Urban Sprawl, Commuting, and Access to Public Transportation in the Southeast

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Abstract:

Urban sprawl has emerged as a major urban planning issue in the past decade, with a variety of urban problems attributed to it. It is accused of consuming excessive amounts of land in an uncontrolled fashion, which leads to an unnecessary separation of land uses and activities and, in turn, increases the demand for mobility. A greater number of trips leads to greater air pollution and other environmental problems, while increased travel may lead to traffic congestion that decreases mobility and access to employment and services (Johnson, 2001; Gillham, 2002). Yet while automobility and accessibility may be diminishing due to the effects of sprawl, the reliance on automobiles is increasing. Urban sprawl is typified by the construction of low-density urban landscapes, with commercial buildings surrounded by parking lots located on large parcels. These parcels are spatially separated from residential areas by distance and crowded arterial streets unsafe for pedestrians. Walking is not feasible in such conditions, and those who do not have access to a car likely will have extremely limited mobility, and may not be able to easily reach potential employment locations within the city.

Keywords: urban sprawl | Atlanta | Birmingham | Tuscaloosa | transit use

Article:

1. Introduction

Urban sprawl has emerged as a major urban planning issue in the past decade, with a variety of urban problems attributed to it. It is accused of consuming excessive amounts of land in an uncontrolled fashion, which leads to an unnecessary separation of land uses and activities and, in turn, increases the demand for mobility. A greater number of trips leads to greater air pollution and other environmental problems, while increased travel may lead to traffic congestion that decreases mobility and access to employment and services (Johnson, 2001; Gillham, 2002). Yet while automobility and accessibility may be diminishing due to the effects of sprawl, the reliance on automobiles is increasing. Urban sprawl is typified by the construction of low-density urban

landscapes, with commercial buildings surrounded by parking lots located on large parcels. These parcels are spatially separated from residential areas by distance and crowded arterial streets unsafe for pedestrians. Walking is not feasible in such conditions, and those who do not have access to a car likely will have extremely limited mobility, and may not be able to easily reach potential employment locations within the city.

The reliance on automobiles in sprawling areas is also necessary because of a lack of transit service. Sprawling areas may lack transit service, and in fact may be fundamentally unsuitable to mass transit because of their low population densities and the absence of large traffic generating centers. The dispersed, low-density sprawl environment does not allow for many separate trips to be combined in one bus or rail route. Within such conditions point-to-point travel with private cars emerges as the only viable transport system, but this could contribute to increased sprawl and so worsen the problem. Despite facing a difficult operating environment, transit is therefore also seen as an important component of any solution to sprawl, as something that must be present if we are to fundamentally alter urban form (Gillham, 2002). The extent to which transit can serve sprawling areas, and the extent to which this service would differ from that in central cities, is therefore an important question.

This paper uses objective methodologies to identify sprawl and the extent of trans it services within three Southern metropolitan areas of different sizes. The goal is to show whether transit service and usage differ in sprawling areas from those found elsewhere within these cities, and whether there is therefore any basis for arguing against transit services (i.e., accepting the inevitability of automobile primacy) within these areas. Investigating the relationships between sprawl and mobility is clearly an important topic, but one that has proven difficult to assess as sprawl is an emotion-laden concept that is often discussed in only vague terms. It is hoped that this research will contribute to attempts to better understand the phenomenon of sprawl and its implications for urban transportation systems.

2. Study Areas and Background

The Atlanta, Georgia, and Birmingham and Tuscaloosa, Alabama, metropolitan areas were used for this analysis. They represent relatively fast growing metropolitan areas of varying size. The Atlanta Metropolitan Statistical Area (MSA) is by far the largest of these and includes 20 counties with a total population of 4.1 million in 2000, a 38.9 percent increase from 1990 (U.S. Census Bureau, 2003). Atlanta is one of the fastest growing large metropolitan areas in the U.S., and it is also considered an emerging center of urban sprawl (Bullard, 2000; Jaret, 2002).

Scheduled bus transit service in the Atlanta area is provided by two agencies. Metropolitan Atlanta Rapid Transit Authority (MARTA) provides the majority of service, with an extensive bus system as well as a much smaller rapid transit rail system (which was not included in this analysis as it serves the areas also covered by bus routes). As of 1999, MART A operated 154 routes that amounted to 1,531 miles (Bullard, Johnson and Torres, 2000). This bus service is concentrated in Fulton and DeKalb counties, as transit services are strongly influenced by the political geography of the metropolitan area, including conflicts between central city and suburban interests. Suburban Cobb County created a much smaller bus system in 1989, covering 345 miles. This system links to MARTA, but there are no through routes from Cobb County to

central Atlanta. Suburban Gwinnett and Clayton counties are currently preparing their own transit systems as well.

