

**Local roads spending and Urban Sprawl: An Analysis of the Causal Relation in the
Detroit Metropolitan Area**

By

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ABSTRACT

Urban sprawl is a phenomenon with widespread negative consequences. Causes of sprawl are complex, and explaining it remains an empirical puzzle to urban scholars. In this study, we examine the causal relationship between local roads spending and community growth, used as a proxy of sprawl. The purpose of the study is to determine whether or not local roads spending is a growth promoting or deterring factor to local communities. Our findings, in the context of the Detroit Metro Area of Michigan, indicates that local roads' spending facilitates community population growth, particularly in communities that are located increasingly away from an urban core or central city. Also, community attributes such as fiscal health, proxied by property tax revenue does facilitates growth. Increasing expenditure for fire protection services, however, tends to discourage community growth. We conclude that local roads spending is sprawl promoting in metropolitan areas. Implications for land resources, and social and economic well being of communities in metropolitan areas are also discussed.

Keywords: urban sprawl, location choice, local roads, public goods, Michigan

1.0 Introduction

“Urban Sprawl” in US metropolitan areas is a widespread phenomenon, with significant negative consequences (Katz et al. 2003; Squires 2002). Sprawl has been linked to loss of farmland and open space (Lopez et al. 1987; SEMCOG 2003), landscape fragmentation (Wilson et al. 2003), environmental pollution (Johnson 2001), inner city decay (Downs 1999; Frank et al. 2000), longer commutes that result in traffic congestion (Ewing et al. 2003; Sarzynski et al. 2006), duplication of public services, fiscal distress in urban and outlying communities (Heimlich and Anderson 2001; Najafi et al. 2006), erosion of social capital (Key 1965, Lackey et al. 1987; Leyden 2003; Putnam 1995; Schweitzer 1999), and stark spatial inequality in distribution of people by race and class (Darden 1975, 1986; Squires 2003, 2002). The negative consequences of sprawl have been the subject of considerable and growing concern among state and local policymakers and many of their constituents. These have also stimulated significant research on the causes and plausible solution to urban sprawl.

Over the last two decades, significant scholarly contributions have been made to the knowledge base about the causes of sprawl. From a metropolitan perspective, the literature identifies two major categories of causes. “Push factors” are those undesirable characteristics of “sending communities” (urban core areas, for example), which encourage urban residents to seek better quality of life and alternative arrangements in suburbs and other less densely populated locations. Some of the push factors identified in the literature include: high crime in urban areas, low quality schools, crumbling infrastructure, low quality housing, unaffordable housing, dilapidated infra, etc. (Jargowsky in Squires 2002). The “Flight from Blight” literature provided the

underpinnings for much of the current thinking about the decentralization of people and jobs in metropolitan areas (Mieszkowski and Mills 1993). While understanding push factors is useful, because they do not specifically explain how and where urban residents settle into suburbs and rural areas, they are not very helpful in understanding the spatial and distributional elements of sprawl across communities.

“Pull factors”, on the other hand, are those desirable characteristics of receiving communities (suburban and rural communities, for example) which attract more urban residents to non-urban communities as they seek better quality of life. Amongst these factors are the following attributes of “receiving communities”: lower crime, better quality schools, new infrastructure, wider range of housing choices, greater peace and quiet, access to rural lifestyle, and open space (Jargowski in Squires 2002; Koles and Muench 2002). Pull factors are largely amenities. According to (Tiebout 1956), who was one of the early pioneers of modern thinking about sprawl, preferences for public goods are the primary drivers of household location choices and the distribution of people across the landscape largely reflects differences in the provision of these public goods. By ignoring, the push factors, Tiebout provides a less than complete framework for looking at sprawl. He focuses largely on the demand side of location in a community (potential new entrants) and totally ignores the fact that existing residents, who represent the supply side (regulation, zoning, anti growth lobbying, etc) also impacts on the ultimate absorption of new entrants into a community.

As can be seen from the above, the concept of sprawl is highly complex and its dynamics are driven by complex sets of factors that operate simultaneously at different scales (Transportation Research Board 1995; Squires 2002). Many of these factors are

systematic and are embedded in the age, structure and culture of urban areas, while others are embedded in the behavior of consumers or households who are drawn into less densely populated areas. One area in the study of sprawl that has gained significant attention in recent decades is the role of government in spurring sprawl. To the extent to which sprawl, which is largely viewed as an undesirable demerit public good, can be controlled through public policies, new government spending patterns and changed government behavior, government can play some role in shaping the future through better management of sprawl.

Transportation, including highways and local roads, represents a particularly major area of state government expenditure. Concern about the potential role of government in growth management has sparked significant interest in the special area of transportation. With a few exceptions, empirical studies have consistently shown that among the many identified causal factors, public spending on transportation is a key facilitator of sprawl (Davis 1996; Downs 1999; Garrison et al. 1959; Handy 2005; Rii 1983). For example, some studies suggest that the development of the interstate highway system significantly reduced the cost of intrametropolitan mobility, encouraging individuals and households to relocate to suburban communities which offer better public goods, amenities and quality of life. Essentially, interstate highways facilitated increasing spatial interactions between the central city and suburban and rural areas (Black 2003; Hanson and Giuliano 2004), and transformed the form, structure, and function of cities (Chandra and Thompson 2000; Ebner 1985; Feridhanusetyawan and Kilkenny 1996; Howe et al. 1998).

The findings about highways are not surprising, considering the nature of highways. Highways make the assets and amenities of non-urban communities more accessible and palpable. However, one element of transportation spending upon which very little information exists is the impact of “local road spending” on sprawl. In Michigan, for example, the state allocates road dollars to local communities based on a formula that is tied to existing infrastructure and population.

What is unique about local roads spending is that state funds are passed on to local entities for the purposes of roads development. The impact on sprawl is therefore likely to depend on how the community chooses to spend these funds (which types of local roads). If a community chooses to invest allocated road funds into road projects that open up corn fields and undeveloped and unrestricted portions of the community to development through roads, then road spending will fuel sprawl and can be viewed in the same vein as highway expenditures. If, however, the community spends its resources on the types of road infrastructure that deter sprawl (e.g. roads that connect nearby highways through town to other communities and to commercial areas, but do not facilitate new developments), then it is very likely that state allocated funds deter sprawl.

