Lessons from the Escalation in Parking Facilities in Older American Cities over the Last Fifty Years

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ABSTRACT

The conventional approach to parking provision in the U.S. has been to anticipate trip generation and provide enough parking to meet the anticipated peak demand. This study reveals that in some places, this has resulted in parking provision that exceeds the total number of drivers or automobiles. This study provides basic data regarding parking provision at the city scale that is needed to better understand the role of parking within complex urban systems.

For this study, data was compiled to assess changes in parking provision and travel behavior for three small New England cities – New Haven and Hartford, Connecticut, and Cambridge, Massachusetts – from 1960 to 2009. The findings reveal that the number of parking spaces per driver doubled in New Haven and Hartford. In Cambridge, however, the number of parking spaces has decreased since 1985, even while the number of drivers increased.

This paper offers explanations for these differing trends and for the apparent disparity between parking provision and real demand in some cities. This study also provides a basis for reevaluating conventional views of parking demand based on the approaches taken in Cambridge.
INTRODUCTION

As automobiles rose to prominence within the United States transportation system, the issue of automobile infrastructure became increasingly important to city planners and policymakers. This was especially true of parking facilities. If places were to grow, it was assumed that most of the growth would be served by automobile, so new development would require supplemental parking facilities. In the city of Hartford, Connecticut, city officials stated in 1972 that, “the most critical improvement to [neighborhood shopping districts] which could be made at this time is the provision of off-street parking facilities” (1). In 1982, responding to the claim that his city had more parking than any other Connecticut city, New Haven Mayor Biagio DiLieto stated that he was, “strongly committed to maintaining and improving parking facilities for workers, shoppers, and visitors in the downtown area” (2).

From the above, it would seem that policymakers in these and other cities have linked increases in activities to the need for increased parking provision. If this contention were true, then logic would suggest that an increase in parking within towns and cities should correspond with an increase in activities. Applying this thinking to U.S. cities, without knowing any other information, one would expect that the cities with the greatest increases in parking over the past fifty years have also experienced the greatest growth of development and activities. And conversely, the cities in which parking has not increased substantially might be struggling to achieve growth.

Based on data compiled for three New England cities – New Haven and Hartford, Connecticut, and Cambridge, Massachusetts – this study reveals that, in fact, the opposite is true. As shown in Figure 1, the number of parking spaces increased considerably in all three cities between 1960 and 1985, during which time their populations were actually decreasing. These trends continued unabated in New Haven and Hartford through 2009. The number of employees working in those two cities also decreased over the study period. In Cambridge, the exact opposite has held true. Between 1985 and 2009, the number of parking spaces in the city of Cambridge actually decreased while the population increased. At the same time, the number of employees working in Cambridge has nearly doubled since 1960.

By 2009, the total number of parking spaces was significantly higher in New Haven and Hartford than in Cambridge, even after accounting for the total number of automobiles in each city. Moreover, New Haven and Hartford have not experienced the growth in activity that was used to justify the increases in parking. These findings suggest that there is a need to understand why increases in parking have been so dramatic in some cities, but not in all, and then to reevaluate conventional approaches to parking provision based on this knowledge.

In this paper we first establish the empirical data on parking provision and other relevant data that is the foundation of this study. Second, we look to understand how the observed patterns in the data can be explained based on what we know from the literature about the factors driving increases in transportation infrastructure (particularly parking) over time on the citywide scale. Finally, we focus on Cambridge whose experience of a decrease in the absolute amount of parking citywide seems to be rare, but is not unique in the country. The goal of this assessment is to understand the changes in policy in Cambridge that might have led to the reversal in the growth in parking starting in the mid-1980s. It is hoped that this might provide some insight for cities wishing to reduce the impact of parking on their urban fabric.
FIGURE 1 Changes in parking, population, and employment between 1960 and 2000.

THE CITIES
The cities in this study were chosen because they represent similar conditions prior to 1960, but they have undergone significant changes regarding their transportation systems, their built environments, and their social and economic status in the five decades since. Up until 1950, Hartford and New Haven were the largest cities in Connecticut. The city of Hartford has experienced a significant increase in automobile use since 1960 and the city of New Haven has experienced a more moderate increase. The city of Cambridge was included in this study.
because it is a similar size as the Connecticut cities but has experienced very little increase in automobile use. In fact, the percent of commuters using automobiles in Cambridge is far lower than any other U.S. city of its size.

All three cities lie at the center of large metropolitan regions that have decentralized to considerable extent, as both housing and jobs have spread outward to surrounding towns. In the early twentieth century, the cities all had struggling manufacturing economies. Today, both New Haven and Cambridge are well known for housing Ivy League schools – Yale and Harvard, respectively – and for their strong student presence. According to the most recent enrollment numbers, New Haven and Cambridge have approximately 33,000 students and 31,000 students, respectively [cite]. Hartford is more commonly known for housing a number of major insurance companies, although it is also home to Trinity College and a number of smaller educational institutions. There are approximately 7,000 students enrolled in Hartford [cite].