Birmingham is a four county metropolitan area of92l,106 people in 2000 (an increase of 9.7 percent since 1990), dominated by Jefferson County with 662,047 people (U.S. Census Bureau, 2003). The transit agency is the Birmingham/Jefferson County Transit Authority, which operates 32 routes totaling 645 miles (Birmingham/Jefferson County Transit Authority, 2003). These routes are concentrated largely in the city of Birmingham and adjacent urban areas, reflecting the decentralized nature of Birmingham.

The Tuscaloosa metropolitan area contains only one county with 164,875 people in 2000, and has had a growth rate of 9.6 percent, slightly less than Birmingham (U.S. Census Bureau, 2003). The metropolitan area is dominated by the city of Tuscaloosa, with significant commercial development concentrated along peripheral highways. The Tuscaloosa Trolley transit system in Tuscaloosa exists on a much smaller scale, with only four routes in service beginning in J 999 (Tuscaloosa Metro Transit, 2003). These routes serve the central area of Tuscaloosa as well as reaching important destinations such as a university, shopping centers, and hospitals.

These metropolitan areas differ greatly in their size as well as their rates of growth, with Atlanta's being well above the national average of 13. l percent between 1990 and 2000 while Birmingham and Tuscaloosa are growing below this level. The three metropolitan areas also differ in their reliance on transit, although all are below the national average of 4.7 percent of workday trips being by transit in 2000 (U.S. Census Bureau, 2003). In Atlanta only 3.7 percent of weekday trips are by transit, while the Alabama metropolitan areas are even more dependent on cars, with only 0.8 percent of weekday trips in Birmingham and 0.5 percent in Tuscaloosa are by bus. These three transit systems likewise differ greatly in terms of performance. In 2000 MARTA carried an average of 546,900 trips per weekday (or 133.39 trips per 1000 residents of the MSA), while in Birmingham there were 10,608 trips per weekday (11.52 trips per 1000), and only 733 tri.ps each weekday in Tuscaloosa (or 4.44 trips per 1000 people) (Federal Transit Administration, 2003).

GIS databases for transit routes in these metropolitan areas were collected from several sources. GIS themes for both MART A and the Cobb County transit system were obtained from the Atlanta Region Information System, a GIS database created by the Atlanta Regional Commission. These two themes were joined together to produce one transit theme for Atlanta. GIS databases for Tuscaloosa and Birmingham transit routes were created from the U.S. Census Bureau TIGER street network database. Streets corresponding to bus routes viewed on the transit system websites were edited to create new themes representing transit routes.

3. Defining and Mapping Sprawl

The use of the term sprawl is commonplace when speaking about undesirable land uses patterns, processes, causes or consequences of urbanization. Unfortunately, despite this increasing attention there is little agreement over how sprawl can be identified (Ewing, 1994; Gordon and Richardson, 1997; Malpezzi, 1999; Galster et al., 2001; Johnson 2001; Hasse and Lathrop 2003). The term describes many separate conditions or processes, and so can be thought of in many

different ways (Galster et al., 2001). 'Sprawl' may therefore refer to various aspects of land use and development processes or their resulting patterns, as well as to the behavioral consequences of these processes.

A growing number of researchers are presenting methods and indexes to quantify sprawl. Galster et al (2001) focused on the thirteen largest cities in the U.S. while Malpezzi (1999) examined all Metropolitan Statistical Areas using census tracts as the spatial unit of analysis. El Nasser and Overberg (2001) examined all MSAs using population and growth inside and outside the Urbanized Area boundary in each metro area. In each study the research resulted in an aggregate index for each of the urban areas in the study. However, focusing only on the metropolitan area ignores the potential for sprawl around smaller cities and even in rural areas (Maret and Dakan, 2002). Sprawl and its consequences should clearly be explored among cities of all sizes, as smaller metropolitan areas can be expected to face challenges as well (Sultana and Chaney, 2003).

