.097***** (0.226)	-0.086 (0.453)	0.156 (0.196)	0.419 (1.044)	-0.535 (0.558)
Number of Jobs	**-0.064**** (0.026)	0.010 (0.024)	-0.172 (0.057)	**-0.152**** (0.075)	-0.043 (0.044)	**-0.287**** (0.137)	-0.060 (0.199)
constant	**-3.154**** (1.393)	-0.614 (1.321)	**-13.446***** (1.930)	-4.824 (3.808)	**-7.345***** (1.587)	-11.434 (9.497)	-2.630 (4.538)
Adjusted R square	0.529	0.640	0.580	0.283	0.568	0.349	0.120
n	273	272	273	273	273	156	273

Robust standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 2-17: Regression results with Population Change Variable, 2002

	Per Capita Current Operations	Per Capita Education Current Operations	Per Capita Highway Current Operations	Per Capita Fire Current Operations	Per Capita Police Current Operation	Per Capita Sewer Current Operations	Per Capita Waste Management Current Operations
State share of state and local total	**-0.574***** (0.090)	**-0.236***** (0.046)	**-0.705***** (0.080)	---	**-0.212***** (0.043)	-0.007 (0.011)	---
Tax Price	0.017 (0.017)	**-0.025*** (0.015)	-0.004 (0.039)	-0.011 (0.037)	-0.014 (0.023)	0.058 (0.059)	0.043 (0.076)
Per capita personal income	0.065 (0.119)	-0.006 (0.118)	0.425 (0.273)	**1.076***** (0.271)	**0.808***** (0.138)	-0.104 (0.538)	0.530 (0.648)
Per capita aid	**0.336***** (0.037)	**0.356***** (0.324)	-0.122 (0.077)	**0.373***** (0.116)	**0.188***** (0.053)	0.096 (0.142)	0.245 (0.155)
Average size of local government	0.018 (0.016)	**-0.060***** (0.015)	**-0.080**** (0.040)	**0.153***** (0.049)	**0.075***** (0.021)	**-0.146**** (0.060)	**0.313***** (0.081)
Population Change, 10 year	0.006 (0.013)	0.009 (0.010)	0.030 (0.032)	0.051 (0.038)	**0.055***** (0.018)	0.048 (0.034)	0.078 (0.064)
Average density	**0.041*** (0.024)	0.030 (0.020)	**-0.125**** (0.049	**0.126*** (0.074)	0.024 (0.037)	**0.225**** (0.109)	0.074 (0.134)
Sprawl Gini	-0.023 (0.036)	0.010 (0.027)	**-0.127*** (0.077)	**-0.270***** (0.072)	**-0.179***** (0.044)	0.075 (0.114)	**0.420**** (0.206)
Percent with at least bachelor's degree	0.074 (0.053)	0.070 (0.040)	-0.138 (0.106)	0.106 (0.113)	-0.049 (0.063)	0.201 (0.189)	-0.118 (0.246)
Average wage	**0.295*** (0.150)	0.214 (0.136)	**0.721**** (0.346)	-0.588 (0.390)	-0.105 (0.177)	0.328 (0.485)	-0.768 (0.602)
Number of Jobs	**-0.071*** (0.028)	0.013 (0.136)	-0.047 (0.068)	**-0.143*** (0.072)	0.016 (0.037)	-0.022 (0.083)	0.058 (0.135)
constant	**-2.279*** (1.238)	**-2.046*** (1.165)	**-10.216***** (2.889)	-0.590 (3.284)	**-5.033***** (1.492)	-4.260 (4.358)	0.212 (5.183)
Adjusted R square	0.507	0.617	0.449	0.242	0.601	0.262	0.139
n	273	272	273	273	273	156	273

Robust standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 2-18: Fixed Effects Panel results

