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Journal
Journal of Public Transportation 12 (4): 21-40., 12(4)

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Publication Date
2009

Peer reviewed

Growth Management and Sustainable Transport: Do Growth Management Policies Promote Transit Use?

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Abstract

Advocates of sustainable development typically consider mass transit to be more sustainable than their automobile-dependent alternatives and desire policies that can achieve higher use of urban mass transit. In this paper, we hypothesize that state-level growth management policies should increase transit use in two ways: first, by limiting core abandonment while accommodating potential increases in population, reducing development elsewhere; and second, by directing new development where transit systems are already well established. We tested this by analyzing 95 metropolitan areas across the United States, 16 with growth-management policies and 79 without. We found that the first set showed a statistically significant improvement in the percentage transit users. The empirical analysis on causality, however, suggests that the improvement is more likely due to an increase in occupancy rates within core areas, by limiting abandonment, rather than in shifting the location of new development to transit areas.

Introduction

The realization that our current ways of living are implicating our quality of life and even our personal human rights have lead to an understanding of the need for alternatives to our current urban development approaches (Daly 1996, Hawken et al.1999). In the realm of urban policy and planning literature, these alternative development modes go by names such as sustainable development, smart growth, new urbanism, and low-impact development. Although somewhat disparate in their approaches, they all advocate a continual improvement in the quality of life of our communities. To date, they generally have focused more on questions of land use than on transport. Some have suggested, however, that a higher priority needs to be placed on sustainable urban transportation systems, because urban transport systems represent the largest and greatest environmental and social opportunity to improving community quality of life (May et al. 2003, Holden et al. 2005)

Progress toward more sustainable transport faces many barriers and challenges (Black 2000, TRB 1997, Hull 2008). According to decennial census data and the American Community Survey of 2005, auto-based travel remains the norm, while the percentages of commuters using transit, biking, and walking have declined steadily from 1990 to 2005. Assuming a continued increase in travel demand and a lack of infrastructure improvements in transit and other alternatives modes, these trends are likely to continue without policy interventions.

Many different approaches and policies to counteract unsustainable transport trends have been proposed in the recent literature (TRB 1997, Hull 2008, Richardson 1999, Richardson 2005, Deakin 2002, May et al. 2007, Banister 2008). The approach to sustainable transport depends on the definition of the concept. Although the definition of the term *sustainability* may differ depending on the context, there are certain social, economic, and environmental factors shared among different transport sustainability concepts (May et al. 2007, Jabareen 2006, Litman et al. 2006). From these perspectives, transit is viewed favorably and considered more sustainable than automobiles (Litman 2007), even though modern automobiles pollute much less than their predecessors and transit vehicles often run while relatively empty. The central question for advocates of sustainable transport is how to encourage the use of mass transit. This paper examines the effects of macro-level land use planning policies on transit mode choice and use (Figure 1). We analyze a specific policy approach—growth management—and examine its potential efficacy by measuring its impact on commuter transit use.

Approaches / Policies or Programs	Investment in infrastructure, technology, information etc	Regulation				Tax & Pricing	Education	Others
		Environmental	**Land Use (Macro)**	Neighborhood Design (Micro)	Other Regulatory			
Manage Travel Demand								
Reduce Trip Length								
Encourage Sustainable Mode Choices			**This Study**					
Innovate System, Operation, Vehicle, Fuel etc								
Remove Institutional and Financial Barriers								
Others								

Sources: (TRB 1997, Hull *2008*, Richardson *1999*, Richardson *2005*, Deakin 2002, May et al.2007, Banister 2008); *Each intersection represents a way of achieving sustainable transport—e.g., we can encourage sustainable mode choices by using tax, pricing, or other financial policy instruments.*

Figure 1. Matrix Showing Sustainable Development Approaches Described in the Literature

The effect of land use measures, especially density, on transport has been rigorously investigated from both theoretical and empirical perspectives (see Parsons Brinckerhoff Quade and Douglas, Inc. 1996 for a summary of previous studies). These investigations have included analyses of growth management influences, and they produced somewhat divergent conclusions. Nelson, for example, argued that state-level growth management policies in Oregon have helped to reduce vehicle miles traveled (VMT) per household (Nelson 1999). Porter and others have suggested that there is a relationship between smart growth programs and decreasing VMTs (Porter et al. 2005). In contrast, Jun concluded that Portland had not significantly reduced automobile use between 1980 and 2000 when compared with other metropolitan areas not under growth-management policies (Jun 2004). Generally, previous analyses have focused on identifying correlations between land use variables and transport use but have provided limited empirical evidence of the causal relationships. Here, we attempt to discern how state-level growth management efforts can contribute to promoting transit use. Figure 2 describes a theoretical basis for our analysis.