Rather than create an index to represent the amount of sprawl in a given metropolitan area, the goal here is to map out sprawling areas within cities in order to allow their locations to be compared to population and transit patterns. A threshold definition of urban sprawl is used here. This follows the widespread use of low densities to measure sprawl, but also adds rapid population growth (Weber and Sultana, 2005). Sprawl is conceptualized as peripheral areas with low population density and high rates of population growth. 1990-2000 population growth and 2000 population densities were used for each metropolitan area as threshold values, along with location outs ide the census defined urbanized area. This leads to the following definitions of sprawl:

> Atlanta = (population density < 852.46 people per square km) and (population growth rate ≥39.34 percent)
>
> Birmingham = (population density < 160.83 people per square km) and (population growth rate ≥7.25 percent)
>
> Tuscaloosa = (population density < 47.11 people per square km) and (population growth rate ≥9.6 percent)

To identify sprawl in Birmingham, Tuscaloosa and Atlanta, the Census Transportation Planning Package (CTPP) was used (Bureau of Transport Statistics, 2004). This is a compilation of socioeconomic and commuting data compiled from the Census Bureau and distributed by the Bureau of Transport Statistics. The CTPP comes in three parts, with Part l containing data by place of residence, Part 2 is for place of work, and Part 3 matches up origin and destinations of work trips. Part 1 was used in this analysis. Sprawl was mapped at the level of Traffic Analysis Zones (TAZs), which are made up of Census blocks but tend to be smaller than block groups. Because only 14 counties in the Atlanta area have TAZs defined, these were used to represent the metropolitan area. Similarly, only two counties in the Birmingham MSA have TAZs, so these two were used. Because TAZ boundaries are not consistent between 1990 and 2000, population surfaces (with 50 meter cells) for 1990 were interpolated from the CTPP using Arc View GIS and population counts transferred to the 2000 TAZ polygons (Weber and Sultana, 2005).

4. Transit Access and Sprawl

Within Atlanta sprawl is clearly concentrated on the periphery of the metropolitan area, with substantial areas of Cherokee, Bartow, Henry, and Coweta counties classified as sprawling, along with smaller portions of each of the remaining counties (Figure 1). Fulton County, the central county of the metropolitan area, contains some sprawl in the far northeast and western sections. These patterns are to be expected given the nature of sprawl and the size of the urbanized area. The transit coverage provided by the Atlanta transit system contrasts with this pattern, as it is concentrated in Central Fulton counties and urbanized parts of DeKalb and eastern Cobb counties. There is very little transit service provided in sprawling (or rural) areas of Atlanta. The only exceptions are in southwestern Fulton county, where several routes pass through rural areas and run on streets that make up the boundaries of TAZs classified as sprawl.

