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Influencing factors behind urban sprawl in the United States

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INFLUENCING FACTORS BEHIND URBAN SPRAWL IN THE UNITED STATES

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Abstract

Urban sprawl concerns planners, urban economists, and city governments because of several negative side effects associated with it. Urban sprawl can be defined many ways, but the Merriam-Webster Dictionary states it as "the spreading of urban developments (as houses and shopping centers) on undeveloped land near a city." Deprivation of the environment, automobile reliance, inner city poverty, and even obesity are suggested to be linked to sprawl. In order to address urban sprawl effectively, its causes need to be identified. Ordinary Least Squares (OLS) regression analysis will be used to show factors that may contribute to urban sprawl in the United States. The model uses more recent data than the previous model by Brueckner and Fansler (1983), which it is based on. The results suggest that population, transportation costs, and violent crime rates are significant factors in explaining the amount of urban sprawl; household income may not be as important as once thought in influencing urban sprawl.

I. Introduction

Shortly after World War II, the American dream was to own a home with a nice yard and a car parked in the driveway. Today, the American dream remains much the same, only escalated in scope. People still want their own home, yard, and car, but with a little extra. The yard must be big enough for a pool, the house big enough for multiple bathrooms, and the garage big enough for multiple cars. As a result, people move away from the city centers, where lot sizes are restricted, to the city edges. The movement from city centers has led to low density residential developments, planned communities on city outskirts, and more individual houses on previously rural land (Nechyba and Walsh 2004). With the increased demand for land, the area of U.S. cities has grown significantly more than the respective growth in population. The rapid expansion of developed land along with a drop in population density has become known as urban sprawl.

The recognition of urban sprawl has initiated debate over the effects sprawl has on society. There have been far more negative effects than positive effects associated with sprawl. Examples include things such as the loss of open space, urban encroachment onto agricultural land, automobile dependency, and even poor health. Some, however, see benefits in sprawl through increased privacy and the freedom for people to fulfill their "American Dream."

The research objective is not to determine the positive or negative effects of urban sprawl, but rather to identify variables that contribute to urban sprawl in the United States. If influential variables can be identified, then local governments can effectively enforce policy to promote or discourage sprawl. Various studies have been done in regards to urban sprawl and the current research is based on one study by Brueckner and Fansler (1983). Their paper was

one of the first economic models constructed to explain urban sprawl. Their study concludes that the amount of urban sprawl in a city is a market process related to population, household income, and agricultural land rent. Three objectives were defined to begin my research: to retest the Brueckner and Fansler study with updated census data, to provide an alternate measure for transportation costs, and to measure the effect other social factors may have on urban sprawl. Ordinary Least Squares (OLS) regression analysis will be the tool used to achieve the results.

II. Defining "Urban Sprawl"

The term "urban sprawl" is a subjective term. A universal way to measure the amount of urban sprawl in a city does not currently exist. Levels of urban sprawl can vary significantly when different measurements are used. A general method originally presented by Brueckner and Fansler (1983) uses the U.S. Census definition of an urbanized land area. Other measures have been formulated in more recent years, each with its own reason and significance. One measure offered by Pendall (1999) calculates the change in county population between a ten year span, divided by the change in urbanized acres of land over that same period. Pendall (1999) could then look at how land use controls affect sprawl over time. A measure used by Wassmer (2008) calculates population densities over time to see if cities use more land area to support the same number of people. According to Wassmer (2008), population densities effectively show the amount of decentralization that takes place in a city. A current trend to measure sprawl is Geographic Information Systems (GIS). When utilized by Song and Zenou (2006), GIS was helpful to compute the percent of a city's land area that fell in different counties. GIS allowed

them to analyze the affect property taxes have on sprawl. Property taxes were hard to analyze before because of the variations in tax rates across different counties.

The various measures of sprawl can make it difficult to provide a concrete definition for urban sprawl. For the purpose of this research, the term urban sprawl will be used in the context given by Brueckner. He describes sprawl as the "spatial growth of cities that is excessive relative to what is socially desirable" (Brueckner Oct. 2000, 66). Most urban economists would agree that city growth has benefits, but growth that exceeds the necessary amount to accommodate the population growth constitutes urban sprawl.