The complex and endogenous nature of a local roads spending funded through state allocations makes such spending an important area of inquiry with respect to sprawl. In contrast to highway spending decisions, which are deliberate state level investments in connecting cities to other areas, the effects of local road spending is not as clear-cut. Consistent with Tiebout, given the amenities that such communities can offer, it is not surprising that highway spending has been found consistently to fuel sprawl (Carlino and Mills 1987). However, local road funding from the State is complex in the sense that

local politics, possible resistance by anti growth advocates, growth control measures, zoning, land use planning, and other factors creep into the analysis of the effect of such spending.

Despite the importance and ambiguity of local road spending, there is a significant gap in the literature about the issue. Only one study in Canada has shown that local roads spending promote sprawl and inefficient urban form (Vojnovic 2000). It is clear that more analysis, specifically in the US context, has to be done to understand the relationship between local roads spending and urban sprawl. One impetus for this study's emphasis on local roads is that, unlike highways, which tend to be an outcome of centralized decision making and funding processes, local roads investments and their derived services are outcome of local decision making process. Such decision making is obviously subject to preferences of the local political leaders and their constituents. For example, a community dominated by anti-growth advocates might make local roads investments that are in sharp contrast to one that is dominated by pro-growth advocates.

Given the above, an appropriate framework for explaining the complex set of interactions necessarily involved in the decision on how to spend local road dollars and the outcomes of such investments is the political economy framework. However, considering that in addition to local decisions about lobbying for state funds and spending such funds, non-residents consider moving into a community based on the amenities and services available to, the location choice framework must also be considered. The growth machinery and anti-growth literature are also relevant (Logan and Molotch 1987).

Urban sprawl has been defined and measured in many ways (Galster et al. 2001; Lopez and Hynes 2003). In this study, we define urban sprawl as a pattern of

urbanization that is characterized by low density and increasing population in communities outside of a central city within a metropolitan area. The objective of this study is to determine the causal relationship between local roads spending and urban sprawl. It seeks to understand whether or not local roads spending is a growth facilitating or deterring mechanism for local communities. The study recognizes that understanding the relationship between local spending and sprawl is important for two reasons: 1) policy inaction is often blamed on the claim that sprawl is driven by consumer and household behavior, which the government cannot control, and; 2) a clear understanding that the government may actually fuel sprawl through its spending patterns at the local community level provides greater impetus for public policy changes. Furthermore, the absence of clear past theoretical and empirical work on local road spending, vis-à-vis highway spending and other sprawl drivers, makes this an important and valuable contribution, from the standpoint of the literature on sprawl.

The plan for the rest of this paper is as follows. In the next section, in order to better understand the demand side for entry into a community, we provide a review of relevant literature on the link between public goods and household location choice behavior. We also reviewed literature on the supply side of the sprawl problem- how communities reach the decision on whether or not to spend state allocated funds to fuel sprawl or deter it. The review of literature section is then followed by the conceptual framework section where the dynamic interactions among actors (current residents, potential entrants, and local political leaders) are used to explain how demand for and supply of public goods, specifically local roads service, results in sprawl. Based on this conceptual framework, an empirical model is developed and estimated using data from

the Detroit Metro Area. Data and estimation, and empirical results follow. The paper ends with the conclusions and implications section.

2.0 Political Economy of Sprawl: A Community and Location Choice Framework

Understanding how suburbanization or sprawl develops requires knowledge of the underlying social, economic, and locational factors that prompt the relocation of people from one geographic location to another. A review of the provision of public goods, specifically local roads, and an understanding of how demand for and supply of such public goods are shaped through politics and policy would provide an important basis for developing a conceptual framework for analyzing the linkage between local roads and urban sprawl. As the literature would reveal, urban sprawl is an outcome of complex individual and collective decisions that manifest in space.

As indicated above, at the community level, sprawl happens because potential entrants want to move into a high status community and existing residents of the community allow it to happen. This framework for looking at sprawl, allows one to develop an approach, which has, embedded within it, community choice, community resistance, growth control, and resource preservation. Therefore, potential entrants demand sprawl while existing residents can supply sprawl. The former operates through the local allies (developers, bankers, local business leaders, and other proponents of growth) while the latter operates through the following local framework (environmentalists, conservationists, homeowners).

The Demand for Sprawl

Although many forces have been identified to cause sprawl, most analyses of sprawl based on location choice behavior clearly recognize that local public goods and

local policies matter for residential choice (Bayoh et al. 2006; Burnley and Murphy 1995; Feridhanusetyawan and Kilkenny 1996; Kim et al. 2005; Thorsen and Uboe 2002). This perspective is grounded on Tiebout's (1956), which asserts that the geographical sorting of individuals and households across communities in a metropolitan area reflects their preference for certain public goods and services and tax package. For example, Bayoh et al. (2006), Hoxby (1999), Nechyba (2000) and Buckley and Schneider (2006) examined education quality spending; Hoyt (2006) studied the size of jurisdictions as this affects public goods provision, Brueckner (2000) examined local tax competition, Calebrese and others (Calebrese et al. 2006) examined zoning, Warner and Heffetz (2002) compared market versus inter municipal cooperation in public goods provision, and Begeshaw (1998) who estimated the determinants of public service expenditure in fast growing municipalities in Michigan. Most of these studies highlight the significance of public goods provision as primary pull factors explaining the suburbanization process.

The appeal for living in communities that have high quality roads service is particularly compelling since roads have positive impacts on property values (Bhatta and Drennan 2003; Brueckner and Joo 1991; Mikelbank 2004), and promote local economic growth (Kemmerling and Stephan 2002; Mitchell 2005). Local roads also impact residents' quality of life in terms of their everyday experiences with traffic and congestion, pedestrian safety, pollution and noise (Marans and Sheehan 2003). Given the utility of high quality local roads service, it is expected that individuals and households would choose to locate in communities that would offer these goods. More likely, communities that would offer the desirable public goods would increase in population as they could become the preferred destination communities in a metropolitan area.

Individuals and households who seek better quality public goods and are potential entrants in suburban communities, therefore, shape the demand side of the sprawl process. The relocation of individuals and households in suburban areas create housing demand and related infrastructure (Byun et al. 2005). Such individuals are assumed to be highly mobile with perfect information. They tend to have higher income and education and who are more likely of Caucasian descent (Berry 1980; Kasarda et al. 1997).