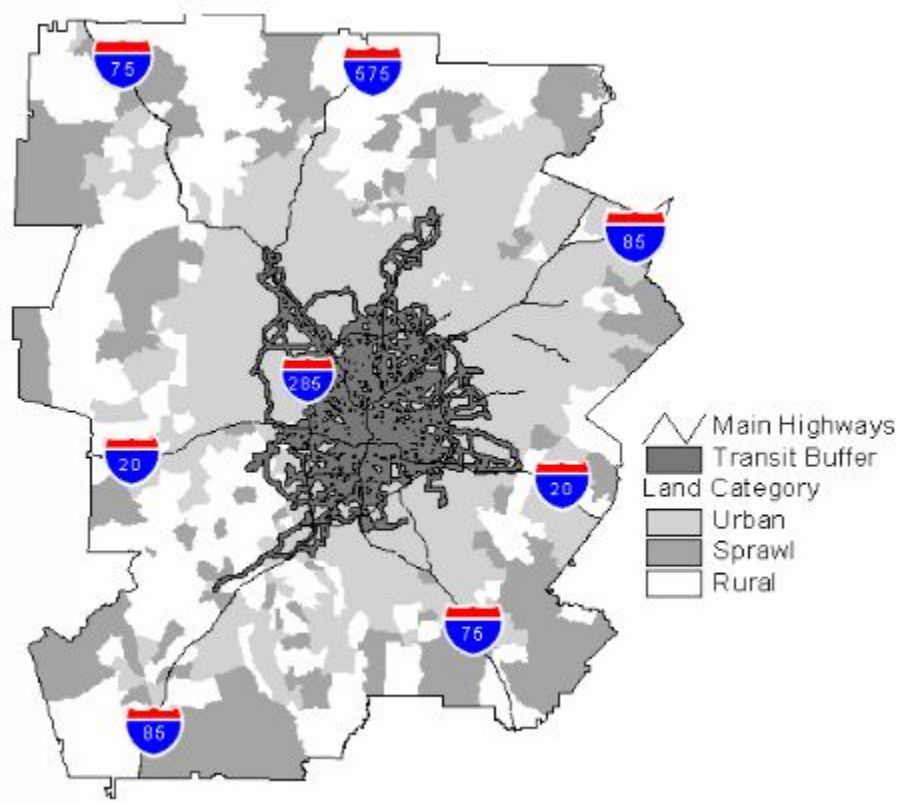

Figure 1. Sprawl and Transit Routes in Atlanta

Birmingham and Tuscaloosa show similar patterns, though with areas of sprawl occurring much closer to the center of these cities (Figures 2). In Birmingham sprawl is heavily concentrated in the northwest and southeast edges of the MSA. Transit service is confined to the urban portions of the metro area. In Tuscaloosa sprawling areas are located throughout the county, but with considerable sprawl along highway corridors. The Tuscaloosa transit system shows a more localized route pattern, with routes contained almost entirely within the urban portions of the city. In each of these metropolitan areas access to transit is clearly not available in sprawl areas, and so sprawl is clearly not to blame for the low transit usage in these cities.

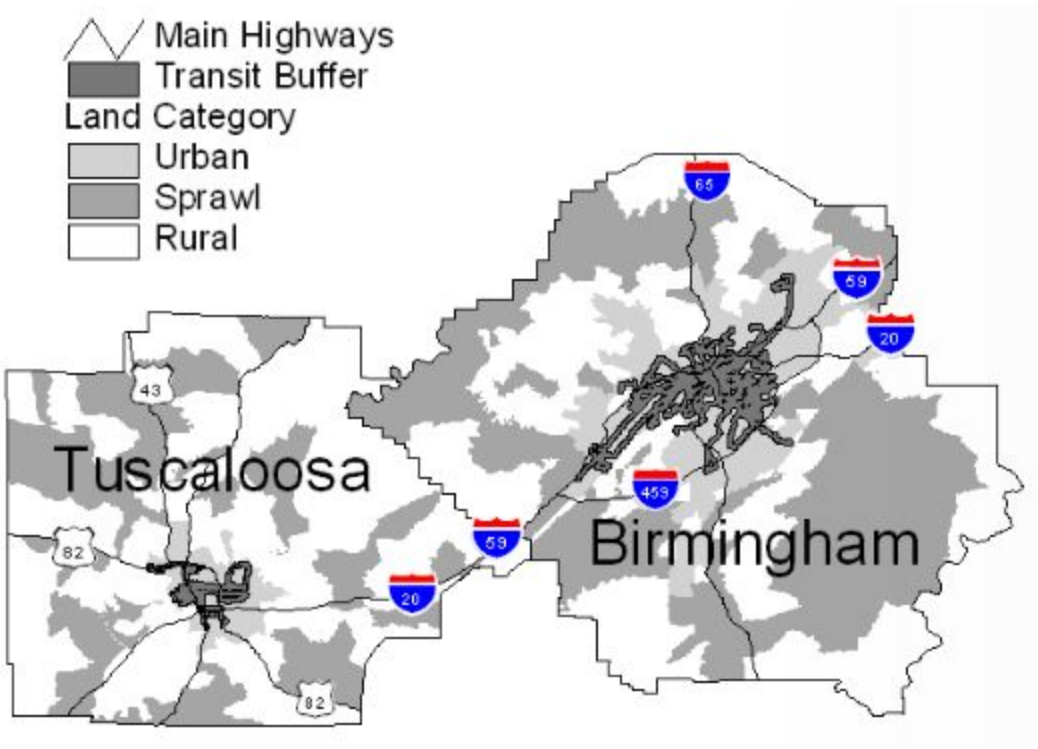

Figure 2. Sprawl and Transit Routes in Birmingham and Tuscaloosa

In addition to mapping transit routes, we can use the CTPP to directly examine transit usage by commuters. Not surprisingly, ANOVA testing reveals that there are no significant differences in transit use between sprawl and urban areas in Tuscaloosa, while Birmingham does show higher transit use in urban areas (Weber and Sultana, 2005). Transit use is significantly higher in urban areas of Atlanta than sprawling areas (3.28 percent in urban versus 0.28 percent in sprawl, at $p = 0.000$).