	Per Capita Current Operations	Per Capita Education Current Operations	Per Capita Highway Current Operations	Per Capita Fire Current Operations	Per Capita Police Current Operation	Per Capita Sewer Current Operations	Per Capita Waste Management Current Operations
State share of state and local total	**-0.248***** (0.093)	**-0.202***** (0.042)	-0.127 (0.101)	---	0.068 (0.056)	0.031 (0.036)	---
Tax Price	-0.027 (0.052)	0.002 (0.042)	0.079 (0.130)	-0.090 (0.208)	-0.079 (0.098)	-0.026 (1.203)	-0.001 (0.333)
Per capita personal income	0.143 (0.185)	**-0.319**** (0.143)	0.541 (0.445)	0.401 (0.711)	-0.324 (0.337)	3.883 (1.525)	-1.098 (1.138)
Per capita aid	**0.195***** (0.045)	**0.125***** (0.036)	**0.203*** (0.110)	0.095 (0.174)	**0.206**** (0.083)	0.446 (0.396)	0.162 (0.278)
Average size of local government	-0.026 (0.028)	-0.022 (0.023)	-0.009 (0.070)	0.036 (0.111)	0.054 (0.053)	-0.167 (0.150)	0.087 (0.178)
MSA population	0.045 (0.052)	0.055 (0.039)	0.024 (0.123)	0.016 (0.196)	0.013 (0.009)	-0.050 (0.037)	-0.002 (0.034)
Average density	-0.216 (0.168)	**-0.210*** (0.128)	-0.007 (0.398)	-0.270 (0.636)	**-0.723**** (0.303)	0.875 (1.592)	-0.540 (1.018)
Gini	-0.056 (0.059)	-0.031 (0.047)	0.176 (0.147)	-0.040 (0.232)	-0.039 (0.110)	**-3.771***** (1.019)	-0.338 (0.372)
Percent with at least bachelor's degree	**0.160*** (0.083)	**0.149*** (0.065)	-0.028 (0.206)	-0.362 (0.325	0.031 (0.154)	-1.095 (0.894)	-0.127 (0.521)
Average wage	-0.060 (0.171)	**0.248*** (0.133)	0.569 (0.416)	0.092 (0.661)	0.195 (0.313)	-1.618 (1.209)	0.332 (1.058)
Number of Jobs	0.095 (0.131)	-0.021 (0.103)	0.023 (0.319)	-0.144 (0.512)	0.335 (0.245)	0.256 (0.819)	1.095 (0.820)
2002 Dummy	**0.283***** (0.067)	**0.421***** (0.053)	-0.210 (0.166)	0.278 (0.265)	**0.462***** (0.125)	-0.526 (0.589)	0.578 (0.424)
constant	0.847 (1.776)	-0.230 (1.409)	-8.862 (4.391)	-3.885 (7.023)	-4.404 (3.335)	-10.542 (14.733)	-14.663 (11.246)
R square within	0.938	0.959	0.587	0.484	0.844	0.750	0.245
n	273	272	273	273	273	156	273

Robust standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 2-19: Regression results with interaction term, 1992

	Per Capita Current Operations	Per Capita Education Current Operations	Per Capita Highway Current Operations	Per Capita Fire Current Operations	Per Capita Police Current Operation	Per Capita Sewer Current Operations	Per Capita Waste Management Current Operations
State share of state and local total	**-0.460*****	**-0.268*****	**-0.790*****	---	**-0.353*****	0.004	---
	(0.071)	(0.038)	(0.071)		(0.043)	(0.040)	
Tax Price	0.039	-0.114	-0.148	0.146	0.065	**-0.751*****	-0.017
	(0.062)	(0.071)	(0.120)	(0.142)	(0.078)	(0.261)	(0.223)
Per capita personal income	**0.221****	-0.062	**0.643*****	**0.969*****	**0.738*****	1.137	0.507
	(0.101)	(0.119)	(0.186)	(0.280)	(0.172)	(0.909)	(0.509)
Per capita aid	**0.398*****	**0.391*****	0.073	**0.331*****	**0.223*****	0.225	**0.460*****
	(0.037)	(0.031)	(0.066)	(0.082)	(0.042)	(0.174)	(0.170)
Average size of local government	0.025	**-0.046*****	**-0.067****	**0.149*****	**0.160*****	0.038	**0.397*****
	(.016)	(0.014)	(0.030)	(0.036)	(0.022)	(0.077)	(0.070)
MSA population	0.060	-0.101	-0.141	0.147	0.091	**-0.873*****	0.011
	(0.066)	(0.070)	(0.125)	(0.149)	(0.084)	(0.281)	(0.264)
Average density	-0.027	0.020	**-0.152****	-0.026	**0.110****	0.353	**0.333***
	(0.037)	(0.052)	(0.063)	(0.095)	(0.058)	(0.233)	(0.195)
Sprawl Gini	0.078	-0.111	0.069	-0.001	**-0.529*****	-1.079	-0.608
	(0.091)	(0.122)	(0.160)	(0.241)	(0.148)	(1.016)	(0.573)
Percent with at least bachelor's degree	**0.095***	0.039	-0.055	0.023	**0.126***	0.091	-0.041
	(0.051)	(0.038)	(0.084)	(0.112)	(0.067)	(0.180)	(0.235)
Average wage	**0.326****	0.115	**0.793*****	-0.030	0.076	-0.216	-0.686
	(0.151)	(0.143)	(0.218)	(0.380)	(0.198)	(0.754)	(0.595)
Number of Jobs	**-0.045***	0.033	**-0.122*****	**-0.153*****	-0.023	0.009	0.038
	(0.025)	(0.024)	(0.045)	(0.059)	(0.037)	(0.133)	(0.178)
Sprawl-Density interaction	-0.013	0.025	-0.027	-0.072	**0.077****	0.142	**0.218***
	(0.018)	(0.024)	(0.033)	(0.047)	(0.031)	(0.196)	(0.124)
Constant	**-2.658****	-1.931	**-11.180*****	-4.309	**-7.123*****	-9.750	-3.165
	(1.267)	(1.193)	(1.865)	(3.110)	(1.597)	(6.752)	(4.796)
Adjusted R square	0.527	0.597	0.599	0.312	0.578	0.356	0.147
n	273	272	273	273	273	156	273

