**Property Taxation, its Land Value Component, and the Generation of "Urban Sprawl": The Needed Empirical Evidence***

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**Abstract**

Does the rate of property taxation in an urban area influence its occurrence of "urban sprawl"? Theory, which relies on the land value component of this taxation, is not clear on this. Furthermore, methodological concerns in earlier empirical analyses of this issue cast doubt on their reliability. The proposed use of panel data from 400 plus United States urban areas, various measures of population density as dependent variables, and a more fully specified set of explanatory variables results in greater confidence that the estimated effect of an urban area's rate of property taxation on its population density is valid.

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## Introduction

The primary objective of this research is an enhanced resolution of the question of whether the rate of property taxation in an urban area influences its population density, and if so, the direction and magnitude of the influence. We know that the form of property taxation practiced in the United States is different from the non-distortionary ideal of a Georgian land value tax assessed on a site's "highest and best use" value. Nevertheless, what remains uncertain are the direction and degree of the distortions generated by the traditional property tax. Theory does not yield clear predictions on this, while implementation issues regarding previous empirical assessments cast some doubt on the reliability of findings from them.

As described by Vickrey (1999), and summarized by Oates and Schwab (2009), property taxation as largely practiced in the United States falls upon both the land and improvement portions of the property taxed. Due to its inability to distort the supply of raw land, the portion of the property tax falling upon land (or site) value is one of the "best" taxes. The portion falling upon improvements to the land is one of the "worst" taxes due to its high likelihood of discouraging such additions to land. Such thinking is the basis of Henry George's (1879) advocacy for a single land value tax based upon its "highest and best use" and more contemporary requests, as summarized in Kenyon, Langley, and Paquin (2012), for limiting the rate of traditional property taxation on mobile business activity.

The vast majority of jurisdictions in the United States levy a property tax that does not distinguish between the land and improvement components of the property taxed. Instead, a single rate of taxation applies to the combined market value of a property's land and improvements in their current and not necessarily "best" use. This form of property taxation raises nearly one-quarter of all own-source state and local revenue in the United States, while the state and local governments of New Hampshire, New Jersey, Illinois, and Texas respectively gather about 43, 37, 31, and 30 percent of their own-source revenue from property taxation.[1] Given the best and worst components of traditional property taxation, the important policy question remains as to the desirability of the degree of reliance on it.

Evidence in support of the beneficial effects of property taxation as practiced in the United States would justify its use. Evidence in support of the negative effects of this property taxation would support its discontinuation and possible replacement with the alternative of a Georgian land value tax. In theory, a possible negative effect of traditional property taxation is its encouragement of urban land development at a lower level of population density (greater "urban sprawl"). Theoretical explorations of this relationship are inconclusive. The few empirical explorations of it have yielded mixed results. In the remainder of this paper, I summarize: (1) the inconclusive nature of the previous theoretical findings, (II) the variety of methods and findings from the previous empirical work on this question, (III) the objectives of this research that follow from the previous lines of inquiry, (IV) the data and research methods employed, and (V) findings, and (VI) policy implications.

**Inconclusive Nature of Previous Theoretical Findings**

Theories of how the rate of traditional property taxation influences population density in an urban area account for the difference between the land and improvements components of this taxation. As discussed in Oates and Schwab (2009), it is theoretically conclusive that a property tax levied on land values based on "highest and best use" is neutral in its influence of when it is most profitable to develop a parcel of vacant land. However, with only a few exceptions, the

[1]Calculated from 2011 values taken from the State and Local Government Finance page at the U.S. Census Bureau's website (http://www.census.gov/govs/local).

value of land for tax purposes in the United States relies on its market value in actual use.[2] Since raw land in an urban area occurs most likely at its fringe, the land component of traditional property taxation (since it relies on use value) is likely to yield lower density patterns (greater sprawl) the greater the rate of property taxation imposed upon it. But as Arnott (2005) shows, this non-neutrality of the land portion of the traditional property tax can be overcome by applying lower property tax rates to agricultural lands at the fringe (e.g., preferential treatment of farmland) and to improvements at the urban core (e.g., directed property tax abatement).

Brueckner (2000) was one of the first to consider the theoretical influence of the improvements portion of the traditional property tax on an urban area's population density. Using urban economic theory, he shows that the traditional property tax discourages real additions to land. Such discouragement results in greater use of low-rise structures and the less intense development of land in an urban area. If fewer multiple story dwellings exist in an urban the greater the rate of property taxation, and an urban area accommodates a static population that desires only a fixed dwelling size, then an urban area with a greater average rate of property taxation is expected to exhibit less population density (greater sprawl). Brueckner (2000) also uses his model to demonstrate that urban sprawl arises from an underpricing of public infrastructure at the urban periphery due to average cost pricing on lower valued housing units due to the use of traditional property taxation to finance it. This is mitigated if user/impact fees are instead used.

Brueckner and Kim's (2003) extension of Brueckner (2000) allows for the possibility that the desired dwelling size of consumers varies due to rate of property taxation. This introduces the possibility that if a portion of the property tax is born by consumers in the form of a higher

[2] Bentick (1979), Anderson (1986), and others have used theory to model the expected result of using actual use value assessment in a land value tax and have shown that it results in an earlier development of raw land than if best use used.

price per unit of dwelling space, they respond with a demand for a smaller dwelling size, and a static urban population will live at a higher population density (less sprawl).[3] Thus, the improvements portion of the traditional property tax results in two theoretically possible, but distinctly opposite, influences of the rate of traditional property taxation on population density in an urban area. Based on Brueckner and Kim's model, the influence that dominates depends on the relative responsiveness of the supply and demand of housing in an urban area to property tax rates. If the demand response of consumers for housing is rather insensitive to property tax rates, and if the supply of improvements in the form of housing is more sensitive to property tax rates – as Brueckner and Kim believe is the case due to the empirical evidence on the greater mobility of housing producers as compared to housing consumers – then greater sprawl is the expected outcome due to a higher rate of property taxation. Nonetheless, Bruckner and Kim conclude that there is a degree of uncertainty in the dominance of one countervailing response of the improvements portion of the property tax to the other and suggest the need for empirical investigations to resolve it.