The Supply of Sprawl

While Tiebout's perspective offers a sound explanation for how sprawl might develop as a result of increasing demand for preferred quality of public goods that mostly suburban communities could offer, a question on whether or not local governments are amenable about attracting new entrants to their communities has oftentimes been raised. Because Tiebout was not clear about the supply side of public goods, it is assumed that local jurisdictions compete to attract entrants or new residents by providing the amenities and goods that people seek.

Note that the assumption on jurisdictional competition for new entrants implies that local jurisdictions are constantly engaged in attracting new residents. It further suggests that local jurisdictions or communities are profit maximizing entities that have available supply of such goods and services (Henderson 1985). Such assumption fails to consider that local political leaders at individual jurisdictions could exercise power in the provision of public goods (Epple and Zelenitz 1981) either by zoning or other land use regulations to control growth (Carruthers 2002, 2003). Tiebout's perspective also fails to recognize that home voters could exercise their influence in opposing additional residents or entrants to the community (Fischel 2001). As it shows, whether or not local

governments and its constituents would allow growth is subject to local political, and socio economic contexts.

Oftentimes the existence of local land use regulations and development policies reveal the preferences and values of local government and its constituents for homogeneous and optimal community size (Ihlanfeldt 2004; Pendall 2000). The presence of (or lack of) growth control and other regulatory mechanisms (i.e. zoning, growth boundary) has been found to affect housing development (Anthony 2004; Byun et al. 2005), and consequently, community growth. Byun et al. (2005) examined how growth controls affect the spatial shift of people from one community to the other and how such process resulted in suburbanization or sprawl in spatially connected communities in a metropolitan area. Their study in California indicated that the enactment of growth control mechanism by a local community triggered spillover effects. People and homebuilding shifted to nearby localities where local growth control was not implemented. In time, this spillover effect progressed from one community to the other, propagating a wave of spatial shift of homebuilding and relocation of people as communities adopted and enacted a growth control strategy.

With regards to local roads, it is unclear whether or not local roads investment could serve as a growth control mechanism, since studies on this area are lacking (Byun and Esperza 2005). However, evidence from studies on applications of growth control on land use, as described above, could provide some insights.

In terms of using local road investment as a growth control tool for local communities, the local leadership has an option to build road infrastructures that could encourage population growth, or those that control growth, given limited revenues for

local roads development. This means that whether or not a community would want to accommodate new growth is a matter of choice on the type of road investments that the leadership may undertake and the support it gets from the constituents or its resident home voters.

Identifying the types of local roads infrastructure that policymakers would choose to invest in has not been easy and studies in this area are lacking (Brueckner 2005, Brueckner and Selod 2006). Few studies have explored the dynamics of local decision making on types of transport systems, given preferences of local residents. Local community residents and local politicians may decide to invest on a transport system that is more expensive and faster (i.e. freeway), or they could opt for slower and less expensive system (i.e. transit). The choice for a transport system at the local level oftentimes reflects the demographic characteristics of the residents and is expressed in the polls (Brueckner and Selod 2006; Sasaki 1989; LeRoy and Sonstelie 1983). Brueckner and Selod (2006), for example, found that a preference for fast and expensive transport system (i.e. freeways) was consistent with the skill level, income, and homogeneity characteristics of local residents. They found that residents who had higher income and skill, and who were living in the suburban areas tended to prefer investment on freeways. Similarly, Leroy and Sonstelie (1983) and Sasaki (1989) showed that suburban residents with higher income preferred high fixed cost and low variable cost system while the central city residents tended to prefer the system with reverse characteristics.

Aside from the local growth control regulations that could affect community growth and consequently sprawl, residents' attitude toward growth and economic development could affect their response to the impending growth as represented by the

potential entrants. Preference for homogeneous communities and the desire to exclude others among current residents motivate residents to put up barriers for growth via land use regulations (Cowan 2006; Ihlanfeldt 2004). It is also possible that in any given community, some residents may advocate for growth while some others may be against it (Logan and Molotch 1987; Logan et al. 1997). Pro growth advocates may prefer road investments that would entice individuals and households to relocate to the community, while anti growth advocates would prefer otherwise. Balancing this conflict between the pro growth and anti growth advocates falls to the local decision makers or political leaders, whose primary interest is in maximizing political capital from their constituents. The notion that “roads and railroads are built not to reduce traffic jams but to get the politicians reelected (Cadot et al. 2006),” may reflect a politician’s ulterior motive about his/her road investment decision and other public infrastructures.

In light of the above, the provision of public goods, such as local roads services, is subject to the decision of local policymakers and the political capital that they hope to generate from their constituencies. Essentially, local policymakers are expected to behave rationally in the sense that they decide on an investment option that potentially would raise their electoral prospects (Hahn 1990). Given that the objective of local policymakers is to maximize the vote from their constituencies, the strength and number of either current residents or potential movers (political clout) who would support their candidacy are important considerations for local policymakers in choosing the type of road investment for the community. Support for the local policymakers or political candidates by its constituents is affected by factors such as the homogeneity and size of the group (Adelaja and Friedman 1999; Adelaja and Gottlieb, 2006), locational context

(Brueckner and Joo, 1991), partisanship (Kemmerling and Stephan, 2002), income, education, skill, political affiliation and other demographic factors that reflect the group's lobbying capacity, preferences and values (Timpone 1988). The local political leader, therefore, wields a strong influence upon the provision (supply) of public goods, such as roads as public goods. Their constituents (current residents and potential entrants) could shape the demand for the public goods. The balance between supply and demand factors has implications for growth patterns across the communities in a metropolitan area.

This review shows that the demand for sprawl is shaped by potential residents, representing the most mobile population groups, who possess certain demographic and socio economic attributes (higher income, educated, predominantly white). They demand high quality public goods, amenities, and services and tax package that are mostly available in suburban communities. The supply side of sprawl, on the other hand, reflects the local community's decision on provision of public goods, such as growth promoting roads investment, and or imposition of growth control mechanism subject to their constituents' preferences. Therefore, the local government wields a strong influence on how sprawl is propagated in metropolitan areas. Moreover, inspite of the existence of strong demand for suburbanization, one should expect that local policies and local political leaders' decision do matter in shaping sprawl. It is possible that local roads spending, as a public good could be used as either growth promoting or control mechanism in similar ways that land use regulations are used.