III. Literature Review

Although the research objective is not to conclude whether urban sprawl is desirable or not, the positive and negative effects of sprawl are important to summarize. Both sides will provide valuable information to understand the factors that cause sprawl and the factors that are caused *by* sprawl.

Many people have deemed urban sprawl to be undesirable because of multiple negative effects linked to it. Perhaps the most evident effect given is the encroachment of urban land onto farmland (Brueckner Oct. 2000). The loss of farmland can be observed easily because sprawl is characterized by the expansion of urban land onto land previously used for agriculture. Increased pollution because of added congestion is also a common side-effect attributed to urban sprawl (Brueckner Oct. 2000). If households move away from the city centers where the most jobs are, then people will have to commute farther and will add to congestion. Other negative effects linked to sprawl include inner city decay (Brueckner April 2000), increased segregation

of social classes, less social interaction (Nechyba and Walsh 2004), and even higher obesity rates due to more car dependency (Frumkin et al. 2004, 97-100).

Even though the majority of people view urban sprawl in a negative way, there are some positive views for sprawl in the U.S. One positive view relies on the amount of privacy demanded by Americans. Many people today value a home located away from the "hustle and bustle" of the city. Household privacy leads some to argue that urban sprawl is a consequence of personal preferences and should be left alone (Wassmer 2008). If people prefer higher densities, then cities would not expand faster than the population growth. Others propose that low density developments also promote a higher standard of living, although little research has been done to support this claim (Holcombe 1999).

Policy to promote or control urban sprawl cannot be made without knowing sprawl's main causes. In order to determine the influencing variables in the regression model, other studies are referenced. Brueckner and Fansler (1983) provide significant evidence for certain causes of urban sprawl with their regression based off the monocentric city model. In their model, the dependent variable consists of 40 urbanized areas, taken from the 1970 Census. The dependent variable was modeled against population, agricultural land value per acre, average household income, and two different variables for transportation cost in the urbanized areas. Their model concludes that the four variables account for almost 80% of urban sprawl. All of the variables were significant except for transportation cost. The findings were confirmed again by McGrath (2005) with updated Census data.

Another theory that can help explain urban sprawl is known as "flight from blight." Social factors such as higher tax rates, higher inner city crime rates, greater inner city poverty, and low-performing central city schools also contribute to urban sprawl (Wassmer 2008).

"Flight from blight" factors are thought to push people away from the inner city, which results in a demand for new developments on the outskirts (Nechyba and Walsh 2004). Property taxes are a specific tax thought by some to impact urban sprawl. One problem for researchers deals with the difficulty in measuring property taxes across urban land areas. Some evidence suggests that the net effect of property taxes is ambiguous (Brueckner and Kim 2003); though others suggest that higher property tax rates reduce urban sprawl. A 2006 study by Song and Zenou used GIS methods to measure effective property tax rates for cities that fall in multiple counties and found that higher property taxes result in smaller cities. Increased property tax rates indicate a higher cost for housing. A higher cost for housing leads to decreased home sizes, increased population density, and a reduction in urban sprawl.

There has been limited research on urban sprawl due to the absence of a universal way to measure city growth patterns. Some models provide evidence that certain variables significantly influence sprawl. The monocentric city model is one model; significant evidence shows that population, household income, and agricultural land rent account for about 80% of the variation in sprawl (Brueckner and Fansler 1983). The "flight from blight" theory also has relevance, but more research needs to be done to determine the significance of social factors.

IV. Methodology

Population rates, household incomes, and agricultural land rents pose a problem for city governments that want to control sprawl. Most of the problem comes with not being able to enforce policies that control population and household income. Land rents can also be troublesome to control because land prices are generally directed by the market. The question

then becomes, if urban sprawl is undesirable, what variables can city governments target to counteract sprawl? The current model examines other possible causes of urban sprawl that policy can better control; it notes that population, household income, agricultural land rent, and transportation cost are still probable determinants of urban sprawl.

Because the regression model is based on a previously conducted model, a variable for population, household income, agricultural land rent, and transportation cost are still included. Other variables tested are derived from the "flight from blight" theory (Nechyba and Walsh 2004) and include inner city crime rates and inner city poverty rates. The dependent variable in the model represents the total land area of each urbanized area (urban sprawl) as measured by the 2000 Census.