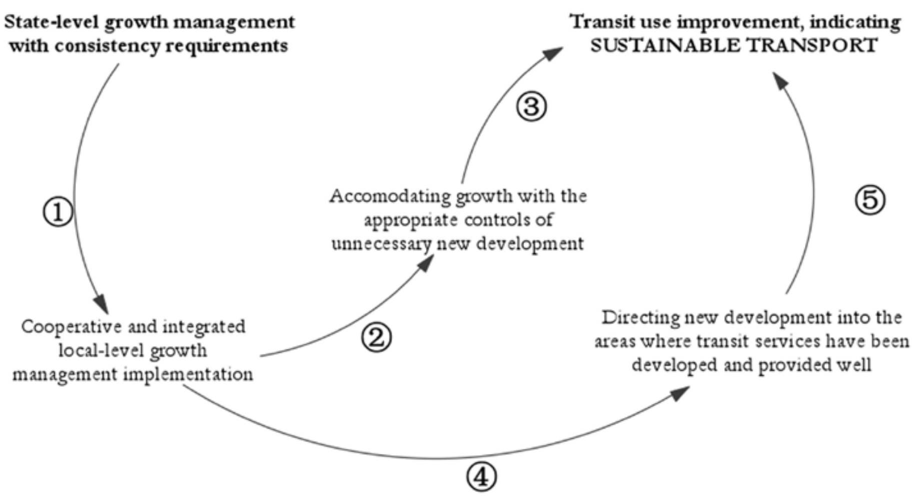

Figure 2. Causal Connections from State-Level Growth Management to Sustainable Transport

The next section presents a brief discussion of growth-management policies and the role of state government in their formulation. We explain how state-level growth-management policies that include consistency requirements promote cooperative and integrated local-level implementation (link 1 in Figure 2). We then describe the basis for determining some of the causal relationships between growth management and transit use (causal links 2, 3, 4, and 5). We present a methodology and the results of our empirical analysis of state-level growth management impacts on transit use. A discussion of our findings precedes a conclusion on the potential policy implications and lessons for transportation and land use planners.

State-Level Growth Management

Growth management has been defined as "the deliberate and integrated use of the planning, regulatory, and fiscal authority of … governments to influence patterns of [land and other physical] development" (Nelson et al. 2004). Although sometimes difficult to distinguish from other regulatory instruments, growth management is considered a proactive planning technique with a distinct vision, purpose, and approach. At their core, growth management programs—urban growth boundaries, service limits, impact fees, adequate public facilities ordinances, etc.—seek to accommodate an expected demand for urban services within a designated area rather than to actually limit or deny growth. Such programs typically target land use modifications related to a long list of urban dilemmas associated with sprawling communities, including VMTs and inefficient public services that can hinder investment in sustainable transport systems (Kim et al. 2008).

One important feature of successful state-level growth management programs is a requirement for planning consistency. Although growth-management initiatives are sometimes seen as state-level policy levers, the specific programs are typically implemented and operated by units of local government. The successful implementation of state policy at the local level requires a) vertical consistency between state-level objectives and strategies and local-level programs, b) horizontal consistency among local governments, and c) internal consistency among each unit's growth management and other investment or regulatory actions (Gale 1992, Knaap et al. 2007, Weitz 1999, Carruthers 2002, Dawkins et al. 2003). These consistency requirements are critical for local government participation, and they are designed to guarantee well-integrated and well-implemented local policy actions. Consistency requirements are also important for analysis; we can expect more uniform statewide enforcement of policy wherever consistency requirements in place.

