CNU 19 – Growing Local
June 4, 2011
Madison, WI

Automobile Use and Activity Level in Small Cities

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Abstract

Since the 1950s, many small American cities have built extensive transportation infrastructure to provide automobile access comparable to that in the surrounding suburbs in order to compete economically. However, based on data from seven cities, this study reveals cities with higher rates of automobile use have lower levels of activity. This is due in part to the limited supply of land in these cities compared to the large amounts of land required to move and store automobiles. Cities with lower automobile use also have generally gained in income relative to the high automobile use cities.

Introduction

American cities built before the twentieth century were structured around transportation comprised mainly of horse-drawn carriages, streetcars, and walking. These modes of transportation are compatible with a mixture of land uses and densely situated buildings, people, and activities. Since the 1950s, however, a majority of the growth around these cities has been in the form of low-density, suburban development that it is highly dependent on private automobiles for transportation. In order to compete economically with these burgeoning suburbs, many of the older central cities have invested heavily in automobile infrastructure including freeways, wider streets and parking facilities. The stated motivation of policymakers in these cities has been to attain a level of automobile accessibility comparable with the suburbs so that the cities will remain attractive destinations within their regions. Unfortunately, private automobiles require much more space for movement and storage than any other common mode of transportation. This means that central cities must devote a greater portion of their valuable land for transportation purposes – potentially at the expense of other more productive activities.

This study looks at seven small American cities over a period of forty years. The goal is to evaluate the relationships between automobile use, land consumption, and urban productivity. The seven cities are Albany, NY; Cambridge, MA; Hartford, CT; Evanston, IL; Lowell, MA; New Haven, CT; and Somerville, MA. These cities each were built-up prior to the rise of automobile use beginning in the 1950s. They were chosen because they represent a wide range of trends in automobile use over the forty-year study period in that some have seen no sustained increase in automobile use while others have seen a large increase. In 1960, the rates of automobile commuting by residents varied in a narrow range from 42 percent in Cambridge to 71 percent in Lowell. Over the next 40 years, this range increased considerably, from automobile use of below 40 percent in Cambridge and to a rate of more than 90 percent in Lowell – a difference of more than 50 percentage points. The focus of this study is to understand how these divergence patterns in travel choice have affected the physical form and the economic viability of these cities.

The Cities

Each of the seven cities in this study has a population of around 100,000 people. In all of the cities but Evanston and Lowell, the population peaked around the year 1950, preceding the predominance of automobiles for transportation. Evanston's population peaked two decades later around 1970, while Lowell's population peaked in 1920 but has risen significantly since 1960.

The cities were all remarkably similar in 1960 in terms of their transportation systems and their level of vitality. The automobile mode shares for resident commuters in all of the cities except Lowell were between 42 and 58 percent; the mode share in Lowell was 71 percent. The median family incomes in all of the cities except Evanston were between $33,000 and $36,000 (adjusted to 2000 dollars); the median family income in Evanston was $53,500.

Between 1960 and 2000, however, the fates of these cities have diverged significantly on a number of measures. For example, the increase in automobile mode share has ranged from less than one percentage point in Cambridge to 22 percentage points in Albany. The greatest increases in median family income were around $25,000 in Evanston and Cambridge. Conversely, the median income dropped by almost $8,000 in Hartford.

Data for all of the cities are listed in Table 1 from left to right in order of increasing resident automobile mode share in the year 2000. The cities are divided into two distinct groups with

markedly different characteristics. The first group contains those cities in which automobile use is below 70 percent for 2000; this includes Cambridge, Somerville, and Evanston. These cities are referred to as low automobile use cities. The second groups of cities with automobile mode share above 70 percent in 2000 – the more automobile dependent cities – includes New Haven, Hartford, Albany, and Lowell.