Earlier theoretical approaches to determining the expected impact of traditional property taxation on urban population density are Arnott and MacKinnon (1977), Sullivan (1984 and 1985) and Mills (1998). Arnott and MacKinnon (1977) ….. Sullivan (1984 and 1985) employs

[3] Note that there is a theoretical debate among economists as to whether a portion of the property tax rate is passed onto property consumers ("Traditional View"), absorbed by property owners ("Capital Tax View"), or best viewed as irrelevant due to the non-distortionary result that housing consumers view property tax payments as payments for local government services that they desire ("Benefit View"). The assumption made by Brueckner and Kim (2003) is that consumers pay at least a portion of the local property tax and this reduces their demand for the size of a dwelling. The same result would occur if a portion of the property tax is born by producers of housing and this decrease in price received per unit of housing results in them offering smaller units for sale. The assumption of a traditional property tax resulting in a smaller dwelling size, through its improvement portion, is only invalid if a pure Benefits View of property taxation applies. Wassmer (1993) and Zodrow (2001) note this as unlikely through reviews of the economic literature on property tax incidence.

a general-equilibrium model of a small open urban area with residential and business sectors, and simulates the replacement of a pure land tax assessed on the highest and best use of land values with a traditional residential property tax. Similar to the previous findings, he reports that this increase in traditional property tax reliance reduces population density (greater sprawl). Alternatively, the theoretical approach of Mills uses a business-based model of a monocentric and open urban area where labor, capital improvements, and land generate a single output. Counter to the theoretical findings previously described, Mills (1998) reports that in his model a greater reliance on a conventional real estate tax results in a smaller urban area (less sprawl). He also states that "[t]he addition of a housing sector would not affect the basic insights from the model" (p. 32).

Inspired by Brueckner and Kim (BK, 2003), Song and Zenou (SZa, 2006) adopt a similar model of suppliers (housing land developers) and demanders (housing consumers) interacting in a closed and monocentric urban area to determine the direction of expected influence of the improvements component of traditional property taxation on population density. Instead of BK's use of a constant elasticity of substitution utility function for dwelling size, SZa use a log-linear utility function that assumes the more reasonable variable elasticity of substitution utility function. Contrary to BK's ambiguous finding regarding the relationship between the degree of urban property taxation and urban population density, SZa derive a certain negative relationship. Furthermore, in Song and Zenou (SZb, 2009), they expand their earlier theoretical model of an urban area to be duo centric (with a central and suburban jurisdiction) where housing developers and consumers enter each of the jurisdictions and equilibrium levels of housing investment and consumption result in both.[4] The equilibrium in SZb's theoretical model indicates that the ratio

[4] Song and Zenou received funding from a David C. Lincoln Fellowship in Land Value Taxation in year 2005 through a proposal titled *Property Tax or Land Tax as the Possible Cure for Urban Sprawl: Theory and Empirical Tests on Property Tax and City Sizes in the U.S*.

of the traditional property tax in the suburban jurisdiction to the central city jurisdiction exerts an ambiguous influence on the size of the urban area.

This brief summary of the previous theoretical investigations into the likely influence of greater reliance on traditional property taxation in an urban area to its population density indicates the likelihood of an affect. When considering the theories just described as a whole, the overall direction of the influence of the rate of traditional property taxation on the generation of urban sprawl points in the direction of greater rates of property taxation generating greater population density. Nevertheless, most of the theories previously discussed leave open the possibility of realistic ways to invalidate this finding. The determination of this relationship in reality occurs only through a well-crafted empirical study. Before turning to a summary of the previously undertaken empirical studies of this type, it is important to consider some of the insights gained from these previous theoretical inquiries that are relevant to the designing of an appropriate empirical inquiry.

All of the previous theoretical models chose to use population density as a negative proxy for sprawl and assume that population is held constant. One important insight from Arnott (2005) on the possibilities that can alter the theoretical influence of traditional property taxation in a UA on its population density are the need to control for differences in the preferential tax treatment of property across United States UAs. This could be due to the preferential tax treatment of farmland at the urban fringe and/or the reductions of property taxes paid on improvements at the urban core (property tax abatements). Importantly, the key difference between the Bruecker's (2000) finding that greater property tax reliance yields greater sprawl, and Brueckner and Kim's (2003), and Song and Zenou's (2006) findings of the opposite, are the possibility of residents altering their size of residential dwelling due to the property tax.

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(http://www.lincolninst.edu/pubs/993_Fellowships).

Brueckner's earlier model unrealistically assumed this "dwelling-size" effect away, and the result of a greater rate of property taxation being only the "improvements effect" causing devopers to construct shorter buildings with less fixed-size housing units (lower population density). Once the later models allows for the possibility of a property tax increase generating both shorter buildings and smaller dwelling sizes, the determination of this change to population density is dependent on whether the improvement or dwelling-size effect dominates. Thus, it is crucial for empirical studies to control for differences across UAs in factors that influence the magnitudes of these two effects. For the improvement effect, this would include measures of zoning or land use controls that restrict building height or size. While for the dwelling-size effect this would include residential characteristics that cause them to be less willing to alter the size of their residence (e.g., age, married, children present, vintage of existing housing, etc.). Finally, the theoretical model of Song and Zenou (2009), that allowed for a more realistic non-monocentric UA demonstrated the need to control for differences in fiscal structures across the UA.