The presence of state-level growth-management policies that include consistency requirements are typically used to distinguish growth-management areas from non-growth management areas (see, for example, Carruthers 2002 and Dawkins et al. 2003), although there is disagreement on which states this encompasses (Weitz 1999, Dawkins et al. 2003). Dawkins and Nelson have identified eight states they believe meet the criteria—Florida, Maine, Maryland, New Jersey, Oregon, Rhode Island, Vermont, and Washington (Dawkins et al. 2003). Porter includes Georgia (Porter 1996), and Anthony expands the list to include California and Hawaii (Anthony 2004). In this work, we used the eight states identified by Dawkins and Nelson (Dawkins et al. 2003), mainly because consistency requirements were included directly in the identification process. Table 1 lists the eight growth-management states used in this study.

Table 1. Eight U.S. States Having Proactive Growth Management (Effective Prior to 2000)

State	Consistency Requirements [a]	Type [b]	Rank by Sierra Club [c]
Florida	V, H, I	State Dominant	11th
Maine	V, H, I	State Dominant	7th
Maryland	V, I	-	3rd
New Jersey	I	State-Local Negotiated	17th
Oregon	V, I	State Dominant	1st
Rhode Island	V, H, I	State Dominant	10th
Vermont	H, I	Regional-Local Cooperative	2nd
Washington	H, I	Fusion	5th

Sources: Gale 1992, Dawkins et al. 2003, Sierra Club 1999

a V, H, and I refer to vertical consistency, horizontal consistency, and internal consistency, respectively.

b Gale classified state-sponsored growth management into four categories – a) state-dominant, b) regional-local cooperative, c) state-local negotiated, and d) fusion (Gale 1992).

c Sierra Club evaluated 50 U.S. states in terms of land use planning efforts to control sprawl (Sierra Club 1999

Growth Management and Transit Use

According to the American Community Survey in 2005, there was significant difference in mode choice between commuters originating from housing units built before 2000 and those built between 2000 and 2005 (Table 2). The difference—almost 50 percent—is suggestive when viewed in relation to statistics on sprawl and abandonment of the urban core (Sierra Club 1999). The results in Table 2 indicate that urban form can influence the population's travel mode choices. In fact, we would argue that promoting changes in urban form is one of the main tenets of contemporary growth management policies (OLCDC 2008). The linkage between increasing utilization of transit systems and growth management policies may be approached in many ways, for example, by improving the pool of potential riders, limiting core abandonment, reducing vacancy rates, accommodating potential increases in population within a controlled area, avoiding unnecessary low-density development, establishing new transit centers, or guiding new development into areas where transit systems are already established.

Table 2. Commuting Mode Choice Differences between Residents of Older and Newer Housing in 2005

Commuting Mode	Commuters Living in Older Housing [a]	Commuters Living in Newer Housing [b]	Gap
Single Occupancy Auto Vehicles	79.3%	84.3%	+5.0%
Multi Occupancy Auto Vehicles	11.2%	10.7%	−0.5%
Transit (Bus, Subway, Rail, etc)	5.0%	2.3%	−2.7%
Bike and Walk	3.2%	1.5%	−1.7%
Others	1.3%	1.2%	−0.1%

Source: 2005 American Community Survey

a Old-house refers the housing units built before the year 2000.

b New-house refers the housing units constructed between 2000 and 2005.

To derive how growth-management policies may contribute to promoting commuter transit use, consider a metropolitan region that consists of *j* zones. We can classify commuters (*C*) in our region into two groups; C^{Old}, commuters originating from the regional housing stock that existed before the policy implementation date; and C^{New} commuters originating from the regional housing stock built after the policy implementation date. Assume that one of the transportation objectives for this region is to maximize the percentage of commuters using transit (s). The share of total commuters using transit (s) in the region might be seen as:

$$s = \frac{C^{Old} \cdot s^{Old} + C^{New} \cdot s^{New}}{C^{Old} + C^{New}} = (1-\alpha) \cdot s^{Old} + \alpha \cdot s^{New} = s^{Old} - \alpha \cdot (s^{Old} - s^{New}) \quad (1)$$

where:

C^{Old} is the number of old-house-living commuters

C^{New} is the number of new-house-living commuters

s^{Old} is percentage of commuters using transit among old-house-living commuters

s^{New} is percentage of commuters using transit among new-house-living commuters

$\alpha = \frac{C^{New}}{C^{Old} + C^{New}}$ is a ratio of new-house-living commuters to total commuters