Table 1 Demographic data for the seven cities – 1960 and 2000

	City	Year	Resident mode share[a]	Population density (residents/ sq. mi.)[b]	Employee mode share[c]	Employment density (employees/ sq. mi.)[d]	Parking provision (sq. ft./ activity)[e]	Automobile ownership (vehicles/ capita)[f]	Median family income[g]
Low auto use	Cambridge	1960	42.2%	16,816	55.6%	10,295	*No data*	0.23	$34,467
		2000	42.8%	15,823	58.3%	17,817	64	0.41	$59,423
	Somerville	1960	49.5%	23,008	57.5%	4,543	*No data*	0.23	$35,059
		2000	57.1%	18,824	70.1%	5,576	82	0.48	$51,243
	Evanston	1960	51.7%	10,288	55.3%	3,637	*No data*	0.32	$53,504
		2000	65.9%	9,634	67.7%	5,603	90	0.52	$78,886
Automobile dependent	New Haven	1960	57.6%	7,895	64.3%	4,390	*No data*	0.27	$34,121
		2000	72.8%	6,419	82.7%	3,934	180	0.40	$35,950
	Hartford	1960	53.1%	9,343	65.8%	6,590	*No data*	0.25	$34,857
		2000	74.2%	7,004	88.1%	6,160	183	0.34	$27,051
	Albany	1960	53.4%	6,069	62.9%	3,498	*No data*	0.24	$33,623
		2000	75.4%	4,475	87.3%	5,123	170	0.46	$39,932
	Lowell	1960	70.5%	6,761	*No data*	*No data*	*No data*	0.23	$33,046
		2000	90.8%	7,720	88.8%	3,004	171	0.49	$45,901

a. Percent of resident commuters traveling by automobile, from U.S. Census
b. Residents per square mile, from U.S. Census
c. Percent of employees traveling by automobile, from U.S. Census and Census Transportation Planning Product
d. Employees per square mile, from U.S. Census and Census Transportation Planning Product
e. Area of exclusive parking facilities (square feet per activity), mapped from aerial photographs
f. Private vehicles per capita, from U.S. Census
g. Median family income adjusted to 2000 dollars, from U.S. Census

As mentioned above, every city but Lowell has seen a slight population drop since 1960. Because the total land area in each city remained the same, the population densities also dropped, as shown in Table 1. These decreases in population are associated with the decentralization of the broader metropolitan areas and the movement of people to the surrounding suburbs. However, during the same period some cities saw an increase in jobs and, thus, an increase in employment density. The increase in Cambridge was substantial. Employment also increased in Somerville, Evanston, and Albany.

Together, the number of residents plus the number of employees indicates the total number of activities occurring in a city as defined by Shin et al. (2009). This measure can be used to indicate the vibrancy of a city. The activity densities for each of the cities in 1960 and in 2000 are shown in Figure 1. Due to decreases in population, the total number of activities dropped in all cities except for Cambridge and Evanston, where the increases in employment were substantial.