Table 1 offers a summary of the four theoretical models already discussed regarding their prediction on how higher property tax rates are expected to influence sprawl, the assumptions made in the model that yield this results, and the implications for an appropriately constructed empirical analysis. Next, I offer a summary of the few empirical studies that have attempted to do this.

**Table 1: Empirical Lessons from Theoretical Work on Property Taxation and Population Density (Urban Sprawl)**

| **Author(s)** | **Prediction for Greater Property Tax Reliance** | **New (from Previous Models) Relevant Assumptions Made in Theoretical Model** | **New (from Previous Models)** Implications **for Regression Controls** |
|---|---|---|---|
| **Brueckner (2000)** | Less population density (increase in sprawl) | Closed urban area with fixed population,<br>Absentee land owners,<br>Model of residential housing produced under constant returns to scale with capital and land,<br>All residents identical,<br>Fixed size of a one-family residential dwelling,<br>Mono-centric employment,<br>Constant-elasticity-substitution (CES) between housing and non-housing good in utility function,<br>Infrastructure financed with general property tax | Population,<br>Zoning or land use controls,<br>User/impact fees infrastructure financing,<br>Employment centrality,<br>Commuting cost |
| **Bruecker and Kim (2003)** | Less population density (increase in sprawl) if improvements effect dominates (less capital-intensive land use through greater low-rise buildings):<br><br>Greater population density (decrease in sprawl) if dwelling-size effect dominates (smaller single-family homes when excise tax effect of property tax raises housing price) | Variable size of residential dwelling | Factors influencing the supply sensitivity of land improvement intensity (high-rise buildings) and demand for size (square feet) of single-family to changes in property tax rate |
| **Song and Zenou (2006)** | Greater population density (decrease in sprawl) | Log-linear (variable-elasticity-substitution > 1) utility function | |
| **Song and Zenou (2009)** | *Prediction if Greater Property Tax Rate in Central City Relative to Suburban City*<br><br>Ambiguous | Duo-centric employment (central city and suburban city)<br>Log-linear (variable-elasticity-substitution > 1) utility function,<br>Different central city and suburban property tax rate | Ratio of central city to suburban city's property tax rate |

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### Table 2: Previous Regression-Based Studies of Sprawl that Used Property Taxation as an Explanatory Variable

| Author(s) | Dependent Variable | Other Explanatory Variables Included (unless noted, based on dependent variable measurement unit) | Measure of Property Taxation [influence derived ] |
|---|---|---|---|
| **Wassmer (2002)** | Real value of "big box" (measured separately as retail, building material, and auto) sales in non-central places in 54 western U.S. metropolitan areas for years 1977, 1987, and 1997 | Real median household income, Population, Previous ten-year population growth, percent population <18 years old, percent population >64 years old, Real value of agricultural products per acre in metro area, Closed-region urban containment (CRC) dummy, Years CRC in place, Isolated urban containment (IC) dummy, Years IC in place, Open-region urban containment (ORC) dummy, Years ORC in place, percent statewide municipal revenue from general sales taxes, percent statewide municipal revenue from other taxes (year and metropolitan area fixed effects) | Percent statewide municipal revenue from property taxes [**not statistically significant**] |
| **Hettler (2002)** | Suburban population as % metropolitan statistical area (MSA) population in 289 MSAs from 1960, 1970, 1980, and 199 | MSA population change in last 10 years, Central city (CC) per-capita taxes, CC percent spending on education, CC percent spending on highways, Suburban (SUB) per-capita taxes, SUB percent spending on education, SUB percent spending on highways, (year and metropolitan area fixed effects) | CC percent tax revenue from property [10 percent increase yields a 1.2 percent **decrease in sprawl** (SUB % MSA pop)]<br><br>SUB percent tax revenue from property [10 percent increase yields a 0.2 percent **decrease in sprawl** (SUB % MSA pop)] |
| **Wassmer (2003)** | Real value of retail sales in non-central places in 54 western U.S. metropolitan areas for years 1977, 1987, and 1997 | Real median household income, Population, Previous ten-year population growth, percent population <18 years old, percent population >64 years old, Real value of agricultural products per acre in metro area, Closed-region urban containment (CRC) dummy, Years CRC in place, Isolated urban containment (IC) dummy, Years IC in place, Open-region urban containment (ORC) dummy, Years ORC in place, percent statewide municipal revenue from general sales taxes, percent statewide municipal revenue from other taxes (year and metropolitan area fixed effects) | Percent statewide municipal revenue from property taxes [**not statistically significant**] |
| **Song and Zenou** | Square mile size of 448 U.S. urbanized areas | Median household income, Population, Median agricultural land value | Weighted average of local property tax |