Considering a regional spatial distribution, s^{Old} and s^{New} can be written as follows:

$$s^{Old} = \frac{1}{\sum_j C_j^{Old}} \cdot \sum_j s_j^{Old} \cdot C_j^{Old} = \sum_j w_j^{Old} \cdot s_j^{Old} \quad (2)$$

$$s^{New} = \frac{1}{\sum_j C_j^{New}} \cdot \sum_j s_j^{New} \cdot C_j^{New} = \sum_j w_j^{New} \cdot s_j^{New} \quad (3)$$

where:

C_j^{Old} is the number of old-house-living commuters in zone j

C_j^{New} is the number of new-house-living commuters in zone j

s_j^{Old} is percentage of old-house-living commuters that use transit in zone j

s_j^{New} is percentage of new-house-living commuters that use transit in zone j

$w_j^{Old} = \dfrac{C_j^{Old}}{\sum_j C_j^{Old}}$ is zone *j*'s share of old-house-living commuters in the region

$w_j^{New} = \dfrac{C_j^{New}}{\sum_j C_j^{New}}$ is zone *j*'s share of new-house-living commuters in the region

If we plug equation (2) and (3) into equation (1), we get the equation:

$$s = \sum_j w_j^{Old} \cdot s_j^{Old} - \alpha \cdot \left(\sum_j w_j^{Old} \cdot s_j^{Old} - \sum_j w_j^{New} \cdot s_j^{New}\right) \quad (4)$$

Expanding the parenthetical piece results in:

$$\sum_j w_j^{Old} \cdot s_j^{Old} - \sum_j w_j^{New} \cdot s_j^{New} = \sum_j w_j^{Old} \cdot (s_j^{Old} - s_j^{New}) + \sum_j s_j^{New} \cdot (w_j^{Old} - w_j^{New}) \quad (5)$$

By plugging equation (5) into equation (4), we get an equation (6) that helps explain the relationship between spatial constructs and approaches to increasing the percentage of commuters using transit.

$$s = \sum_j w_j^{Old} \cdot s_j^{Old} - \alpha \cdot \left[\sum_j w_j^{Old} \cdot (s_j^{Old} - s_j^{New}) + \sum_j s_j^{New} \cdot (w_j^{Old} - w_j^{New})\right] \quad (6)$$

Equation (6) implies that, to attain the assumed objective (maximize transit use (*s*)), the planners in this region would need to:

[A] Maximize transit ridership among those residing in the existing housing stock:

$$\sum_j w_j^{Old} \cdot s_j^{Old}$$

This suggests that increasing transit use in zones where many commuters already reside (*j*'s with large w_j^{Old}) will provide the biggest increase in use for dollar invested.

[B] Minimize share of new-house-living commuters to total commuters:

$$\alpha = \frac{C^{New}}{C^{Old} + C^{New}}$$

because

$$\sum_j w_j^{Old} \cdot (s_j^{Old} - s_j^{New}) + \sum_j s_j^{New} \cdot (w_j^{Old} - w_j^{New}) = s^{Old} - s^{New} > 0$$

This is a logical outcome since commuters living in new housing units (C_j^{New}) are less likely to use transit systems.

[C] Minimize the gap between old and new housing transit users:

$$\sum_j w_j^{Old} \cdot (s_j^{Old} - s_j^{New})$$

This means, in each sub-zone, new housing units need to be accessible to existing transit systems or be linked to the transit system development or investment.

[D] Minimize new housing development in places inaccessible to transit:

$$\sum_j s_j^{New} \cdot (w_j^{Old} - w_j^{New})$$

Reduce the gap between w_j^{Old} and w_j^{New} (i.e. $w_j^{Old} - w_j^{New}$) for *j*s where s_j^{New} is potentially large (i.e., areas where a good transit service system is available).

Of the four resulting relationships, growth management policies can affect commuter transit use most directly in two of them: [B], by limiting core abandonment and accommodating potential increases in population within a controlled area (avoiding unnecessary fringe development); and [D], by directing new development into areas where transit systems are already well established. Since improving the ridership among commuters originating from the existing housing stock [A] and reducing the gap in transit use between existing and new housing unit commuters [C] might be accomplished more effectively outside of growth control programs, we do not analyze these relationships in our empirical analysis.