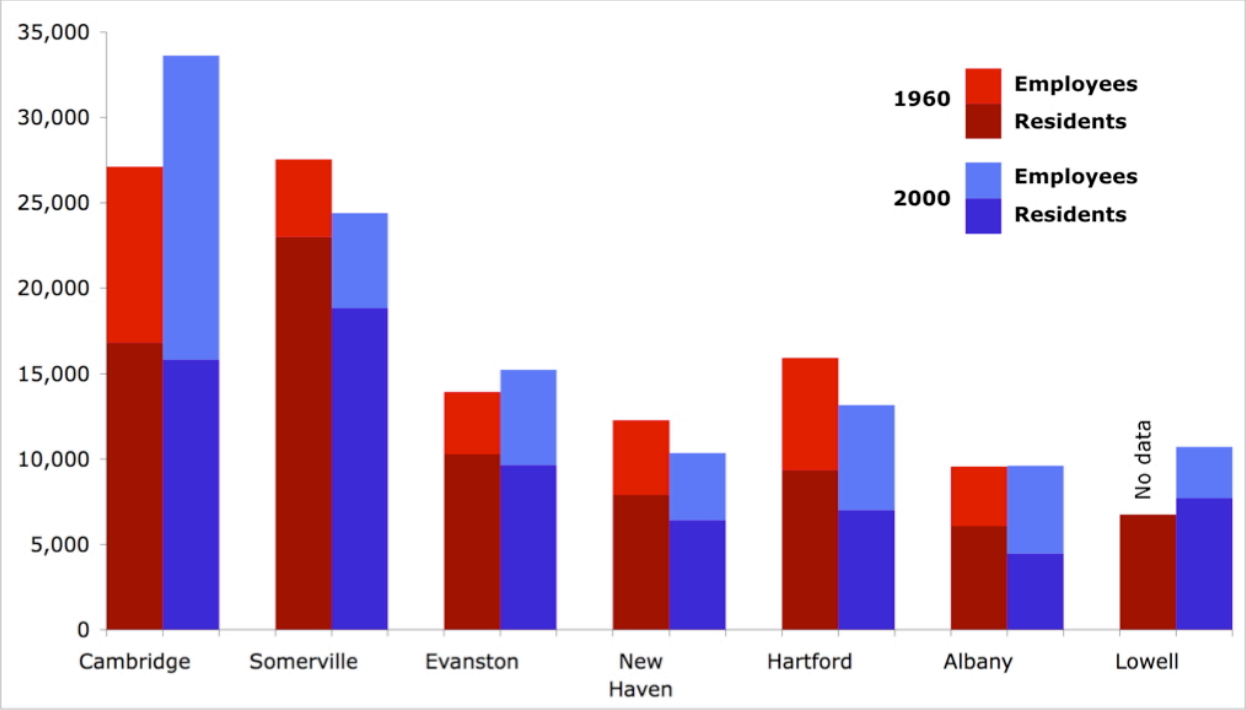

Figure 1 Activity density (residents plus employees per square mile)

Along with a change in the employment base for each city, there have also been changes in the travel behavior of employees. Employee automobile use increased significantly in every city except Cambridge, where automobile use dropped by more than 15 percent.

In addition to the rate of automobile use, this study considers the rate of automobile ownership in each city. In 1960, automobile ownership was around 0.25 vehicles per capita for all cities except Evanston, where automobile ownership was 0.32 vehicles per capita. Ownership increased in all cities by the year 2000, from a low of 0.34 vehicles per capita in Hartford to a high of 0.52 in Evanston.

In order to understand how the built environment varies among the cities, we also estimated the total amount of land in each city that is devoted to parking. This was done using aerial photographs and a manual mapping procedure carried out in ArcGIS. These estimates include the footprints of surface lots and built parking structures, but it does not account for on-street parking. The total parking per activity in each city is shown in Figure 2. This figure shows that the parking provision in automobile dependent cities is twice as high as in those cities with low automobile use.

Collectively, the evidence above suggests that there is a strong link between automobile use in a city, the way land is used, and productivity and vibrancy of that city. These relationships are examined more closely in the following section.