Three of the original variables are measured in a similar way to the 1983 model. Population represents the urbanized area population not living in group quarters, income represents the median household income, and agricultural land rent represents the median agricultural land value per acre for the county that contains the urbanized area. Population and income statistics were taken from the U.S. Census for the year 2000. Agricultural land values per acre were taken from the 1997 Census of Agriculture.

The transportation cost variable is measured differently than the original model. Brueckner and Fansler represented transportation costs through two different variables: the percentage of commuters that use public transit and the percentage of households with one or more vehicles. Today, virtually every household has at least one vehicle and since little variation exists between the total vehicles per household, a new measure of transportation cost was sought after. Transportation costs for the current model are collected from a unique formula developed by the Center of Neighborhood Technology (CNT), a non-profit organization that focuses on

sustainable development. The CNT provides a measurement for local housing and transportation cost called the "Housing + Transportation Affordability Index." To retrieve transportation costs for the model, the housing costs of the index were not included. The measure used in the model is the total monthly transportation cost per household for the city contained in each respective urbanized area. According to the CNT website, the transportation costs are determined as follows:

> The household transportation model is based on a multidimensional regression analysis, in which a formula describes the relationship between three dependent variables (auto ownership, auto use, and transit use) and nine main independent household and local environment variables. Neighborhood level (Census block group) data on household income (both average and median), household size, commuters per household, journey to work time (for all commuters, transit commuters, and non-transit commuters), household density (both residential and gross), block size, transit access, and job access were utilized as the independent, or predictor variables (Center for Neighborhood Technology 2010).

Crime statistics were taken from the FBI Report of Offenses Known to Law Enforcement for 2000. The FBI provides local municipality crime statistics for violent crime and property crime, both of which are reported as the total number of offenses and the rate of offenses per 100,000 people. Violent crime rates for the local municipality are used in the final model. City poverty rates were taken from U.S. Census Bureau data sets for the year 2000. "Flight from blight" theory says that poverty pushes people out of the central city. Therefore, family poverty rates for each urbanized area's *central place* were used for the model.

V. Anticipated Results

The current regression model is expected to produce similar results for the population, household income, and agricultural land rent variables as Brueckner and Fansler (1983). The population and median household income coefficients are expected to be positive. As the population or median household income of an urbanized area increases, the land area of that urbanized area will increase. An increase in population would lead to an increase in land area to support more people, given that the population density stays relatively stable. Also, if the total income of a single household increases, then the household will be able to spend more money on land (i.e. a bigger house, garage for cars, yard for kids). The agricultural land rent coefficient is expected to be negative. With an increase in the price of agricultural land that surrounds an urbanized area, the more expensive it becomes for developers and households to occupy that land. Households with limited incomes are forced to purchase smaller lot sizes as the agricultural land rent increases. People will either choose to move closer to their jobs in the city center or compromise with less land in the suburbs. Urbanized land areas would not expand as rapidly, which confirms the negative effect agricultural land rent has on urban sprawl.

The transportation cost coefficient is still predicted to be negative, even though an alternative measure is used. The inverse relationship suggests that people can afford to live further from city centers as it becomes cheaper to travel to jobs, grocery stores, and recreational activities in the city. Households will be able to devote a larger portion of their income to housing costs, and will move to new developments with larger lot sizes on the outskirts of the city.

The coefficients for city crime rate and inner city poverty rate are predicted to be positive in accordance with the "flight from blight" theory. Higher crime and higher poverty in central cities are expected to push people out and increase city urbanized land area (Nechyba and Walsh 2004). Households may move to the suburbs to escape the adverse effects of a high crime rate. Inner city poverty may entice households to move because of lower quality schools and lower social statuses associated with poorer neighborhoods.