Empirical Analysis

As shown above, growth management policies might potentially contribute to increasing the percentage of transit commuters by discouraging unnecessary new development and directing a higher proportion of new development into the areas where transit systems are already established. The critical question then is—are they working? Are growth management policies effective in increasing transit ridership? In this section, we try to determine whether or not contemporary growth management policies are effectively contributing to increasing the percentage of commuters using transit and through what causal mechanisms. We look at this question by statistically comparing three indicators in regions that are contained within growth management states with regions that are not to see if variations in transit ridership exist.

Indicators

Our first regional transit use indicator is simply a measurement of the change in the percentage of commuters that use transit (Δs) from 2000 to 2005. The comparison will help determine whether regions that are contained within growth management states show a discernable difference in transit use over the areas without similar policies.

Although a statistically significant Δs will help describe the differences between growth management areas and non-growth management areas, it may not be useful in discerning how the change (positive or negative) might be achieved. Based on our previous analytical framework, we are most interested in whether the change is due to limiting core abandonment and accommodating potential increases in population within a controlled area (avoiding unnecessary fringe development) and by directing new development into areas where transit systems exist. These questions require an analysis of occupancy rate change and an analysis on the location of new developments.

Occupancy rates—i.e., percentage of occupied houses to total housing units—can be a good measure of how well a region successfully controls unnecessary new development, and the authors have shown in previous work that growth management programs can affect occupancy rates (Kim et al. 2008). When housing markets boom and sprawl, a large number of housing units are abandoned or temporarily vacant, especially in core areas. On the other hand, when markets are controlled and core abandonment and unnecessary fringe development are limited, vacancy rates decrease—increasing occupancy rates.

We use a development location index, $\sum_j w_j^{New} \cdot (s_j - s)$, to assess the spatial distribution of new development in a region, in this case, whether or not it occurs in transit ready areas. When an increasingly large proportion of new development—i.e., a large w_j—occurs in an area where transit use is lower than the regional average—i.e., negative $(s_j - s)$—the index will be negative. In contrast, when new development is directed into areas with a positive $(s_j - s)$, areas of higher transit use percentages, the index will be positive. Although not part of this work, tracking an index of this kind over time would help determine if growth is being directed to established transit areas.

Data Sources

For this work, we use a number of data sets, including the 2005 American Community Survey (ACS) and their Public Use Microdata Samples (PUMS), along with the U.S. Census Bureau decennial census of 2000. The PUMS provides sampled data on a wide range of information on housing units including the year of construction and resident commuting mode. It also informs on the location of the sampled housing units by Public Use Microdata Area (PUMA), which are generally sub-regional zones within Metropolitan Statistical Areas (MSAs) or Primary Metropolitan Statistical Areas (PMSA). The 2005 ACS PUMS data enable us to derive new development location indexes for individual regions.

Study Areas

Our geographies consist of individual MSAs as defined by U.S. Office of Management and Budget in 1999 and used for the 2000 census. In the case of very large metropolitan areas classified as Consolidated Metropolitan Statistical Areas (CMSAs), the PMSAs within the CMSAs are regarded as the unit of analysis. In terms of growth management and planning policies in general, PMSAs more consistently reflect governance and potential policy enforcement geographies.

Among the more than 300 MSAs and PMSAs available, the 103 regions containing populations of more than 500,000 in the year 2000 are selected. Because MSA or PMSA boundaries are not exactly matched with PUMA boundaries, we redefined the geographic boundaries of some of the regions by adding adjacent counties to the existing 1999 definition. A boundary redefinition is not workable in four regions—the Hartford MSA, the Boston-Worcester-Lawrence CMSA, the Denver-Boulder-Greeley CMSA, and the New York-Northern New Jersey-Long Island CMSA—and are not considered in this study. There are also four regions that straddle both growth management and non-growth management states—the Philadelphia-Wilmington-Atlantic City CMSA, the Wilmington-Newark PMSA, the Providence-Fall River-Warwick MSA, and the Washington-Baltimore CMSA; these regions are also excluded from consideration. Of the original 103 eligible MSAs or PMSAs, 95 are used this analysis; 16 of them are within growth management states, while the remaining 79 are outside of any growth management states.