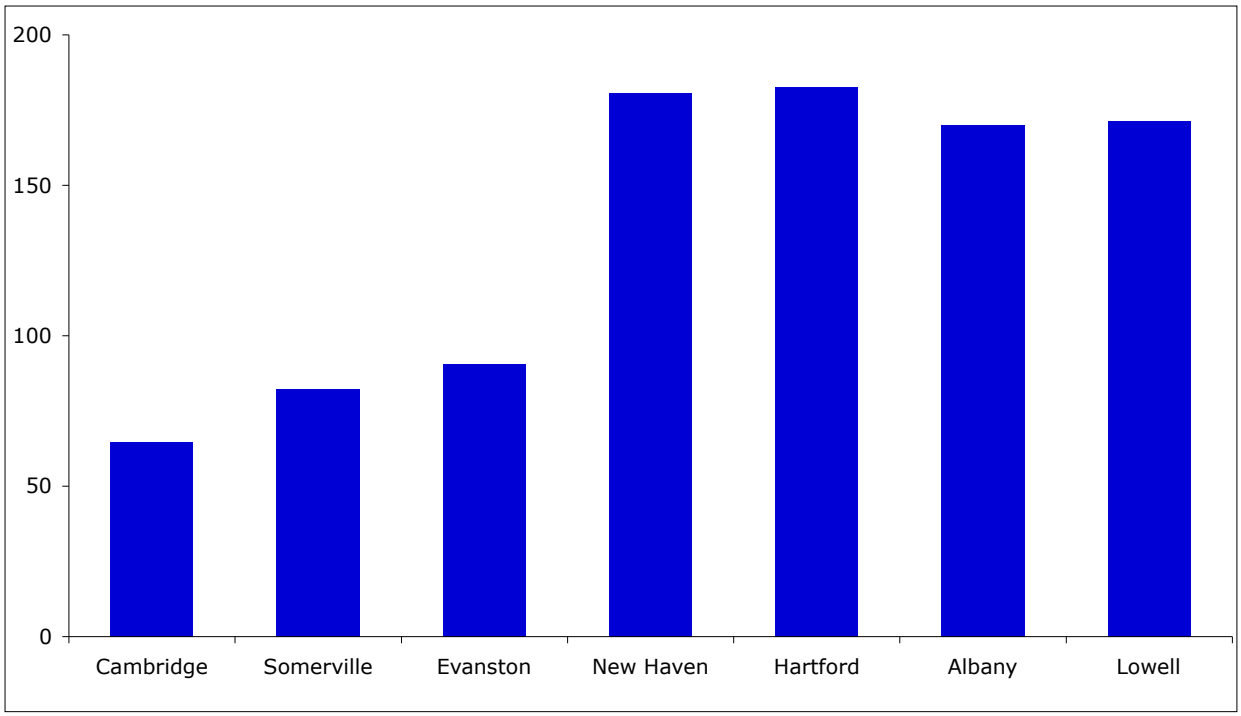

Figure 2 Parking provision in the year 2000 (square feet of parking per activity)

The Relationship Between Automobile Use and Activity Level

A number of studies have investigated the relationship between automobile use and the built environment. Most of this work considers the impact of design features and land use on travel behavior. In a comprehensive review of empirical evidence, Ewing and Cervero (2001) concluded that the rate of automobile use is lower in traditional urban neighborhoods than in contemporary suburban neighborhoods and it is lower in areas with a higher population density, a higher employment density, or a greater degree of land use mixing. More recent studies by Cervero (2002) and Frank et al. (2008) have further verified these findings. This suggests that changes to the built environment can be cause for an increase or a decrease in automobile use.

However, there is also evidence to suggest that this is a two-way relationship and that the rate of automobile use can effectively impact the built environment and land use patterns. In one of the few studies that considers the relationship from this perspective, researchers at the University of Pennsylvania developed a theoretical model explaining the relationships between automobile use, land consumption, and activity level in mathematical terms (Shin et al., 2009). The relevant findings from this study are illustrated in Figure 3. The blue lines in the figure represent the conditions in a theoretical city with a finite boundary as automobile use and land use change.

The blue line to the left of the vertical axis indicates that as the land used for increases, the land used for other activities must decrease, and vice versa. The blue line to the right of the vertical axis indicates that as automobile mode share increases, the amount of land used for transportation must also increase. This is because the space required for the movement and storage of an automobile is a magnitude of order higher than any other common mode of transportation.

To understand this concept more clearly, consider when the automobile mode share in a city increases from point A to point 1 in Figure 3. This will correspond with an increase in the amount of land used for transportation from point B to point 2. As this land increases, the

remaining land available for other activities must decrease from point C to point 3. This will result in a lower number of total activities, unless the land use intensity increases. The lost activities typically relocate further out in the surrounding region, outside of the urban core.