What follows is a conceptual framework that theoretically characterizes the behavior of local political leadership, given local electoral preferences related to growth. The framework explains possible responses (from potential movers and current residents)

to local leadership's decision on roads investment and the possible implications on the pattern of growth in a given metropolitan region.

3.0 Conceptual Framework

An appropriate place to start the analysis of the impacts of local road service on community growth is to understand the various interconnections and relationships between the local leadership and the corresponding response that could come from current residents in regards to the local policymakers' roads investment decisions. Given that a state's road spending allocation is made in a context of a politically fragmented metropolitan region, local communities have the authority and choice to invest in roads development that either promote or restrict population growth. The choice of roads investment at the local level could be motivated by the local economic growth strategy to attract people and jobs, thereby increasing tax base. On the other hand, local communities could choose to invest in roads infrastructure that restrict population growth or one that could control the size of the community and protect the decreasing utility of residents that may result from congestion, overcrowding, and diminishing quantity and quality of local public goods, services and available natural amenities.

Since roads connect communities and facilitate mobility and accessibility between areas within a community, the choice of local community road investments would be an important consideration for individuals and households locational choices. The discussion in the previous section allows the identification of specific variables that would inform in developing the empirical model of community growth via population change. Using the Tiebout framework as spring board in our analysis, the following section articulates the objectives of the specified key actors as they make locational choices, their possible

response and reactions toward investment decisions, and road investments that may define the character and nature of the growth pattern at the local community level. It is assumed that the pattern of population change at the community level has broader implications to the pattern of growth in a given metropolitan region. The explanation highlights the expected utility of different actors that influence the demand for and shape the supply of roads and other public goods and services. The role that local political leaders play in investment decisions is also articulated.

Utility/Objective Function of Potential Movers into a Community

The potential movers or new entrants to the community represent the demand side for housing, public goods and services, and amenities in a non-urban community. They are driven by the desire to maximize utility, subject to a budget constraint. Utility for the potential residents is assumed to encompass quality of life, which include public goods and services (e.g. roads, school, and housing quality), private goods, and natural amenities (e.g. open space). Tiebout (1956) suggests that residents would consider the bundle of goods and services and desirable tax burden when making a location decision. People in the Tiebout world are concerned about obtaining a high quality of local goods and services with lowest per capital tax burden as possible.

While community growth due to choice of road investment may provide a preferable scenario for new entrants, their enjoyment of the available goods and services, and natural amenities available in the community of choice could be affected as crowding may ensue and quality of public goods and services may decline. The new potential entrants or movers could resort to “yardstick competition” (Besley and Case 1995) and may compare alternative locations given specific public goods and services, tax burdens,

housing stock and prices, and job opportunities. An individual or household will not move out from her/his current location or community unless the alternative location offers a higher or better level of the desirable bundle of goods and services that they desire.

Utility/Objective Function of Current Residents

Most homeowners advocate for high quality and well maintained local roads as these potentially increase property value and improve private productivity (Brueckner and Joo 1991). They may be less supportive of a road investment that promotes greater flow of through traffic movement such as improving the arterial or collector roads, increasing speed limit, and expanding lanes (Black 2003). Similar to the effects of growth control tools, local roads investment that control growth could protect properties against the negative impacts of growth. These negative impacts may include declining property value due to a deteriorating local roads stock and related services.

Some local residents, particularly the homeowners in a community would tend to advocate for “less to no growth” because of concerns over congestion, the diminishing quality of public goods and services, and the likelihood that the tax price would increase to accommodate the growing demand for public goods and services in a community with increasing population. They would also be concerned about growth as it imposes a diminishing quality, quantity, and accessibility to natural amenities available in a community. However, some current residents in a community may support growth promoting initiatives since these bring potential jobs and improve tax base of the community. The goal of these growth supporting residents then is to advocate to their

local policymakers to join the “race to the bottom” policy (Fischel 2001) by voting for tax cuts, and supporting larger capacity road investments for the community.

When growth is accommodated or allowed by local policymakers, the reduction of enjoyment of the available open space due to increased housing and infrastructure development is likely. In addition, competition for accessibility and satisfaction derived from the remaining natural amenities would become stiff as more people attempt to experience and access such open public good provisions available in the community.

Granting that the decision by local policymakers is to invest in growth controlling road projects, potential entrants or movers could shift to alternative communities that either have growth promoting road investments, or “less to no growth” controlling land use regulations. In cases where local policymakers adopt growth enhancing rather than growth controlling road investment, some current residents, especially homeowners, will more likely opt for “exit” as their utility from natural amenities, public goods and services, and preference for community size would be undermined (Percy et al. 1995).

Nonetheless, current residents, especially homeowners, typically resort to “voice” and participate in local activism, and create partnerships with other interest groups to preserve their properties. They would more likely advocate for the enforcement of local land use regulations, and roads investments that control growth and promote social exclusion (Hughes 1975; Pendall 1999, 2000).

Current residents/homeowners constitute the primary source of fiscal resources in a community. Therefore, local policymakers have a keen interest in responding to their concerns. Moreover, homeowners provide the largest pool of political capital that local policymakers will have to consider in making road investment decisions. It is plausible to

hypothesize then that given the tendency of local homeowners for preference to maintain or increase their property value, the current resident would choose local road spending that would control or deter potential movers to the community.

Utility Function of Local Political Leaders

Suburban communities present a better climate with respect to most of the desirable goods and services, job opportunity, and natural amenities (Ebner 1985, Jordan et al. 1998). Limiting the ability to move into a community are zoning and regulatory frameworks in place, and road investments that affect the flow of people between places of work, rest, and play. Local policymakers could opt for larger capacity road investment such as arterials and collector roads, rather than local neighborhood roads that primarily serve the purposes of individual properties and neighborhoods. This option would reflect a tendency of the local policymakers to favor roads investment that attracts individuals to locate in the community. Investments away from local roads would suggest the leadership's lack of sensitivity to homeowners, whose primary goal is to secure their property value and the neighborhood. On the other hand, investment on high capacity roads would more likely attract private investments and people to the community, as this would mean that housing cost will go down and would be more affordable to the new entrants or potential movers.