VI. Model

The OLS regression model draws from a sample size of 100 randomly chosen urbanized areas in the contiguous 48 states. The sample was drawn from a population that includes only the urbanized areas contained in one county because agricultural rents per acre are available at the county level. The estimating equation used to model the influence each variable has on the amount of urban sprawl is shown as

$$AREA = \beta_o + \beta 1(POPN) + \beta 2(LMEDHI) + \beta 3(TCMONC) + \beta 4(VCRATE)$$

Where: AREA = Total land area of each respective urbanized area

POPN = The population of the urbanized area not living in group quarters

LMEDHI = Natural log of the median household income in each urbanized area

TCMONC = Transportation cost per month for the city in each urbanized area

VCRATE = Violent crime rate for the city contained in each urbanized area

Several variations of the variables were run to achieve the model above. Heteroskadasticity and multicollinearity in the model were analyzed and are corrected. Natural logs of all the variables were tested to account for possible nonlinear relationships. Only the natural log of median household income was used to provide the best results in association with the data.

The current model does vary from Brueckner and Fansler's original model. As mentioned before, transportation cost is measured differently and a crime rate variable was added to help explain other possible influences on urban sprawl. A variable for inner city poverty was not included due to multicollinearity problems with the income variable.

One major change with the current model is the exclusion of the agricultural land rent variable. Agricultural land rent may be endogenous when included in the model. Previously, agricultural land rent was expected to have a negative correlation with the amount of urban sprawl. As agricultural land prices increase, there will be less urban sprawl because of higher costs to develop new land. When the agricultural land rent variable was included, its coefficient consistently produced a positive sign. One explanation for a positive sign may be the way in which the dependent variable, urbanized land area, is measured. The measurement of the dependent variable did not take into account the size or proportion of the county that was already developed. The percentage of county land already developed could affect the agricultural land price per acre. Evidence shows that agricultural land closer to an urban area has a higher price per acre (Guiling et al. 2009). Table 1 provides an example.

An urbanized area such as Casper, Wyoming is rather small compared to the county (Natrona) it falls in. In addition, the total urbanized land area of Casper is only 26.12 square miles, which suggests a low amount of urban sprawl. The agricultural land rent of Natrona

County is about $190 per acre. An urbanized area such as Flint, Michigan occupies much more of the county (Genesee) it falls in and has a much larger urbanized land area of 231.12 square miles. The agricultural land rent of Genesee County is higher as well at $2100 per acre. Similar examples can be found throughout the sample taken. Table 1, along with the other examples, suggests that the higher the proportion of urbanized land in a county, the more expensive it becomes to purchase any remaining agricultural land in that county. Agricultural land becomes scarce as more land becomes developed in a county. More agricultural land will also fall in close proximity to developed land. The model would then show a positive coefficient. The amount of urbanized land area influences the agricultural land price per acre. As the area of urbanized land in a county increases, the agricultural land value in that county will also increase

Table 1

Urbanized Area	County	UA Land Area (Sq. Mi.)*	County Land Area (Sq. Mi.)*	% of county containing UA's	Ag. Land Price per Acre**
Casper, Wyoming	Natrona	26.12	5,339.88	0.49%	$190
Flint, Michigan	Genesee	213.12	639.64	33.32%	$2108

***2000 U.S. Census; **1997 Census of Agriculture**

VII. Descriptive Statistics

The descriptive statistics for the data are shown in Table 2. The variables show a wide range of values. Outliers in the sample have been omitted. The average area for all urbanized areas is 69.17 square miles. Tucson, Arizona had the largest urbanized land area at 291.35 square

miles and Tracy, California had the smallest at 12.77 square miles. Population also varied widely. The highest population was San Jose, California at about 1.5 million and the lowest population was San Luis Obispo, California at about 43,000. The urbanized area with the highest crime rate was Spartanburg, South Carolina with 2,445 yearly incidents per 100,000 residents and the urbanized area with the lowest crime rate was Lee's Summit, Missouri with 73.6 yearly incidents per 100,000 residents.