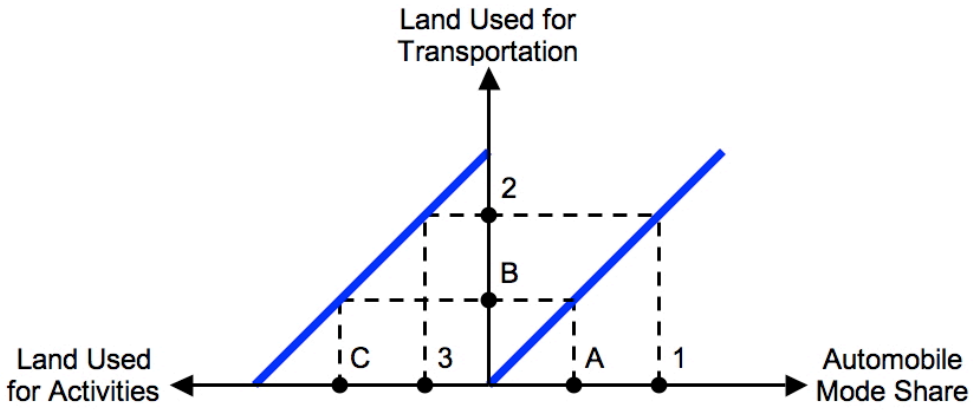

Figure 3 Theoretical model of land consumption

The evidence above regarding automobile mode share and activity density supports the general premise of this theoretical model that a higher rate of automobile use corresponds with a lower number of activities within an area. This relationship is also shown in the plot of mode share versus activity density for the seven cities shown in Figure 4. In general, the higher the automobile mode share is in a city, the lower the activity density.

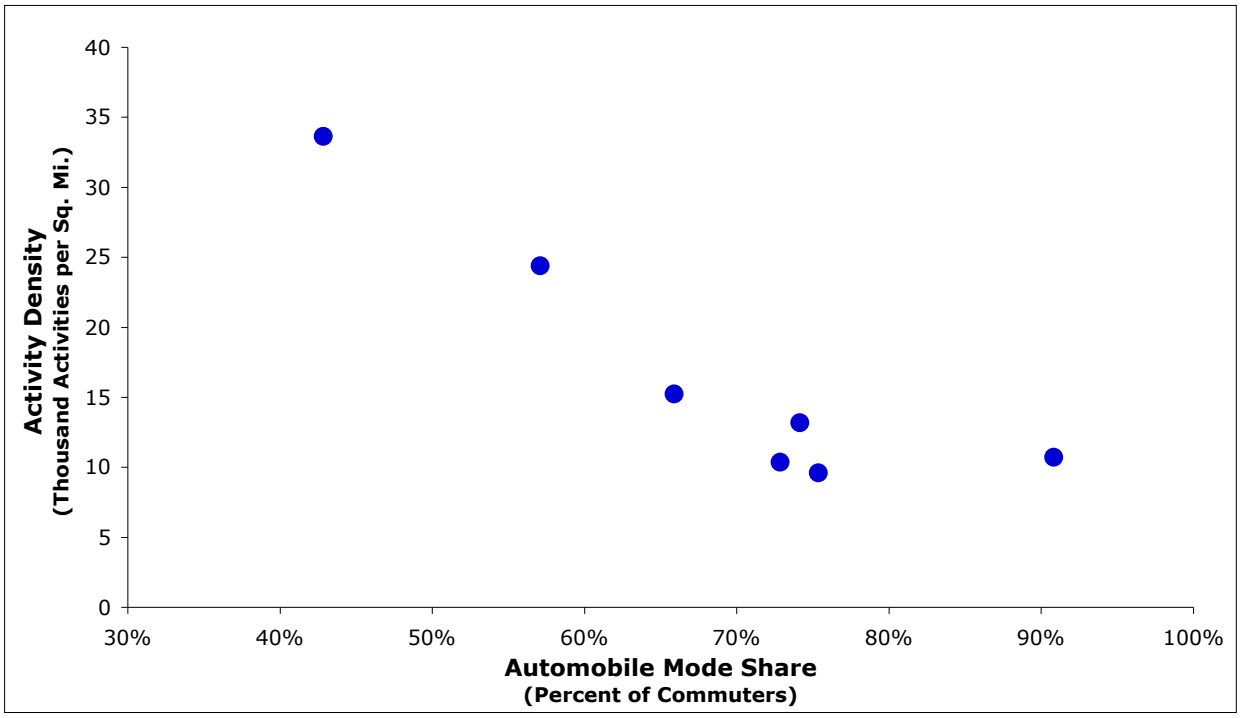

Figure 4 Relationship between automobile mode share and activity density

The evidence also suggests that – in accordance with the theoretical land consumption model – the amount of land used for transportation is a key factor related to automobile use and activity level. Figure 2 above illustrates this point in that the amount of land devoted to parking in automobile dependent cities is nearly twice as high is in cities with low automobile use. In all of these cities, there is a limited amount of useable land and an increase in parking means that there is less land available for productive activities. This potentially impacts the number of activities that can be supported.