5. Evaluating Transit Access and Density

While sprawl may not directly contribute to poor transit usage, low population densities within urban areas may still be a major factor in its lack of use. For this reason, the population densities in areas that have access to these transit systems were evaluated to see if this is the case. Access to transit systems is defined using a proximity-based approach. Those people living within a critical distance of a bus route will be assumed lo have access to the transit system, while those living farther away do not. A buffer of 0.25 miles was created around each bus line lo represent areas near bus routes for each of the three metropolitan areas. This distance represents an estimate of the farthest distance people are likely to walk to reach public transit (Shaw, 1991; Murray et al., 1998). Representing distance to actual bus stops would of course be more appropriate, but these data were not available for all study areas.

The population and number of transit users within this buffer distance was interpolated from TAZs, again using data from the CTPP. The extent to which populations and workers in different areas of Atlanta, Birmingham and Tuscaloosa have access to the transit systems is shown in Table 1. Surprisingly, about the same percentage of MSA population lives within walking

distance of a bus route in each of the three MSAs, varying from a low of about 28 percent in Atlanta to 3 I percent in Tuscaloosa. However, access values differ greatly when examining only central city populations, with over 91 percent or Atlantans near a bus route, but only 63 and 56 percent of Birminghamsters and Tuscaloosans, respectively, having access. In each city suburban access to transit is much lower, near to that of the level of the metro area. As shown above, transit access is clearly a central city phenomenon in these metropolitan areas, though it must be remembered that the percentages of actual transit users in the Alabama cities is much lower than that in Atlanta. As was obvious from the maps, very few people in sprawling areas of Birmingham or Tuscaloosa live near transit lines, so these categories were omitted from the table.

Table 1. Population with Access to Transit Lanes

	Population			Transit Users		
	Total	**With Access**	**Percent**	**Total**	**With Access**	**Percent**
Atlanta MSA	3774698	1051087	27.85	48423	36619	75.62
City of Atlanta	416474	378924	90.98	20334	18856	92.73
Suburbs	659532	185702	28.16	7247	4925	67.96
Rural	219884	2525	1.15	535	48	8.97
Sprawl	211540	542	0.26	315	0	0.00
Urban	3343274	1048020	31.35	47573	36571	76.87
Birmingham MSA	805368	240761	29.89	2789	1895	67.95
City of Birmingham	242820	151727	62.49	2236	1667	74.55
Suburbs	379402	81555	21.50	405	217	53.58
Tuscaloosa MSA	164875	51427	31.19	115	46	40.00
City of Tuscaloosa	77906	41866	53.74	58	44	75.86
Northport	19435	5581	28.72	0	0	0.00

The pattern for workers who use transit to get to work is similar, though it is clear that many transit commuters live outs ide the 0.25 mile buffer distance. While over 92 percent of transit users in Atlanta live within this buffer distance, only about 75 percent of those in the Alabama cities do. Even lower percentages are found in the Birmingham and Atlanta suburbs (and none in Northport, the only suburb of Tuscaloosa). Transit commuters in urban areas of the Atlanta MSA (which corresponds to the census defined urbanized area) have access rates quite similar to that of transit users in the entire MSA.

Population densities within the transit service areas can also be examined (Table 2). As expected, central cities have higher densities than suburbs, while areas classified as urban have far higher densities than sprawling areas (and sprawling areas in Atlanta have much higher densities than the average for the Tuscaloosa MSA). However, population densities in rural areas of the Atlanta MSA actually have lower densities than sprawling areas, while for Birmingham and Tuscaloosa there is little difference between rural and sprawl (at the current time, however sprawling areas have much higher population growth rates). Population densities in areas with and without transit access show a very consistent pattern, with accessible areas having from four times (in Atlanta) to about 28 times higher densities (in Tuscaloosa) than non-accessible areas. In the Alabama cities accessible areas have higher densities than do even the central cities. If densities are the sole criteria for evaluating transit efficiency, sprawling areas clearly offer less opportunity for the efficient operation of transit services, as do suburbs.

Table 2. Population Density by Area

Area	Population	Population Density	Percent Using Transit
Atlanta MSA	3774698.00	323.94	2.54
City of Atlanta	416474.00	1211.55	11.38
Suburbs	659532.00	579.11	2.16
Rural	219884.00	59.48	0.50
Sprawl	211540.00	78.24	0.30
Urban	3343274.00	636.60	2.81
In Transit Buffer	1051087.00	1086.75	7.09
Outside Buffer	2723611.00	254.90	0.85
Birmingham MSA	805368.00	160.84	0.76
City of Birmingham	242820.00	638.10	2.32
Suburbs	379402.00	276.54	0.22
Rural	98914.00	49.80	0.03
Sprawl	99620.00	47.09	0.24
Urban	606834.00	670.32	0.98
In Transit Buffer	240761.00	1010.01	1.94
Outside Buffer	564607.00	118.39	0.33
Tuscaloosa MSA	164875.00	47.12	0.16
City of Tuscaloosa	77906.00	450.62	0.18
Northport	19435.00	504.09	0.00
Rural	40309.00	18.58	0.07
Sprawl	17175.00	15.12	0.46
Urban	107391.00	553.11	0.14
In Transit Buffer	51427.00	936.74	0.22
Outside Buffer	113448.00	32.94	0.13