Results

All three indicators—the percentage of transit users, occupancy rate, and the new development location index—revealed what might be considered positive outcomes (Table 3) in terms of transit use for areas contained within growth management states. More specifically, MSAs and PMSAs in growth management states showed a 0.47 percent improvement in the percentage of commuters using transit (Δs) between 2000 and 2005, while areas in non-growth management states exhibit a decrease of 0.10 percent (–0.10% Δs). Considering that the average percentage of commuters using transit in the U.S. has been about 5 percent of the total, the magnitude of improvement (0.47%) is not trivial, and the magnitude of the difference between groups (0.57%) was found to be statistically significant at a 99.9% confidence level.

Table 3. Summary of Analysis Results

Indicator		*Regions in Growth Management States*	*Regions in Non Growth Management States*	*Difference*	*T-test Outcome*
Indicator 1: 2000-2005 Change in *s*	Sample Mean	+0.47%	–0.10%	+0.57 percentage points	Statistically Significant (99.9%)
	Sample Standard Deviation	0.00656	0.00595		
Indicator 2: 2000-2005 Occupancy Rate Change	Sample Mean	–1.28%	–1.95%	+0.67 percentage points	Statistically Significant (95%)
	Sample Standard Deviation	0.00767	0.01569		
Indicator 3: New Development Location Index	Sample Mean	–0.00418	–0.00731	+0.00313	Statistically Insignificant
	Sample Standard Deviation	0.01586	0.00896		
Number of samples		16	79		

Both groups showed, on average, negative changes in occupancy rates from 2000 to 2005 (Table 3), within a relatively normal distribution (Figure 3). Previous research (Nelson 1999, Kim et al. 2008, Anthony 2004) has shown that occupancy rates can decrease due to core abandonment and excessive fringe development; and consequently population densities decline over time. In this work, we found a statistically significant difference (95% confidence level) between the changes in occupancy rates in growth management areas and non-growth management areas.

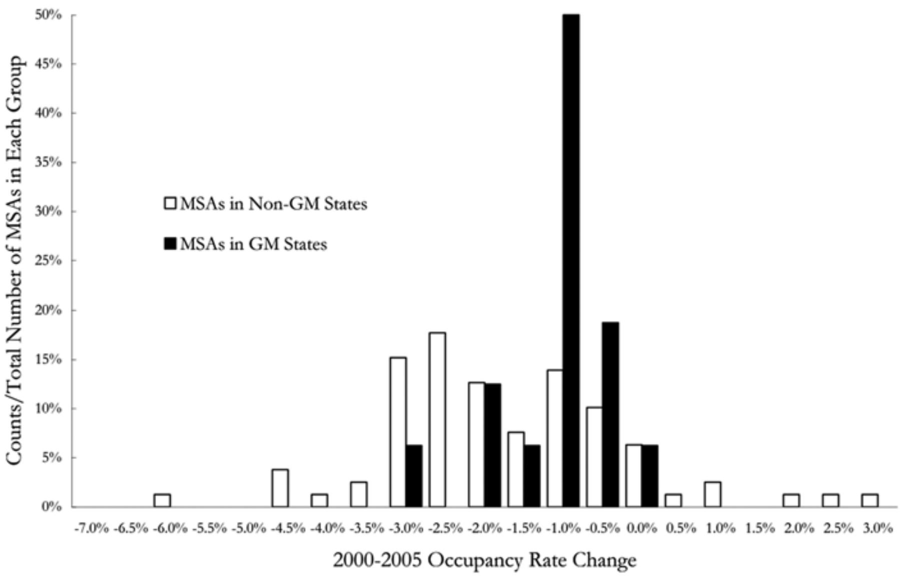

Figure 3. Occupancy Rate Change Indicator

Data on the development location index found both groups to be negative. Although the regions in growth management states were slightly better than non-growth management areas, the gap between the two groups is not statistically significant. This suggests that development may not be well directed toward already serviced transit areas in either condition. This further implies that the sprawl paradigm is still pervasive in both conditions.

Discussion and Policy Implications

Improving the sustainability of our communities requires that we better understand the complex relationship between land use and transportation. In this paper, we focus on one aspect of this relationship—the effects of macro-level land use planning policies on mode choice. More specifically, we attempt to discern whether growth management efforts contribute to promoting transit use and, if so, through what causal mechanisms. We looked at 95 metropolitan areas across the U.S.—16 within and 79 outside of growth management program jurisdiction. We found that MSAs and PMSAs that areas contained within growth management jurisdictions showed a statistically significant improvement in the percentage of commuters using transit. This is consistent with previous studies (Nelson 1999, Porter et al. 2005) and helps support an argument that growth management efforts can contribute to reducing auto-dependency and promote more sustainable transport. We argue that, theoretically, the causal relationships between growth management policies and the noted increase in commuter transit use might be derived in several ways, including limiting core abandonment and accommodating potential increases in population within a controlled area and directing new development into areas where transit systems are already well established.