Automobile Dependence in Cities

By dividing the seven cities into two distinct groups – one with low automobile use and the other with a high level of automobile dependence – very different trends and characteristics become more apparent. These differences are quantified in Table 2. The differences between automobile use and parking provision are most evident. In the cities with low automobile use, commuter mode share is below 70 percent and there are fewer than 100 square feet of parking per activity. In the group of automobile dependent cities, commuter mode share is above 70 percent and there are roughly 175 square feet of parking per activity. This relationship was discussed above. However, classifying the cities in this way reveals other important trends.

Table 2 Average values by city classification type – 1960 and 2000

City type	Year	Resident mode share[a]	Population density (residents/ sq. mi.)[b]	Employee mode share[c]	Employment density (employees/ sq. mi.)[d]	Parking provision (sq. ft./ activity)[e]	Automobile ownership (vehicles/ capita)[f]	Median family income[g]
Low auto use	1960	47.8%	16,704	56.1%	6,158	*No data*	0.26	$41,010
	2000	55.3%	14,760	65.4%	9,665	79	0.47	$63,184
Auto dependent	1960	58.7%	7,517	64.3%	4,826	*No data*	0.25	$33,912
	2000	78.3%	6,405	86.7%	4,555	176	0.42	$37,209

a. Percent of resident commuters traveling by automobile, from U.S. Census
b. Residents per square mile, from U.S. Census
c. Percent of employees traveling by automobile, from U.S. Census and Census Transportation Planning Product
d. Employees per square mile, from U.S. Census and Census Transportation Planning Product
e. Area of exclusive parking facilities (square feet per activity), mapped from aerial photographs
f. Private vehicles per capita, from U.S. Census
g. Median family income adjusted to 2000 dollars, from U.S. Census

First, although the population density dropped in all of the cities since 1960, the employment density increased in all of the low automobile use cities. The average increase was 3,500 employees per square mile. This change was most noteworthy in Cambridge, where the increase was more than 7,000 employees per square mile. The average employment density in the automobile dependent cities dropped slightly, although data for Lowell was not available.

The changing employment patterns in Cambridge are even more remarkable when we consider the employee mode share in all of the cities. The employee automobile mode share increased by at least 10 percentage points in all of the cities except Cambridge, where it increased by fewer than 3 percentage points. The city's high employment density – nearly three times as high as any other city in this study – is possible largely because so few employees are using automobiles for their commute. If the automobile mode share were even as high as the next highest city, this could mean more than 10,000 additional employees driving to work in

Cambridge. The amount of land needed to for these additional vehicles would be very difficult or expensive to accommodate.

The second important distinction between the cities with low automobile use and the automobile dependent cities is how well the former have performed economically over time. In 1960, the median family income was roughly equal for all of the cities except Evanston. Many of the cities faced competition from the surrounding suburbs for jobs and housing. Since 1960, however, the cities of Cambridge, Somerville, and Evanston have successfully retained jobs and incomes have increased significantly for its residents. The more automobile dependent cities – including New Haven, Hartford, and Albany – have struggled despite major development efforts. In fact, the urban renewal efforts and highway construction that took place through 1960s have been the subject of criticism for their apparent role in the decline of these cities (McCahill and Garrick, 2010). Although there is not enough evidence in this study to attribute a causal relationship between urban vitality and transportation diversity, a strong correlation between the two variables is suggested by the numbers.

The third difference between low automobile use cities and automobile dependent cities pertains to the rates of automobile ownership and use. The rates of automobile ownership in the low automobile use cities are among the highest of all the cities in this study, with Evanston being the highest. This suggests that automobile ownership may be more closely related to income than to the rate of automobile use or to other measures of travel behavior. The most likely scenario in these higher income cities is that families own personal vehicles for certain types of trips – such as traveling outside of the city or performing certain tasks – but they rely on other modes of transportation for commuting and for local trips. The residents in these cities have the privilege of owning automobiles, but they also have the convenience of diverse transportation systems, so that they may choose not to rely on their automobiles.

Historical Perspective

In order to better explain how cities have changed in such different ways over time, in this section we provide a brief review of historical policy decisions for two of the cities in this study. These two cities are Cambridge – where parking provision is the lowest and the increase in automobile use was the smallest – and Hartford – where parking provision is the highest and the increase in automobile use was among the largest.