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| **(2006)** | (UAs) for year 2000 | per acre, Per-capita state and local government transportation expenditure | millage rates<br>[10 percent increase yields a 4.0 percent **decrease in sprawl** (square miles)] |
| **Wassmer (2006)** | Square mile size of 452 U.S. urbanized areas (UAs) for year 2000 | Median household income, Population, percent population <18 years old, percent population >64 years old, Percent population born in state, Average household size, Agricultural land price per acre, Percent employed in wholesale/transportation/warehousing, Percent employed in management/finance/insurance/real estate, Percent employed in construction, Central places (CP) percent population poor, CP percent population Asian, CP percent population African America, CP percent population Latino, CP crime rate, CP median age home, Number of CPs, Number of counties, percent statewide municipal revenue from general sales taxes, percent statewide municipal revenue from other sales taxes, percent statewide municipal revenue from local income taxes, percent statewide municipal revenue from other taxes, Urban containment present and years in existence (various measures), Statewide urban growth management present and years in existence (various measures) | Percent statewide municipal revenue from property taxes<br>[**not statistically significant**] |
| **Marshall (2008)** | Calculated Gini coefficient (GC), index of dissimilarity (ID), and sprawl index (SI) that all positively measure the degree of sprawl in occurring among Census tracts in 306 U.S. metropolitan statistical areas in 1990 and 2000 | Real total personal income, Population, Previous ten-year population growth, Real value of agricultural products per acre in metro area, Real average home price, Percent eligible population attending public K-12 school, Central city (CC) percent MSA non-white population, Total municipalities, Statewide subnational taxes divided state personal income<br>(year fixed effects) | Effective property tax rate (EPTR) measured as aggregate household specific property taxes paid divided by aggregate market value of home reported on Census long form<br>[10 percent increase yields a 0.7 percent **decrease in sprawl** using GC, 1.4 percent **decrease in sprawl** using ID, and 2.8 percent **decrease in sprawl** using SI]<br><br>Standard Deviation of EPTR<br>[10 percent increase yields a 0.01 percent **increase in sprawl** using GC; not statistically significant for ID and SI] |
| **Wassmer (2008)** | Square miles (SM) or population density (PD) of 452 U.S. urbanized | Per capita income, Percent households earning > $100K, Population (excluded when population density used as dependent variable), percent population <18 years old, percent population >64 years old, Percent | Percent statewide municipal revenue from property taxes<br>[**not statistically significant** for SM, |

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| | areas for year 2000 | households married, Agricultural land price per acre, Percent employed in wholesale/warehousing, Percent employed in management/finance/insurance/real estate, Percent employed in public administration, Percent households earning one or more autos, Central places (CP) percent population poor, CP percent population Asian, CP percent population African America, CP percent population Latino, CP crime rate, CP median age home, Percent CP housing two or less rooms, Number of counties, percent statewide municipal revenue from general sales taxes, percent statewide county revenue from general sales taxes, State dummies to account for state institutions and land use regulations | 10 percent increase yields a 1.4 percent **increase in sprawl*** using PD]<br><br>Percentage statewide county revenue from property taxes<br>[**not statistically significant** for SM and PD] |
| **Song and Zenou (2009)** | Acres, population density gradient (lower represents greater sprawl), and employment density gradient (lower represents greater sprawl) of 445 U.S. urbanized areas for year 2000 | Simulated income, Population, Median agricultural land value per acre, Highway lane miles, Number commuters using public transit, Climate dummies, Percent employed in service, CP crime rate | Ratio of weighted average property tax millage rates of suburbs to central city<br>[10 percent increase yields a 0.005 **decrease in sprawl**** using acres, 0.52 percent **decrease in sprawl** using population density, and 0.56 percent **decrease in sprawl** using employment density] |
| **Woo and Guldmann (2011)** | Population density gradient (lower represents greater sprawl), and employment density gradient (lower represents greater sprawl) of 135 U.S. metropolitan statistical areas for year 2000 | Per capita income, Percent population rural, Percent population own home, Percent employed in manufacturing, Percent employed in wholesale, Percent employed in retail, Percent employed in finance/insurance/real estate, Percent households earning one or more autos, Central business district (CBD) population density, CBD employment density, Central city (CC) Percent households earning > $100K, CC housing vacancy rate, CC age since incorporation, CC homeownership rate, CC total federal expenditure per capita, Federal expenditure per capita on housing, Federal expenditure per capita on transport, Number of cities, State planning legislation for land use elements dummy, State adoption of local comprehensive plans dummy | Percent statewide municipal revenue from property tax<br>[10 percent increase yields a 1.3 percent **increase in sprawl*** using population density gradient, **not statistically significant** using employment density]<br>Percentage statewide county revenue from property tax<br>[10 percent increase yields a 0.8 percent **decrease in sprawl** using population density gradient, **not statistically significant** using employment density] |
| **Gomez-Antonio, Hortas-Rico, and Li (2014)** | Percentage of undeveloped land around residential land within immediate neighborhood for 1,194 subsample of | Percent in poverty, Population growth 1930 to 1990, percent population 25-45 years old, percent population >65 years old, Average number children in household, Percent with college degree in 1991, Percent population not from EU, Automobiles per household in 1991, Distance from CBD to nearest highway, Highway density, Percent employed in | Percent municipal revenue from local property taxation<br>[one standard deviation increase yields a 1.44 unit **increase in sprawl*****] |

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| | 3,895 possible municipalities with Spain's urban areas in 2000 | wholesale/transportation/warehousing, Percent employed in manufacturing, Percent employed in retail, Distance to urban area's central city, Percent local revenues intergovernmental, Dummy if political majority from 1991 to 1994 belong to "Left" party, Mean maximum temperature, Mean minimum temperature, Average precipitation, Percent land open space, Percent land devoted to leisure/sports, Percent land classified as "wetland", Percent land covered by water, Index terrain ruggedness, Elevation range | |

*This detected influence is only statistically significant at an 89% confidence level in a two-tailed test.

**Song and Zenou (2009, p. 826) state the acre elasticity with respect to the property tax ratio is -0.27 with no explanation for how they derived this. Thus, I choose to report the value of 0.005 derived from their reported property tax ratio regression coefficient of -45.7 multiplied by the reported mean of this explanatory variable (0.91), divided by the reported mean of the dependent variable measured in acres (90,424), multiplied by ten.

***Not enough information is given to translate this finding to an elasticity as reported for the other regression studies. Also, these results are not reported in working paper and were obtained from Miriam Hortas-Rico by email ( miriamhortas@ccee.ucm.es ).