Local political leaders are keen on securing the political capital from their constituencies. They are sensitive about providing high quality public goods and services. On the other hand, local political leaders are also concerned about costs involved in maintaining roads infrastructure and other public goods and services. Since property tax comprises the primary source of revenue for local governments (Fischel 2001), local

political leaders could choose growth enhancing investment opportunities more than growth controlling roads investments. However, they are also sensitive about “voice and exit” from disgruntled residents due to possible congestion resulting from increased housing and infrastructure development in the community. Thus, political leaders would carefully choose a type of road investment that would meet their residents’ demand and provide other goods and services without undermining their political capital.

The conceptual framework described in the preceding paragraphs characterizes the expected behavior of local or current residents and potential residents or movers given investment decision on local roads by local political leaders. The behavior of the local leadership provides insights to the possible growth outcome in a given community, contingent upon the political capital that it hopes to generate from its constituents. Thus, the theoretical discussion presented above allows the following null and two alternative hypotheses to be stated.

H₀: Local roads spending does not affect community growth at the local community level (sprawl).

H₁: Local roads spending facilitates community growth (sprawl)

H₂: Local roads spending controls or deters community growth (sprawl).

It is assumed that all actors involved in the provision of public goods and services, specifically roads, behave in such a way that they maximize their utility. Community growth is affected by locational decision of individuals and households who consider local community provisions of private goods P , public goods G (e.g. roads service, school, fire, and police protection services), natural amenities A (e.g. open space), and demographic factors D , subject to his/her budget constraint Y . Equation 1

expresses the utility function of individual or household decision makers when considering residential location options.

$$Max U(P, G, A, D) s.t. Y \tag{1}$$

To capture the effects of accessibility of individuals and households to suburban amenities, distance L from a central city to a particular community (of choice) is added into Equation 1. The distance factor measures the influence of accessibility to suburban amenities, and public goods and services factors, which affects location choice and subsequently population growth at the community level.

Since local policymakers wield influence on the supply of public goods and services, particularly roads investment, political factors V are important considerations in road investment decisions at the local level, as well as in securing local (e.g. levy taxes) and external support (e.g. grants from higher tier government) to finance local public goods and services. The number of voters (n), and political affiliation (a) of current residents could affect the provision of road service in a given community. Therefore, Equation 2 below provides the adjusted framework, which captures the effects of the political factors (V) with regards to local roads service provision.

$$Max U\{P, G[r(V(n, a))], A, D, L\} s.t. Y \tag{2}$$

It should be noted that the conceptual framework emphasizes the importance of roads service provision in location decisions, and *ceteris paribus*, how it may function as either a growth promoting or deterring mechanism for local communities. Assuming that the overall utility function of individuals and households is positive, relocation of potential entrants in a given community could be expected. Otherwise, if their utility

function is negative, potential entrants could either remain in their current location or resort to available community or locational alternatives as substitute. Likewise, the sign of the utility function of the current residents in a given community could lead to a particular response. Current residents may exert “voice” or “exit,” depending on the local policies and regulations on roads investment and other public goods and services, private goods, and other locational considerations that could affect their utility in the current community. Equation 3 shows the potential residential location decision, R , of individuals and households (potential and current residents) based on their overall utility function.

$$R = \text{Max}_{i, A, D, L} U_i \{P, G[V(n, a)], A, D, L\} - \text{Max}_o U_o \{P, G[V(n, a)], A, D, L\} \text{ s.t. } Y \quad (3)$$

where i and o are subscripts for community. If $R > 0$, individuals and households (specifically potential entrants) would relocate to community i ; if $R < 0$, they would stay in their current community o . If $R < 0$ for current residents, they could opt for “exit,” then possible relocation in alternative communities (e.g. community i) where they would seek to improve overall utility. Otherwise, they could resort to “voice” and participate in local initiatives that could improve their current overall utility.

The conceptual framework presented above shows how revealed preferences through the locational behavior of individuals and households may determine the level of desirability or attractiveness of communities based on their utility function characteristics.

4.0 The Empirical Model

As described in the previous section, the framework adopted here conceptually explains how local roads may provide explanation for the geographical sorting of individuals and households across communities in a metropolitan area. Moreover, the framework allows an analysis of how sprawl evolves given location choices that reflect individual preferences for public goods and amenities, while keeping in mind that local policymakers and their constituents wield influence in the provision of such goods.

The conceptual model suggests that the location decision of an individual or household is affected by a community's provision of public goods and other factors related to social, economic, political, and spatial factors subject to his/her budget constraint. These factors motivate the individual or household to choose one location over the other, or to move or stay in the current residential location.

Population change in a community should indicate whether or not the types of public goods and amenities provided in a given community meet the demand and preference of individuals and households. A linear specification of the empirical model is used and presented in Equation 4 below. The empirical model is estimated via Ordinary Least Squares regression to determine whether or not change in population between the two time periods for each community is predicted by demographic factors, public and private goods provision, political factors that affect the public goods (e.g. roads investment decision) provision, and other community characteristics. The change in population between the two time periods is regressed against the value of initial level of independent or predictor variables (year 1992).

$$\Delta Pop_c = \alpha_c + \beta_c P_{c(t-1)} + \chi_c G_{c(t-1)}(V(n, a)) + \gamma_c A_{c(t-1)} + \phi_c D_{c(t-1)} + L + \varepsilon_c \quad (4)$$

where ΔPop_c is the percentage population change in community c between 1992 and 2002, P_c is the private goods characteristics in community c , G_c , is public goods and services, A_c is the available natural amenity, D_c is the average values for demographic characteristics of residents in a community, V_c is the political characteristics that affect road investment decision and other public goods, L_c is the distance between a central city and a community that measures accessibility to public goods and amenities, and ε_c represents other factors that affect population change in community c .

The empirical model is tied to the objective of the paper which is to determine the relationship between local roads spending and community growth (sprawl), which has implications to the pattern of metropolitan sprawl. Roads investment at the local level is analyzed whether or not it functions as either a growth promoting or deterring in a given community. The empirical model presented above allows other public goods and other factors that are theorized to predict location choice, keeping in mind that a fully specified model could avoid misspecification errors in modeling a complex phenomenon such as urban sprawl.