Prior to 1960, both Hartford and Cambridge were facing a loss of residents and businesses as their metropolitan regions decentralized. In the time since, both cities have taken starkly different approaches to transportation planning in an attempt to address potential economic decay.

Development in Hartford during the 1950s and 1960s was marked by significant urban renewal efforts including the razing of many city blocks and the subsequent construction of a massive freeway system through the center of the downtown. It is evident from the historical records that it was believed that these freeways along with ample parking would allow easy access to the city from its surrounding suburbs and improve the competitiveness of the city. Soon after these changes took place, however, some city council members began to express concern that the new transportation infrastructure could result in “strangulation of the City.” They acknowledged that the city’s parking facilities encouraged the use of automobiles by commuters and that this ran contrary to the city’s long-term transportation goals. Despite these concerns, city officials continued to support the construction of new parking facilities and automobile use in the city continued to rise.

Although officials in the city of Hartford have repeatedly acknowledged the consequences of over-dependence on automobiles, they have continuously implemented policies that favor automobile use over other modes of transportation. As a result, a considerable portion of the city's most valuable land continues to be devoted to the movement and storage of automobiles. At the same time, walking and bicycling in the city has remained a less appealing option for residents and employees.

In contrast to Hartford – and to many cities throughout the U.S. throughout the 1950s and 1960s – citizens and political leaders in Cambridge brought strong opposition against the construction of freeways. Their efforts helped prevent any freeways from being built and historical neighborhoods from being razed. This movement laid the groundwork for the diverse transportation system that exists has today. It wasn't until after 1980, however, that the city officials in Cambridge really began to implement policies aimed intentionally at curtailing the impacts of automobile use in the city. These efforts began in 1981 with the introduction of new zoning codes that limited the amount of parking allowed for all new construction. In contrast, today, most American cities still specify a required minimum amount of parking required for new construction.

In 1992, city officials in Cambridge introduced a Vehicle Trip Reduction Ordinance that shifted the focus of planning efforts in the city away from single occupancy vehicles and towards walking and bicycling. This initiative was advanced further in 1998 when the city passed its Parking and Transportation Demand Management ordinance. The ordinance requires businesses to develop a plan for reducing the amount of parking and the number of vehicle trips before a permit can be issued for most new non-residential parking facilities. A city official reevaluates the plans on a regular basis.

Today, Cambridge has the second lowest percentage of residents commuting by automobile of any American city with a population greater than 100,000 – led only by New York. The records suggest that this has not occurred without active decision-making by city officials and planners. Their efforts and the efforts of citizen activists in Cambridge to improve the role of non-automobile transportation in the city seem to have had a profound impact.

Implications of the Findings

For this study, data from seven small American cities was compiled to test the impacts of automobile use on the cities' physical form and their economic viability. The findings reveal that in cities with low automobile use, there is significantly less land used for transportation purposes and there is a greater concentration of activities per square mile. The preliminary conclusions from this data is that in order for pre-automobile cities to stay economically viable, it is beneficial for them to develop diverse transportation systems that use urban space efficiently, instead of devoting significant amounts of land to the movement and storage of automobiles.

This study also shows that automobile use is lowest in the cities with the highest incomes, even though these cities are those with the highest rates of automobile ownership. This suggests that individuals will choose not to use their automobiles when there are diverse transportation choices and where non-automobile modes of transportation are attractive options.

The historic record suggests that it is a commonly held belief that the successful growth and development of American cities depends on providing the highest possible level of automobile access. This belief is reinforced by the relative success of automobile-oriented suburbs compared to urban central cities. Planners and officials in many cities have embraced this view over the last five decades by encouraging freeway construction and greater provision of parking.

The evidence from this study, however, suggests that the most vibrant cities are those in which there are diverse transportation choices. This allows these cities to use urban land for productive activities instead of using it to provide automobile infrastructure. This consideration should be a key component in comprehensive urban development strategies. Moreover, a review of historical policies for two of the cities in this study reveals that policy decisions have the potential to influence significant changes in land use and travel behavior over time. Therefore, policies for economic development should take into consideration the long-term impacts of transportation infrastructure on the built environment.

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