We found a statistically significant gap in occupancy rate, with higher rates in the growth management regions, implying good control over unnecessary new development. But there was little statistical support that new development was taking place in transit accessible areas. This implies that the improvement in transit use might be due mainly to increased occupancy rather than a structural shift in locating new development to areas already serviced. It might be argued that an increase in occupancy (especially in areas already well serviced by transit) is an important and low-cost first step that must take place before any tangible change in community structure can be realized. And, as many growth management programs are relatively new (as compared to other programs), they might not yet be mature enough to exhibit these adaptations.

Another potential explanation for the lack of locational reordering might be an imperfect integration of growth management policies with transportation planning and investment decision making. Many growth management programs only loosely define areas where new development might be advantageous to their communities rather than actively encouraging development in transit-ready areas or new-transit-investment sites.

Finally, we think that additional explanations for the observed relationships might exist, particularly the connection between land use and transportation planning decisions at the local level. In fact, micro level considerations may go further in explaining the nature of our observed relationships than the state-level growth management policies. Our ongoing work focuses on seeking these relationships. We also think, however, that this paper is an important and timely step in the discourse on state-level land use policies. As governments increasingly search for more sustainable choices in spite of falling and failing budgets, investment decisions become more critically scrutinized. In our opinion, public transportation infrastructure is one such choice that also needs coherent policies that support long-range sustainability and adequate use of that infrastructure in order to be successful. Many of these policies will be borne from state level growth management policies.

It is our opinion that, to maximize the potential contribution of growth management programs, we must implement policies that promote consistency, perhaps more broadly construed. We need consistency not only with other units of governments and across plans, but with other planning disciplines and agencies. More specifically, we need more integration and better consistency between land use and transportation policies. This will require a more complete and better understanding of the complex relationship between transportation and land use. But without it, we may not realize the promises of smart growth and or sustainable development. In fact, the successful integration of growth management and other land use planning with quality transportation planning will immeasurably improve our potential for realizing more sustainable systems (Figure 4).

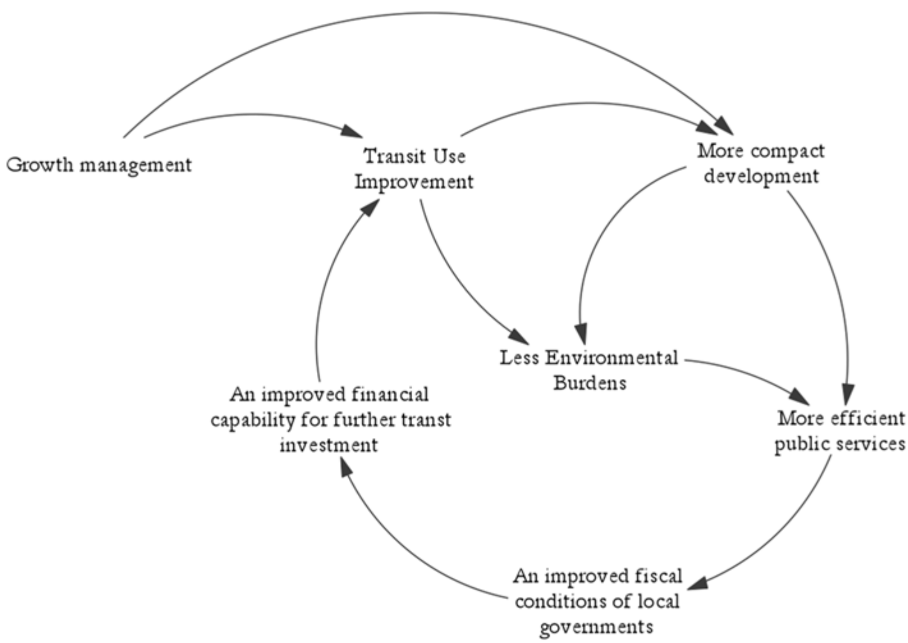

Figure 4. Sustainable Growth Management and Transport Integration

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