## Table 3: Previous Regression-Based Studies of Sprawl Not Using Property Taxation as an Explanatory Variable

| Author(s) | Dependent Variable (size, year(s), & source) | Explanatory Variable Categories (measures used) | Regression Specifics |
|---|---|---|---|
| **Brueckner and Fansler (1983)** | Square miles of urbanized land area<br><br>40 U.S. urbanized areas from 1970 (U.S. Census Bureau) | Muth-Mills Models of urban spatial size<br>**Population**<br>**Income** (Household)<br>**Agricultural rent** (Median agricultural land value in UA county)<br>**Commuting cost** (% commuters using transit, % households own auto) | Linear-Linear specification |
| **McGrath (2005)** | Distance to urban fringe = (square miles of urbanized land / $\pi)^{0.5}$<br><br>33 largest U.S. metropolitan statistical areas from 1950, 1960, 1970, 1980, and 1990 (U.S. Census Bureau) | Muth-Mills Models of urban spatial size<br>**Population**<br>**Income** (Real personal income)<br>**Agricultural rent** (Real state average per acre agricultural land value)<br>**Commuting cost** (Regionally adjusted private transportation CPI) | Log-Mixed Log specification<br><br>Year fixed effects |
| **Burchfield, Overman, Puga, and Turner (2006)** | Percentage of square kilometer of land surrounding average urban dwelling left undeveloped<br><br>275 metropolitan areas for new dwellings between 1976 and 1996 (High altitude and satellite images) | ***Ad hoc*** **Muth-Mills Models of urban spatial size** (Central employment, 1902 streetcar passengers, 1920 to 1970 mean decennial population growth, Bars/restaurants per thousand, Urban fringe road density)<br><br>**Geography** (Percentage urban fringe over aquifer, Elevation range in urban fringe, Index of urban fringe terrain ruggedness, Mean cooling degree days, Mean heating degree days, 1970 to 1990 percent population growth)<br><br>**Political Institutions** (Percentage urban fringe incorporated, 1967 percent intergovernmental transfers of local revenue, Herfindahl index of incorporated places size) | Linear-Linear specification |
| **Ke, Song, and He (2009)** | Distance to urban fringe = (square miles of urbanized land / $\pi)^{0.5}$<br><br>650 Chinese cities from 1994 (Chinese Statistical Yearbook for | Muth-Mills Models of urban spatial size<br>**Population** (Permanent population, Temporary population)<br>**Income** (Average salary)<br>**Agricultural rent** (Value of product per unit agricultural land)<br>**Commuting cost** (Length paved city road per resident, Number highways | Log-Log specification |

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| | Cities) | passing center district, Rail station in city, Commercial airport in city)<br><br>**Control dummies** (National capital, County capital, Resource center, Central region, Western region) | |
| **Zenou and Patacchini (2009)** | Population density growth rate<br><br>30 European towns and cities between 1991 and 2001<br>(European Urban Audit Dataset) | Muth-Mills Models of urban spatial size<br>**Population**<br>**Income** (Income per capita)<br>**Commuting cost** (Auto ownership per capita, Employment rate)<br><br>**Flight from blight** (Percentage population not from European Union country, Crime rate) | Linear-Linear specification |
| **Deng, Huang, Rozelle, and Uchida (2010)** | Hectare size of urban core<br><br>2063 county sampling units in 1995 (Scientific Data Center, Chinese Academy of Sciences) | Muth-Mills Models of urban spatial size<br>**Population**<br>**Income** (Gross domestic product (GDP), Percent GDP from industry, percent GDP from service)<br>**Agricultural rent** (Public investment to agriculture)<br>**Commuting cost** (Highway density)<br><br>**Geography** (Distance to port, Distance to capital, Share of land flat, Average slop of land, Average elevation. Average annual rainfall, Average annual temperature) | Log-Mixed Log specification<br><br>Includes lagged (1988) dependent variable<br><br>Spatial autocorrelation accounted for |
| **Fallah, Partridge, and Olfert (2012)** | Index (0 to 1) where one represents all Census Block Groups at population density below overall U.S. metropolitan median value<br><br>U.S. metropolitan statistical areas (MSAs) from 1980, 1990, and 2000 (U.S. Census Bureau) | Muth-Mills Models of urban spatial size<br>**Population** (Average value of previous population changes, Standard deviation of previous population changes)<br>**Income** (Log per-capita income, Gini coefficient of income)<br>**Agricultural rent** (Share of undeveloped land)<br><br>**Flight from blight** (Central city poverty rate) | Lin-Mixed Log specification<br><br>Year and MSA fixed effects<br><br>Residuals assumed to be correlated with a geographic cluster<br><br>All explanatory variables lagged one period |
| **Geshkov** | | | |

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| **and DeSalvo (2012)** | Square miles of urbanized land area<br><br>Subsample of 182 U.S. urbanized areas within a single county and a single metropolitan area from 2000 (U.S. Census Bureau) | Muth-Mills Models of urban spatial size<br>**Population** (Household number)<br>**Income** (Mean household income)<br>**Agricultural rent** (Mean market value of agricultural land per acre in county)<br>**Commuting cost** (State annual highway expenditures divided by "users")<br><br>**Land use controls** (Minimum lot size zoning dummy, Maximum lot size zoning dummy, Urban growth boundary dummy. Maximum FAR restriction dummy, Minimum square footage limitation dummy, Maximum building permits dummy, Minimum number of persons per room dummy, Impact fee dummy) | Lin-Lin specification |
| **Paulsen (2012)** | (1) Change in amount of developed land<br><br>Between 1992 and 2001 for 329 U.S. metropolitan area<br>(National Land Cover Database)<br><br>(2) Square miles of urbanized land area<br><br>Apply the year 2000 definition of 329 urbanized area to calculate comparable areas for years 1980, 1990 and 2000<br>(U.S. Census Bureau) | Muth-Mills Models of urban spatial size<br>**Population** (Household number)<br>**Income** (Median household income)<br>**Agricultural rent** (Mean market value of agricultural land per acre in county) | Lin-Lin specification<br><br>MSA fixed effects |
| **Tanguay and Gingras (2012)** | (1) percent of population living in metropolitan area center<br><br>(2) percent of low-density density housing in metropolitan area<br><br>(3) Median distance travelled to reach work in metropolitan area<br><br>Subsample 12 Canadian metropolitan statistical areas from years 1986, 1991, 1996, 2001, and 2006 | Muth-Mills Models of urban spatial size<br>**Population**<br>**Income** (Median household income)<br>**Commuting cost** (Gas price, Consumer price index of urban public transportation) | Lin-Lin specification<br><br>MSA fixed or random effects |