Table 2

Variable	Mean	Std. Deviation	Maximum	Minimum
AREA (sq. miles)	69.17	54.37	12.77	291.35
POPN	160,330	218,870	42,755	1,517,100
MEDHIN (per year)	$39,554	$10,024	$20,633	$74,133
TCMONC (per month)	$817.01	$57.65	$697.00	$976.00
VCRATE (yearly incidents per 100,000 residents)	664.26	463.98	73.6	2,445.0
Sample Size = 100				

VIII. Results

The results are similar to that of Brueckner and Fansler (1983) and follow the predictions stated earlier. Population and violent crime are statistically significant in explaining the amount of urbanized land area at the 1% level. Transportation cost is statistically significant in explaining the amount of urbanized land area at the 5% level. The population and violent crime coefficients are positive and the transportation cost variable is negative, coinciding with the previous predictions. The household income variable in the model has a positive coefficient, but

is not statistically significant. With an adjusted R-square of .7911, the model has similar explaining power to that of Brueckner and Fansler (1983).

Statistical Results Table of the OLS Regression Model

Variable	**Estimated Coefficient**	**T-Ratio**	**P-Value**
Dependent: Urbanized Land Area (AREA)			
Population Not Living in Group Quarters (POPN)	0.20109E-03	7.446	0.000***
Natural Log Median Household Income (LMEDHI)	15.440	1.320	0.190
Transportation Cost per Month (TCMONC)	-0.12925	-2.455	0.016**
Violent Crime Rate (VCRATE)	0.29901E-01	4.441	0.000***
Constant	-40.339	-0.3794	0.705
** Significant at the 5% level ***Significant at the 1% level	**N= 100**	**R=.7995**	**ADJ R^2=.7911**

Some slight differences are shown in the current model from what Brueckner and Fansler found. Brueckner and Fansler showed that income was significant and that transportation cost was not significant in explaining the amount of urbanized land area. The difference in significance between Brueckner and Fansler and the current model may be due to a variety of factors, maybe even how the variables were measured. The current results suggest that household income is not as influential on urban sprawl as it was in 1970. There are two possible reasons for this. First, people today may be enticed to save more of their income rather than spend it on housing. Other expenses cause households to accommodate by not building large properties in the suburbs. Second, there may be a trend toward living in the central city as cities

across the U.S. revitalize their central city districts. Home prices per square foot are generally higher in the central city, which attracts only higher income people to move there.

Other than updating Brueckner and Fansler's model with recent data, the research objective was to look for other variables that may contribute to urban sprawl. The model's results show that a city's violent crime rate has significance. As predicted in accordance with the "flight from blight" theory, higher crime entices people to move away from the crime. Households move out of the central city to the suburbs where less crime occurs. A variable for property crime rates was also tested and resulted in similar, but slightly less significant results.

Alternatively, the high significance of violent crime could actually be influenced by urban sprawl affecting crime rates in a city. One way to characterize sprawl is the building of new homes and developments around a city. New developments outside the city lead businesses and people who can afford them to move into the area. When the relocation is complete, the lower income households are left in the central city. The population demographics of the inner city shift to lower income households and become run-down over time. Higher crime rates are shown to be more prevalent when there are large income inequalities between inner cities and suburbs (Kelly 2000).

IX. Conclusion

Urban sprawl will continue to be an ongoing debate in the United States. If governments deem sprawl to be undesirable, variables can be addressed to counteract it. The results of the current model agree with Brueckner and Fansler in that population has a significant positive influence on urban sprawl. The results suggest that the effect of household income on sprawl is

less significant than in 1970. Transportation costs, on the other hand, are significant. Households seem to be more sensitive to higher transportation costs when it comes to urban sprawl. Commuting costs could be more important than other household characteristics when considering location. If electing to live closer to their jobs in the city, households sacrifice larger lot sizes and urban sprawl is reduced.

If governments want to address sprawl, the results suggest that crime could be an important factor to target. Local governments have to consider the costs and benefits associated with crime protection in their cities. It may be more costly for a local community to increase protection against crime than to allow the possible adverse effects of urban sprawl.

Research on urban sprawl has increased in recent years. As cities grow and urban area definitions become more complex, it becomes increasingly difficult to even formulate a way to measure sprawl. Further research can help define urban sprawl measures. The use of population densities as a measure of urban sprawl could be useful in future research. Geographic Information Systems (GIS) could be utilized by those who have skills with GIS software in order to provide more accurate measures of sprawl and its causes. The utilization of GIS would be very helpful to measure agricultural land rents in proportion to the amount of urbanized area in a county, which proved to be an issue in the current model.

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