The Case Study Site

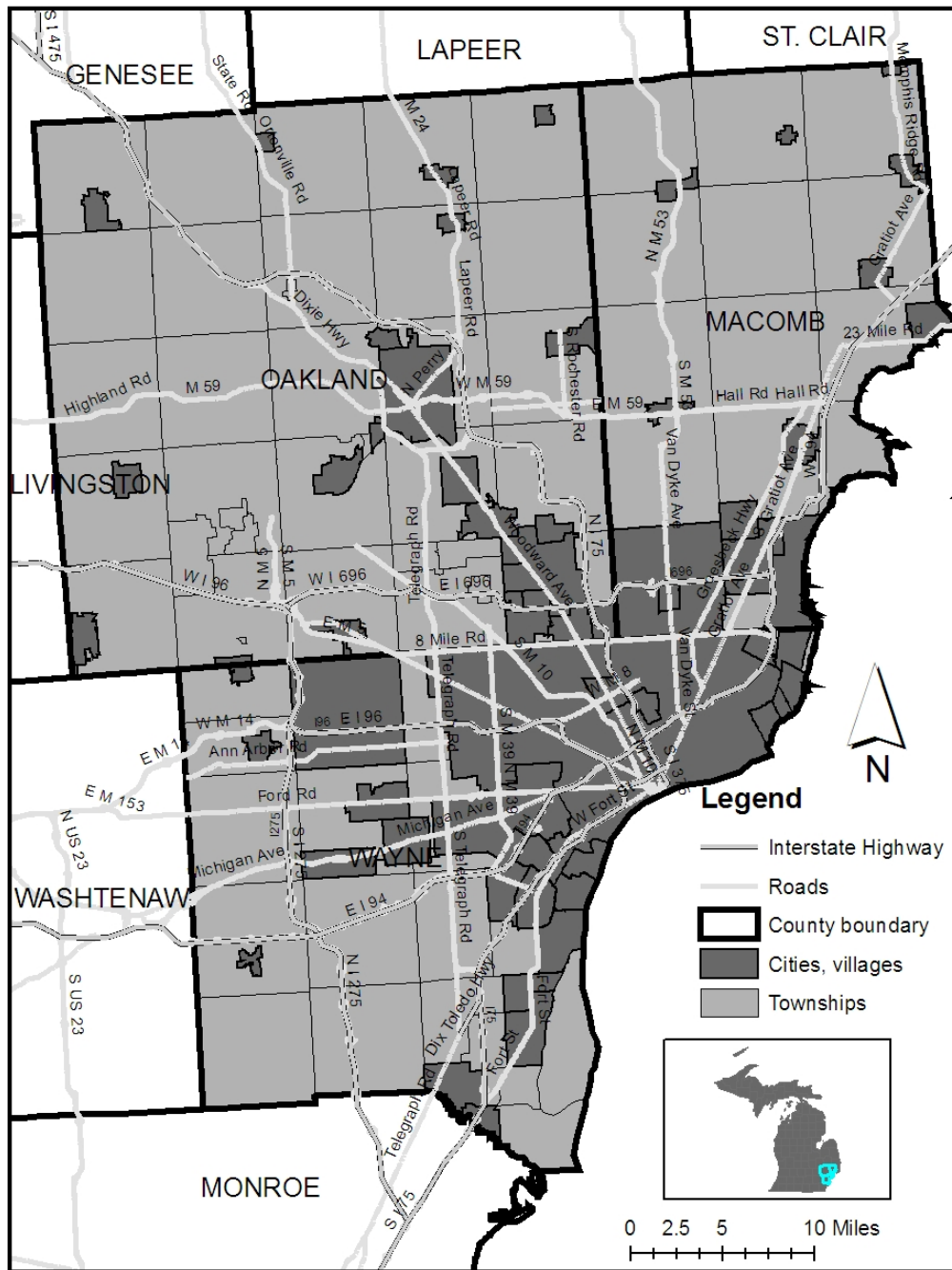
The Detroit metropolitan area, which comprises the Tricounty Areas of Wayne, Oakland, and Macomb counties, is the geographic context in which the empirical model will be tested (Figure 4.1). The region consists of seventy six (76) cities, forty two (42) townships, and thirteen (13) villages (Gavrilovich and McGraw 2000). This region has and is experiencing an unprecedented spatial, economic, and social transformation since the World War II. As a result of people and job decentralization, disparity based on race and class has characterized the region. As of the 2000 Census, over four million people

lived in the metro area with more than three million people located outside the city of Detroit (U. S Bureau of the Census 2000). The pattern of population distribution showed that the city of Detroit lost more than half of its population since the 1950s and massive out migration from the central city still continues to the present. The United States Bureau of the Census estimated that the population of the city of Detroit was 1.85 million. As of 2006, less than half or 871,121 people are estimated to be living in the city (US Bureau of the Census 2000).

The Detroit metropolitan area continues to experience the highest rate of urbanization within the Southeast Michigan region. Limoges (2001) reported that thirty three percent (33%) of the Southeast Michigan region's land area of about 1,967 square miles are urbanized as of 1995. This urbanized area was about 4 times the size of the 1950 urbanized area. Since then, it is estimated that additional 17% of the land area have been urbanized within the last decade. Jobs in the Metro Detroit are also highly decentralized. Nationally, 65% of all jobs are located within 10 miles of the central business district. In Detroit, only 22% of jobs are located within a 10 miles radius (Katz et al. 2003).

The situation in the Detroit region offers a critical opportunity for studying the causal relationship between public transportation spending and sprawl. Understanding the underlying and proximate factors causing suburbanization and sprawl will contribute to the ongoing policy discussion and discourse on land use change in Michigan.

Figure 4.1. The Study Area



5.0 Data and estimation

The empirical estimation is undertaken in the context of the Detroit Metropolitan Area for the two time periods covering 1992 and 2002. Due to data constraints, individual locational decision of specific individuals or households is not measured. The data constraint is such that information about persons and/or households, including personal attributes, residential location, and work location, among others are not readily available to the public. Also, while some information are available at the block level (i.e. housing count), no exact residential location information on individuals are available at the block level. It should also be noted that data availability dictated the temporal coverage of the empirical estimation. The data came from different sources. Data on some variables were available in ten years interval as reported in the decennial census of the US Bureau of Census (i.e. income, population count). Other variables have data that are collected in five years interval (i.e. expenditures on parks, police protection).