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| **DeSalvo and Su (2013a)** | (1) percent of square kilometer of land surrounding average urban dwelling left undeveloped<br><br>275 metropolitan areas for new dwellings between 1976 and 1996 (High altitude and satellite images) [same as Burchfield et al. (2006)]<br><br>(2) Square miles of urbanized land area<br><br>Subsample of 277 U.S. urbanized areas from 1980 which match the metropolitan areas used by Burchfield et al. (2006)<br>(U.S. Census Bureau) | Muth-Mills Models of urban spatial size<br>**Population** (Number households)<br>**Income** (Median household income)<br>**Agricultural rent** (Average value of farmland per acre)<br>**Commuting cost** (Gasoline price)<br><br>***Ad hoc*** **Muth-Mills Models of urban spatial size** (Central employment, 1902 streetcar passengers, 1920 to 1970 mean decennial population growth, Bars/restaurants per thousand, Urban fringe road density)<br><br>**Geography** (Percentage urban fringe over aquifer, Elevation range in urban fringe, Index of urban fringe terrain ruggedness, Mean cooling degree days, Mean heating degree days, 1970 to 1990 percent population growth)<br><br>**Political Institutions** (Percentage urban fringe incorporated, 1967 percent intergovernmental transfers of local revenue, Herfindahl index of incorporated places size) | Linear-Mixed Log specification |
| **DeSalvo and Su (2013b)** | Square miles of urbanized land area<br><br>Subsample of 552 U.S. urbanized areas (UAs) from 1990, 2000, and 2010<br>(U.S. Census Bureau) | Muth-Mills Models of urban spatial size<br>**Population** (Population)<br>**Income** (Median household income, Median household income squared)<br>**Agricultural rent** (Average value of farmland per acre)<br>**Commuting cost** (Gasoline price)<br><br>***Ad hoc*** **Muth-Mills Models of urban spatial size** (Bars/restaurants per thousand)<br><br>**Geography** (Percentage urban fringe over aquifer, Elevation range in urban fringe, Index of urban fringe terrain ruggedness) | Linear-Mixed Log specification<br><br>Year and UA fixed effects |
| **Paulsen (2013a)** | Square miles of urbanized land area<br><br>Apply the year 2000 definition of 329 urbanized area to calculate comparable areas for years 1980, | Muth-Mills Models of urban spatial size<br>**Population**<br>**Income** (Median household income)<br>**Agricultural rent** (Mean market value of agricultural land per acre in county) | Lin-Lin specification<br><br>MSA fixed effects |

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| | 1990, and 2000<br>(U.S. Census Bureau) | **Land use controls** (State growth management program dummy; or Nonlocal urban containment program dummy; or Significant state planning constraint dummy; or Wharton index of regulatory restrictions on residential development dummy) | |
| **Paulsen (2013b)** | Change in urban housing density; or change in marginal land consumption per new urban household, change in housing unit density in newly urbanized areas, change in percent of new housing units located in previously developed areas)<br><br>Apply the year 2000 definition of 329 urbanized area to calculate comparable areas for years 1980 and 2000<br>(U.S. Census Bureau) | Muth-Mills Models of urban spatial size<br>**Income** (1980 Median household income)<br>**Agricultural rent** (1980 Mean market value of agricultural land per acre in county)<br><br>**Flight from blight** (1980 urban housing density, 1980 metropolitan percent minority, Percent of housing units built before 1950)<br><br>**Political Institutions** (1980 general purpose governments per capita)<br><br>**Land use controls** (1980 metropolitan land area, Percent land undevelopable, Urban containment dummy, Significant state planning constraint dummy or Wharton index of regulatory restrictions on residential development dummy) | Lin-Lin specification |
| **Su and DeSalvo (2013)** | Square miles of urbanized area (UA) land, sprawl index from Burchfield, et al. (2006), square miles of UA per capita, and vehicle miles travelled<br><br>Subsample of 552 U.S. urbanized areas (UAs) from 2000<br>(U.S. Census Bureau) | **Muth-Mills Models of urban spatial size**<br>**Population (Household number)**<br>**Income (Median household income, Median household income squared)**<br>**Agricultural rent (Average value of farmland per acre in county)**<br>**Commuting cost (State highway expenditure per user)**<br><br>***Ad hoc*** **Muth-Mills Models of urban spatial size** (1977 central city employment )<br><br>**Geography** (Percentage urban fringe over aquifer)<br><br>**Flight from blight** (Violent crime in central city)<br><br>**Political Institutions** (1967 intergovernmental transfers as a percent of revenues )<br><br>**Land use controls** (Minimum lot size zoning dummy, Urban growth boundary dummy, Minimum number of person per room dummy) | Linear-Mixed Log specification<br><br>Three-stage-least squares simultaneous regression model |

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**<u>Methods and Findings from the Previous Empirical Work</u>**

Five previous empirical studies offer insights on whether reliance on traditional property taxation in a United States urban area exerts a measurable influence on its population density. Two of these studies, both by Song and Zenou (2006 and 2009), set out to specifically test the theoretical assertions of Brueckner (2000) and Brueckner and Kim (2003). The remaining three, by Wassmer (2002, 2006, and 2008), were guided by the investigation of a different hypothesis of what generates urban sprawl, but controlled for the possible influence of property taxation.