Robust standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Table 2-20: Regression results with interaction term, 2002

	Per Capita Current Operations	Per Capita Education Current Operations	Per Capita Highway Current Operations	Per Capita Fire Current Operations	Per Capita Police Current Operation	Per Capita Sewer Current Operations	Per Capita Waste Management Current Operations
State share of state and local total	**-0.599***** (0.082)	**-0.254***** (0.042)	**-0.690***** (0.071)	---	-0.216 (0.046)	-0.004 (0.011)	---
Tax Price	0.089 (0.071)	-0.011 (0.101)	-0.164 (0.138)	0.004 (0.177)	0.102 (0.096)	**-0.574***** (0.179)	0.521 (0.331)
Per capita personal income	0.138 (0.110)	0.020 (0.118)	0.300 (0.264)	**0.929***** (0.272)	0.697 (0.150)	-0.269 (0.465)	0.766 (0.605)
Per capita aid	**0.336***** (0.035)	**0.367***** (0.034)	-0.099 (0.075)	**0.359***** (0.109)	0.155 (0.065)	**0.204*** (0.120)	**0.256*** (0.145)
Average size of local government	**0.027*** (0.016)	**-0.046***** (0.015)	**-0.083**** (0.036)	**0.159***** (0.045)	0.091 (0.021)	**-0.095*** (0.052)	**0.384***** (0.093)
MSA population	**0.127*** (0.073)	0.029 (0.103)	-0.177 (0.146)	-0.015 (0.187)	0.118 (0.099)	**-0.686***** (0.209)	0.547 (0.370)
Average density	-0.063 (0.040)	0.045 (0.051)	**-0.258***** (0.073)	-0.025 (0.082)	0.094 (0.057)	**0.199**** (0.094)	-0.113 (0.235)
Sprawl Gini	**0.226**** (0.110)	-0.152 (0.140)	**0.337*** (0.204)	0.254 (0.275)	-0.452 (0.163)	0.094 (0.261)	0.721 (0.867)
Percent with at least bachelor's degree	0.078 (0.050)	-0.027 (0.040)	-0.098 (0.099)	0.172 (0.107)	0.017 (0.067)	**0.323*** (0.172)	-0.128 (0.253)
Average wage	**0.281*** (0.146)	0.155 (0.131)	**0.657**** (0.308)	-0.505 (0.368)	-0.081 (0.177)	0.192 (0.450)	-0.627 (0.580)
Number of Jobs	**-0.058**** (0.027)	-0.001 (0.022)	-0.009 (0.059)	**-0.132**** (0.064)	0.026 (0.035)	0.052 (0.072)	0.028 (0.130)
Sprawl-Density interaction	**-0.041**** (0.021)	0.037 (0.027)	**-0.093**** (0.039)	**-0.112**** (0.050)	0.050 (0.030)	-0.018 (0.054)	-0.052 (0.152)
constant	-1.575 (1.232)	-1.814 (1.144)	**-9.635***** (2.651)	-0.174 (3.227)	-5.013 (1.511)	-6.562 (4.130)	0.765 (5.612)
Adjusted R square	0.524	0.603	0.471	0.255	0.597	0.293	0.162
n	273	272	273	273	273	156	273

Robust standard errors in parentheses
*significant at 10%, ** significant at 5%, *** significant at 1%

Vita

Julie Lynn Marshall was born May 18, 1976 in Long Beach, California. She graduated from Los Alamitos High School in Orange County, California and moved to Knoxville, Tennessee to continue her academic career at the University of Tennessee. In May 1999, she received her B.A. with a major in environmental studies and a minor in botany. Julie then entered the Graduate School at the University of Tennessee, where in May 2001 she earned her M.A. in economics. Julie continued on with her studies in pursuit of a Ph.D. in economics. She accepted an offer from the Joint Committee on Taxation, in Washington, D.C. beginning in the summer of 2008, after completing her Ph.D.