The geographic data were obtained from the official website of the Michigan Geographic Data Library, Center for Geographic Information (Michigan Geographic Data Library; <http://www.mcgi.state.mi.us/mgdl/>; last accessed 12/30/2006). Data on the State's transportation allocation were from the MDOT Michigan Department of Transportation Annual Reports, Report number 139 (Michigan Department of Transportation). All other community level data on population, household and per capita income, local government spending on highways and other public services were obtained from the official website of the US Bureau of the Census and in some cases, directly from the Census of Government unit specialist in the US Bureau of the Census.

As noted in the empirical model section, the approach for the empirical investigation consists of examining community and locational characteristics related to public and private goods, amenities, demographic and political factors, and whether or not these have effects on population change at the community level. The empirical estimation will be based on aggregate measures or indicator of population change between 1992 and 2002, using the community (townships, cities, and village) as the unit of analysis. Population change at the community level is assumed to reflect the community's attractiveness (or lack of) given amenities, public and private goods provision, and political factors. These explanatory factors represent the "community context," or quasi Tiebout (Percy et al. 1995) reflecting community conditions that are maybe influenced by local government intervention or decision (p.7).

The use of the population change as indicator of sprawl follows that of Burchell (2002) and Dye (1980). The change index is used to identify which communities have increased or decreased in population, a measure of a community's attractiveness for household relocation. It is used as the dependent variable in the subsequent community choice model estimation.

For empirical estimation, key variables that measure private goods P_c , public goods G_c , local community amenities A_c , the demographic characteristics D_c , political factors determining the public goods provision V_c and distance between a central city to a community are described below and summarized in Table 5.1. These factors measure the social, economic, political, and spatial considerations that enter in to the utility function of individuals and households' location choice behavior.

Median housing value $VALUE_c$ is a proxy for the characteristic of housing quality as a private good P in a given community. Public goods services G are represented by highways and local roads, fire and police protection expenditures ($HIGHWAYS_c$, MTF_c , $FIRE_c$, $POLICE_c$), assuming that the level of expenditure on these is a good index for the level of service provision in a given community.

Due to the inavailability of data that classify investments according to either growth promoting or growth controlling roads, the political affiliation factor is not included in model testing. The absence of this information allows us to speculate that roads service provision at the local level may not reflect the political orientation of the residents in a community, and road spending allocation is assumed to be politically neutral. However, the base population or size of a community, which measures political clout $POPULATION\ 1992$, provides a clue about the existing demand for public goods in a given community. We used the total State's allocated dollars through the Michigan Transportation Fund (or the Act 51 dollars) and total highways expenditure as proxy for roads service provision. The Michigan Transportation Fund (MTF) formerly known as the Motor Vehicle Highway Fund provides a primary revenue for the development of roads and transportation networks in the state of Michigan. It was established through the Public Act 51 of 1951, which governs state appropriations for interstate and local highways and public transportation programs (Hamilton, 2003). Local communities receive MTF dollars from the State of Michigan for construction, maintenance, and upgrading of local and community roads, while the highways expenditure $HIGHWAYS$ include revenues coming from different sources (Federal, State, local) as reported by the Census of Governments of the US Bureau of the Census.

Table 5.1. The Definition of Variables and Data Sources.

Variable	Description of variable	Source
<i>INCOME</i>	household median income	U. S Bureau of the Census
<i>DISTANCE</i>	distance from Detroit (miles)	Computed by one of the authors using Hawth's Tools
<i>HIGHWAY</i>	per capita highway expenditure	Census of Governments, U. S. Bureau of the Census
<i>VALUE</i>	Medina value of owner occupied houses (2000)	U. S Bureau of the Census
<i>FIRE</i>	per capita fire expenditure	Census of Governments, U. S Bureau of the Census
<i>LIBRARY</i>	per capita library expenditure	Census of Governments, U. S Bureau of the Census
<i>PARKS</i>	per capita parks expenditure	Census of Governments, U. S Bureau of the Census
<i>POLICE</i>	per capita police expenditure	Census of Governments, U. S Bureau of the Census
<i>MTF</i>	Michigan Transportation Fund (State grant)	Report #139, Michigan Dept. of Transportation
<i>NONWHITE</i>	percent % non white	U. S Bureau of the Census
<i>TAX</i>	per capita property tax revenue	Census of Governments, U. S Bureau of the Census

Household median income *INCOME*, local property tax revenue *TAX*, and non white population *NONWHITE* are proxies for the demographic and economic characteristics of a given community. The amenity factor in the model is represented by expenditure on parks *PARKS_c*. Finally, distance *DISTANCE* in miles between a central city and a community in the study area is a proxy for the level of accessibility to public goods and other characteristics available to individuals and households in a given community. Equation 5 allows for testing whether population change at the community level is predicted by the variables described above.

$$\begin{aligned} \Delta POP_c = & \beta_0 + \beta_1 VALUE_{c(t-1)} + \beta_2 HIGHWAYS_{c(t-1)} + \beta_3 MTF_{c(t-1)} + \beta_4 FIRE_{c(t-1)} + \\ & \beta_5 POLICE_{c(t-1)} + \beta_6 PARKS_{c(t-1)} + \beta_7 INCOME_{c(t-1)} + \beta_8 NONWHITE_{c(t-1)} + \quad (5) \\ & \beta_9 TAX_{c(t-1)} + \beta_{10} POPULATION1992 + DISTANCE + \varepsilon_c \end{aligned}$$

Following preliminary tests to account for violations of the OLS modeling assumptions, spatial autocorrelation was detected as indicated by Moran's *I* and Lagrange Multiplier tests. To account for this problem, a spatial lag specification is used. The final empirical model is thus re-specified as:

$$\begin{aligned} \Delta POP_c = & \beta_0 + \rho(WPOP_c) + \beta_1 VALUE_{c(t-1)} + \beta_2 HIGHWAYS_{c(t-1)} + \\ & \beta_3 MTF_{c(t-1)} + \beta_4 FIRE_{c(t-1)} + \beta_5 POLICE_{c(t-1)} + \beta_6 PARKS_{c(t-1)} + \quad (6) \\ & \beta_7 INCOME_{c(t-1)} + \beta_8 NONWHITE_{c(t-1)} + \beta_9 TAX_{c(t-1)} + \\ & \beta_{10} POPULATION1992 + DISTANCE + \varepsilon_c \end{aligned}$$

where ρ is the spatial autoregressive coefficient, W is the spatial weight matrix constructed based on contiguity of neighboring communities, and $WPOP_c$ is the spatial lag of population change. The maximum likelihood estimation procedure is utilized in estimating Equation 6.