Due to the need to control for the multiple influences that determine an urban area's population density in order to isolate the influence of one of them, all of these studies use multiple regression analysis. Four of the five studies use year 2000 data from the nearly 460 urbanized areas (UAs) in the United States, while Wassmer (2002) uses data from 54 Western United States Metropolitan Statistical Areas (MSAs) drawn from 1977, 1987, and 1997. Rather than a MSA which is based on politically-established county boundaries, a UA is the more appropriate measure of what constitutes an urban area due to its use of population density minimums to define its border,

Song and Zenou (2006, p. 525) wish to empirically test the finding of their previously described theoretical model that the property tax rate reduces the spatial extent of urbanized areas. Using the dependent variable of acres in 448 United States urbanized areas in 2000, they control for the additional causal factors of population, income, agricultural land rent, and public transportation expenditures. Song and Zenou (2006) find that **a one percent increase in a UA's property tax rate results in about a 0.40 percent decrease in a UA's acres (less sprawl).** Their property tax variable is a GIS calculated, weighted by area, aggregate measure of city, county, and school property tax rates in a UA. They appropriately recognize that this measure of property taxation is endogenous to the UA's population density – through less population density requiring greater infrastructure and higher rates of property taxation – and use instrumental variable estimation.

Song and Zenou (2009) employ the same data set and dependent variable used in their 2006 analysis, and add population or employment density gradients (a lower value indicating greater sprawl) as two additional dependent variables in their regression analyses. Based upon their duocentric urban model described earlier, they alter the measure of urban area property taxation used as an explanatory variable to be a GIS calculated, weighted average, of suburban (non-central places in the UA) to central place property tax rates. They again recognize the endogeneity of this key explanatory variable, but failing to find suitable instruments for it, do not correct for this concern. Besides the group of explanatory variables employed in their previous study, they also add climate, service sector employment share, and central place crime rate measures. They also substitute measures of highway miles (considered endogenous and instrumented with 1947 values), auto use, and public transit use for their previously used measure of county-weighted transportation expenditures. They find that **a one percent increase in the ratio of suburban to central place property tax rates reduces the size of the urban area by -0.27 percent (less sprawl), and that an increase in this property tax ratio raises population and employment densities (greater centralization or less sprawl) in an urban area.** In considering the validity of this finding, note its basis on: (1) a ratio of property tax rates and (2) a biased endogenous regression estimate.

The empirical-based analyses of Wassmer (2006 and 2008) are similar to Song and Zenou's in that they use regression analysis to examine the causes of differences in the land size of United States urbanized areas in 2000. Though the primary focus of this research is not a detection of the influence of the rate of property taxation, and instead a detection of the influence of the use of urban containment/statewide growth management in Wassmer (2006) and auto reliance in Wassmer (2008). Nevertheless, both studies include measures of statewide reliance on the property tax to raise local own-source revenue. This inclusion is based on the theoretical expectation that difference in UA land sizes are driven by "fiscalization of land use" causal factors along with "natural evolution," "flight from blight," and unaccounted for statewide or regional factors. The property tax measure in Wassmer (2006) is the 1997 percent of the statewide, own-source local revenue derived from property taxation in the state the UA is located in. For a UA in multiple states, this value is a weighted average based on the percentages of a UA's land area in different states. Wassmer (2008) refines this measure by allowing its separate calculation by county and municipality. Contrary to Song and Zenou (2006 and 2009), Wassmer (2006 and 2008) finds that **statewide measures of local reliance on property taxation exert no influence on an urban area's population density**. While similar to Song and Zenou, Wassmer (2008) found that a **one percent increase in a state's municipal reliance on property taxation decreased population density (more sprawl).**

Also worth considering is the earlier regression work by Wassmer (2002) that examined the influence of local sales tax reliance in a state on the degree of retail sprawl in the state's urbanized areas by using the metropolitan statistical area (MSA) as the unit of analysis. The percentage of the MSA's retail sales occurring in non-central places for 54 MSAs in the western United States in years 1977, 1987, and 1997 acts as a positive proxy for the degree of "retail urban sprawl" occurring in these MSAs. Using a fixed effect regression technique, and a group of explanatory variables derived from the same theory used in Wassmer (2006 and 2008), I found that **a statewide measure of municipal reliance on local sales taxation generates greater**

**retail sprawl, but a similar statewide measure for property tax reliance does not.** But in considering the relevance of all of my regression findings as an empirical test of the influence of property taxation on urban population density, remember that though the use of municipal reliance on property taxation is likely to be positively correlated to the rate of property taxation, a direct measure of the rate of property taxation is preferred due to its specific use in the theories described earlier.

The previous empirical findings on the influence of the rate of property taxation in an urban area on population density are not entirely conclusive. But what these previous studies do offer is a base of relevant ideas and methods from which to build upon for an improved study. I summarize these as:

- the Census calculated urbanized area (UA) being the appropriate unit of analysis;
- the variable relevant to testing the theory of property taxation's influence on population density (as understood through theories relevant to land value taxation) is the rate of property taxation;
- a contemporaneous measure of a UA's average property tax rate is endogenously determined with UA size; and
- a well specified regression model that controls for all of the major factors expected to determine differences in a population density (or broader conceptualized measures of urban sprawl) across United States urbanized areas is needed to identify the "true" influence of the property tax rate.