Table 3. Regression Model for Transit Use in Atlanta

Variable	Percent using transit
Adjusted R^2	0.674
Constant	0.949
Percent drive alone	-0.423
Percent bike or walk	-0.082
Average commute time	0.500
Average commute time by car	-0.244
Average commute time by bus	0.118
Average commute time by bike/walking	
Average household income	0.096
Percent below poverty	0.242
Average vehicles per household	
Percent leave during morning rush	0.106
Percent black	0.228
Sprawl Dummy	
Population density	0.064
Household density	
Housing density	0.474
Worker density	-0.418

To evaluate relationships between transit use and densities, stepwise regression was carried out for Atlanta, using the percentage using bus transit to commute to work as the dependent variable. A set of variables representing socioeconomic characteristics of residential TAZs was used as independent variables. Four measures of density were included, that of people, households, workers, and homes, along with a dummy variable representing whether a TAZ was coded as

sprawl or not. Greater transit use would be expected with each. Other variables, including mode choice, race, income, and commuting time were included. The results (Table 3) show that higher transit use in Atlanta is associated with higher housing and population densities (as expected), but lower worker densities. High unemployment within densely populated central city areas may account for this discrepancy. Many other variables are important to predicting transit use, including the presence of large black populations. Transit use is also greatest where few drive alone to work, bike, or walk, and where average commute times are longest. However, transit use is greater where driving times are lower, which is surprising. Bus trans it clearly varies within Atlanta, but densities are only one factor in this distribution.

6. Conclusions

This research has provided straightforward methodologies for mapping sprawl with common spatial data sets. With these procedures it is easy to examine the relationships between sprawl and transit and avoid continued reliance on subjective statements based on aesthetic reactions to the built environment. In the cases of the three Southern cities examined here, sprawling areas do in fact possess different socioeconomic characteristics and transit usage, which confirms common notions about sprawl. However, th.is research also suggests that claims that transit cannot adequately serve sprawling areas remain to be definitively answered, as any problems with transit service in sprawling areas is clearly due more to limited transit operations or a limited scale of service than to low densities. Focusing attention on increasing densities may not only fail to solve the problem, but could serve to perpetuate it by shifting attention away from substantial political geographical issues in transit service provision. This is similar to arguments that have been made against other sprawl solutions, such as the New Urbanism (Marshall, 2000).

These findings apply to a large polycentric metropolitan area, a medium sized decentralized industrial city, and a small auto-oriented metropolitan area. In addition to the desirability of applying similar methodologies to a larger number of cities, including locations outside the South, several important issues remain unresolved by this research and merit additional attention. First, there is also a need to incorporate information about demand for transit services. Population compositions will be different throughout metropolitan areas, and it may be that there is lower demand for transit services within sprawling areas (though whether this is due to the absence of services in these areas is another question). It may be the case that low demand, rather than low density, is the problem. If this is the case, than attempts at increasing transit effectiveness by creating residential forms with greater population and housing densities, such as with transit villages and neo-traditiona.1 developments (Boarnet and Crane, 2001), may be of limited utility. The use of Demand Responsive Transport (DRT) based transit systems may also substantially alter any relationship between transit efficiency and density by allowing transit services to be oriented around individuals rather than aggregate populations. Incorporating the location of employment and actual travel patterns of transit users is also crucial in order to better assess the extent to which the transit system is providing adequate mobility. Part 3 of the CTPP offers some possibilities for examining this issue.

If Atlanta is successful in developing a coordinated transit system among all counties in the metropolitan area this may greatly change the relationship between sprawl and transit service observed for that area (Jaret, 2002). The political geographical of transit is likely to be far more

important to transit service in sprawling areas than population or housing densities near bus lines, and cannot be ignored. Statements made about the inadequacy of transit service in sprawling suburban locations may actually be more a comment on the limited spatial scale of transit operations than a meaningful comment on urban form or travel behavior.

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