6.0 Empirical Results for Population Change Model

The null hypothesis tested in this paper is that road spending does not facilitate community growth at the community level. The alternative hypotheses are: 1) local roads spending facilitates community growth; and 2) local roads spending deters community growth. Results of the autoregressive model estimation show a high R squared value ($R^2=0.92$), which suggests that 92% of the variation is accounted for by the eleven predictor variables in the model. Among the specified variables to predict population change, four variables were statistically significant at the levels ranging from less than 1% to 10%.

Results indicate that the coefficient for local roads spending is positive and statistically significant at less than 10% level. The coefficient of local roads spending suggests that for each per capita dollar increase of lagged MTF allocation that a community receives, a corresponding 0.01 person is added to the community. This translates into the following: a \$100 per capita increase of MTF local roads spending that a community receives corresponds to an increase in 1 person to the community. This result generally supports prior findings about the facilitating effect of spending on roads, particularly highways, on urban sprawl. It further suggests that a community with higher investment on local roads tends to attract people and is a destination community for individuals and households. The coefficient for the distance variable DISTANCE is positive and statistically significant at the 1% level. The result suggests that for every mile that a community is located away from a central city (e.g. Detroit), a corresponding change in population of 103 persons are added to the community between 1992 and 2002.

The property tax revenue variable is also positive and significant at the 1% level. A dollar increase in per capita tax revenue, corresponds to a 0.39 persons added to the community. Therefore, a \$100 per capita tax revenue increase corresponds to an additional 39 individuals between 1992 and 2002. This means that communities that are fiscally advantaged are more likely to attract people and increase in population. These communities would be considered destination communities for potential residents. On the other hand, the coefficient of fire expenditure variable FIRE, while significant at the 1% level, is negative. It shows that a per capita \$100 increase in expenditure for fire protection, corresponds to a reduction of 74 individuals in the community between 1992 and 2002. This finding suggests that communities with increasing expenditure on fire

protection, which are mostly established and urbanized places, are actually losing population. The increasing fire protection expenditure is most likely creating a disincentive for individuals and households to relocate or stay in those communities.

The coefficient for the population at the initial level (POPULATION 1992) was not significant. The result suggests that prior population size does not affect future population change. This suggests that size does not necessarily make a reliable predictor of future growth for a community. The variables property value, parks and police expenditures, percent nonwhites, and household income were not statistically significant.

Our test for spatial proximity through the spillover effect variable yielded a negative coefficient and the significance level of less than 10%. The estimated coefficient of -0.24 suggests that communities that are surrounded by neighboring communities that gain 1 individual tend to lose .24 individuals. This translates to a 100 persons gain in neighboring communities tends to reduce population in a given community by 24 individuals. This finding aptly describes the Detroit Metropolitan Area, where the city of Detroit and some of its inner ring suburbs are experiencing declining population while the neighboring suburbs are growing. Thus, our empirical finding allows us to reject the null hypothesis that local roads spending does not facilitate community growth, and accept the first alternative hypothesis that roads spending does facilitate community growth. A summary of the parameter estimates is presented in Table 6.1.

Table 6.1 Population Change And Hypothesized Determinants

Variable	Coefficient	t-statistic
Intercept	-3341.95*	-1.78215
Population 1992	0.19	1.4
MTF92	0.01*	1.88
VALUE	-0.002	-0.53
DISTANCE	103.36***	3.75
TAX	0.39***	4.35
FIRE	-0.74***	-3.32
HIGHWAY	-0.17	-0.83
PARKS	-0.16	-0.61
POLICE	0.21	1.26
NONWHITE	-10.66	0.41
INCOME	0.03	1.23
WChangeinPop	-0.24*	-1.78
R ²	0.92	

7.0 Conclusion and Implications

This paper sought to explain sprawl in metropolitan areas. Our analysis across the municipalities in the Detroit Metro Area indicated that local roads spending, and some indicators of fiscal health and spatial or locational factors facilitate population change in a given community. However, increasing fire protection service factor tended to discourage population growth. Our finding is consistent with prior studies that found a positive causal relationship between roads spending (specifically on highways) and sprawl. This means that communities that have higher lagged per capita roads spending allocation tended to facilitate an increase in population in certain communities. It also suggests that better local roads service is a particular public good that facilitates individual and household relocation.

The pure distance effect on sprawl is also well supported as our findings show that population change is influenced by locational or spatial factors (e.g. distance in miles between a community and central city). Suburban and exurban communities, or those places located increasingly away from a central city, tend to increase in population than those located near or at the periphery of a central city in a metropolitan area. It is clear based on these findings that the pattern of distribution of MTF roads allocation is rewarding the suburban communities and in effect, the State government of Michigan through its local roads spending policy, is reinforcing the incidence of sprawl in metropolitan areas.

Overall, these findings provide information about complex factors that explain population change in local communities. With regards to roads spending in the context of Detroit metropolitan area, we found that the local roads spending factor serves as a growth promoting mechanism for local communities in suburban areas.

Significant implications can be drawn from these findings. Given that local roads spending facilitates population growth in communities that are located increasingly away from a central city, it is expected that the trend of suburban sprawl would more likely continue. A sustained pattern of suburban sprawl has implications to land resources and the environment, and social and economic well being of people and communities. As people suburbanize due to their attraction to better roads service and other public goods in communities away from a central city, more land would be needed for housing development and related infrastructures. As such, suburbanization would be detrimental to the sustainability of land and environmental resources.

Given that local roads spending facilitates community growth, the tendency for competition among local community political leaders to vie for higher roads allocation is expected to continue. Such competition takes away opportunities for regional cooperation and mutual aid among local governments in addressing issues of region wide importance such as economic development, roads and police services, among others. Additionally, as jobs and economic incentives relocate to suburban areas, spatial inequality is more likely to be sustained, therefore, current and future efforts to revitalize the central cities would be undermined.

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