(c) Objectives of this research that follow from the previous lines of inquiry

The primary objective of the research proposed here is a better resolution of the question as to whether the rate of traditional property taxation in an urban area influences its population density (urban sprawl), and if so, the direction and magnitude of the influence. We know that the traditional form of property taxation practiced in the United States is not the non-distortionary ideal of a pure land value tax assessed on a site's highest and best use. But what still remains uncertain are the direction and degree of the distortions generated by the traditional property tax. Theory is not clear on this, and issues in the implementation of previous empirical assessments cast doubt on its reliability.

I will work toward the achievement of this study's primary objective by meeting the secondary objectives of (1) offering a more detailed summary of relevant theory, (2) offering a more detailed summary of previous empirical work, (3) offering a summary of previous thoughts on what urban sprawl is (beyond low population density) and what causes it, (4) gathering data on appropriate dependent and explanatory variables for a regression analysis, (5) using appropriate panel-data estimates to conduct the regression analysis, and (6) disseminating my findings through seminar presentations, a scholarly article, a practitioner-focused article, and a chapter in a book I intend to write on the *Causes and Consequences of Urban Sprawl in the United States*.

(d) Data and research methods I will employ

A principal innovation of the research proposed here is the use of data from the 400 plus comparable United States urbanized areas in existence in the years 2000 and 2010. Previous empirical work did not have the option to use data from more than one cross section of United States urban areas because the Census chose to alter the method used to calculate the land area of a United States UA after each decennial census before year 2000.[5] In year 2000, the Census committed to use the same method in all future decennial censuses to define the geographical

[5] Paulson (2012) uses GIS methods to overcome the Census definition of what counts as urban being different in each decade prior to year 2000, to create a panel of three-years of comparable United States urbanized areas using the 2000 definition applied to Census block data from 1980 and 1990. He then runs a regression with UA land area as the dependent variable, but unfortunately does not include the UA's rate of property taxation as an explanatory variable. Paulson chooses instead to include only the "natural evolution" influences of UA population, income, and agricultural land value.

footprint of a UA.[6] Thus, a change in the square miles of a UA between 2000 and 2010 is due to forces like the rate of property taxation in the UA acting upon land use decisions, and not corrupted by a definitional change as could have been the case in previous decennial censuses prior to year 2000.

The population density of a United States urban area (or its square miles after controlling for population) will remain the primary dependent variable in my proposed regression analysis, but I also plan to explore the reasonableness of using other measures of urban sprawl proposed in the literature. As Galster, *et al.* (2001) note, these include a lack of continuity, concentration, clustering, centrality, nuclearity, mixed uses, and proximity. Because the Census designation of year 2000 urbanized areas included a listing of central places (CPs) for each UA, it is possible to account for these additional dimensions by gathering population density data from these central places for the years 2000 and 2010. A greater concentration of a UA's population in its CPs should point to a more continuous, concentrated, clustered, central, mixed use, and proximate development pattern in the UA and thus less urban sprawl. Thus, I will compute the additional dependent variable measures of CP population density, non-CP population density, and the ratio of CP to non-CP population densities to check if the influence that the UA's rate of property taxation varies in its influence on these measures in regression analyses.

I also propose to use a different measure of a United States urbanized area's rate of property taxation as the key explanatory variables of interest in this study. As described earlier, this variable must be some measure of the average rate of property taxation experienced in a UA. Song and Zenou (2006 and 2009) chose to use an elaborate GIS-based calculation of these values, that after all their efforts, could not be included directly in their regression analyses due

[6] See the Department of Commerce (August 24, 2011), Urban area criteria for the 2010 Census, *Federal register* (76)164, at https://www.census.gov/geo/reference/pdfs/fedreg/fedregv76n164.pdf for details.

to its endogenous determination with population density. In their 2006 research they accounted for this through the appropriate two-stage regression analysis, but were unable to do this in their 2009 analysis. To avoid this endogeneity concern, that if present must be corrected for, I propose to use the effective tax rate (EFT) values that the Minnesota Taxpayers Association (2000 and 2011) calculate for the largest city in each of the 50 states for the desired years of 2000 and 2010. These EFTs are calculated separately for a fixed type of single family home, apartment, commercial, and industrial property. EFTs indicate the percentage of the property's market value that is paid in state and local property taxes after accounting for sales to market value ratios, classification rates, property tax rates, and property tax credits that differ across jurisdictions. Since I intend to use the Minnesota Taxpayer's Association value calculated for the largest city in a state as a representative proxy of the relative degree of property taxation between different states, it is entirely appropriate to consider these as exogenous to an urban area's population density and use them as reported. When a UA straddles multiple states, I will employ a weighted by land area average of EFTs in the relevant states. I know these EFTs are not the exact EFT for an urban area that Song and Zenou (2006 and 2009) tried to derive through elaborate GIS methods. However, I do believe that they are as reasonable proxies to the exact EFT for a United States urban area as Song and Zenou (2006) used in their two-stage method of predicting the actual effective tax rates using per-capita state aid to K-12 schools as an instrument in a first-stage regression, and then using these fitted values in the desired second-stage regression. Since the Minnesota Taxpayer Association EFTs exist for four different classes of property, I will be able to measure an influence for each class of property's EFT, and for an overall influence of traditional property taxation on population density by aggregating them together in weighted total EFT by collecting data on the percentage of the city's property base falling under the four different classifications.

The gathering of the proposed data set allows for the use of panel-data regression estimation techniques (fixed-effects or differenced) that control UA-specific influences that do not change over time. Such influences were unaccounted for in previous empirical work. Doing so results in greater confidence that the estimated effect of UA's average rate of property taxation on its population density does not suffer from omitted variable bias. Furthermore, I will take great care in otherwise eliminating such bias by building a fully-specified causal model of all measurable factors expected to influence differences in urban population density by drawing upon theories of how not only property tax rate is expected to influence this, but also the other theories offered by urban economists on what influences the population density of a UA and its CPs.

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