In 1960, the median family income for each of the three cities was around $43,000, adjusted to 2009 dollars (3). In Hartford, the median income dropped to less than $34,000. In New Haven, it increased to $48,000. In Cambridge, the median income doubled to more than $90,000 (4).

THE DATA

In order to complete this study, data was compiled from a wide variety of sources. A major contribution of this study is the estimation of the total number of parking spaces for each city over time. Parking policies are usually established for individual sites and development projects, but there is very little knowledge of their citywide impacts over time. One major reason is that parking data is very difficult and time consuming to aggregate at the city scale. Nonetheless, parking is an essential component in a complex urban system that involves the interaction between a large number of environmental, social, and economic factors. In order to better understand these interactions, we need basic data to characterize the scale and scope of the system.

Estimates of parking provision were developed by digitizing the amount of land used for parking from historical aerial photographs. These estimates are based only on spaces in surface lots and in freestanding parking structures, so the actual number of spaces in each city would be even higher after accounting for on-street parking, underground structures, and small private driveways. Surface lots and freestanding structures are particularly important to consider, however, because they have grown so dramatically in many cities and because these facilities greatly impact the built environment.

Digital scans of historical aerial photographs were acquired from map archives at the University of Connecticut and the University of Massachusetts. Recent parking conditions were digitized using aerial imagery from Google Maps and Bing Maps. Digitizing is a manual process whereby surface parking lots and parking structures are identified and mapped using ESRI ArcMap software. The researchers identified parking areas as areas visible in the aerial photography that are used for the storage of automobiles plus the space needed to maneuver those vehicles. This does not include on-street parking, underground parking, or small lots and driveways with space for three or fewer vehicles. If an area was not clearly identifiable as a parking area, it was indicated as such in order to determine a margin of uncertainty for each city and year. Aerial photographs were available for each city once prior to 1960, once in the mid-1980s, and once in 2009. The precise years are indicated in the summary of data in Table 1. The total area for surface lots was adjusted proportionally to account for areas without aerial coverage for a given year.
The total number of parking spaces in each city for each year was determined by assuming that the average area of a parking space (plus space to maneuver) is 350 square feet (32.5 square meters). This estimate was determined from a sample of more than 100 surface lots identified in this study. The average height of parking structures was assumed to be 4.5 levels in New Haven and Cambridge and 6.5 levels in Hartford. These estimates were chosen based on a survey of parking structures in each city.

**TABLE 1 Estimated number of parking spaces from aerial photographs**

<table>
<thead>
<tr>
<th>City</th>
<th>Year</th>
<th>Surface lots</th>
<th>Structures</th>
<th>Total</th>
<th>Uncertainty (+/-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Haven</td>
<td>1951</td>
<td>21,690</td>
<td>0</td>
<td>21,690</td>
<td>3.9%</td>
</tr>
<tr>
<td></td>
<td>1986</td>
<td>69,830</td>
<td>8,860</td>
<td>78,690</td>
<td>0.9%</td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td>93,140</td>
<td>13,270</td>
<td>106,410</td>
<td>0.3%</td>
</tr>
<tr>
<td>Hartford</td>
<td>1957</td>
<td>42,040</td>
<td>4,500</td>
<td>47,040</td>
<td>9.8%</td>
</tr>
<tr>
<td></td>
<td>1986</td>
<td>95,160</td>
<td>9,940</td>
<td>105,100</td>
<td>7.8%</td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td>115,070</td>
<td>26,360</td>
<td>141,430</td>
<td>1.9%</td>
</tr>
<tr>
<td>Cambridge</td>
<td>1952</td>
<td>18,760</td>
<td>2,810</td>
<td>21,570</td>
<td>1.9%</td>
</tr>
<tr>
<td></td>
<td>1985</td>
<td>45,400</td>
<td>9,360</td>
<td>54,760</td>
<td>0.3%</td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td>38,660</td>
<td>13,190</td>
<td>51,850</td>
<td>2.0%</td>
</tr>
</tbody>
</table>

Data regarding demographics and commute trip characteristics, including means of travel and geographic travel patterns, were compiled from U.S. Census records (5,6,7,8) the National Historical Geographic Information System (3), the American Community Survey (4), and the Census Transportation Planning Product (9). A summary of population, employment, travel means, and vehicle ownership data is shown in Table 2. In that table and elsewhere in this paper, a driver is defined as any resident of the city or employee in the city who commutes by automobile.

Given the variety of sources from which the data were compiled, the years during which data were collected do not always align. Most of the demographic data was available for every decade from 1960 to 2000 and for 2009. Therefore, 1960 was considered the beginning point of this study. The earliest estimates of parking were from prior to 1960, so the number of parking spaces in surface lots was estimated for the year 1960 through linear interpolation, and the number of parking spaces in garages was assumed to be the same in 1960 as in the year the first aerial photograph was taken.

Since parking estimates were established for the year 1985, it was considered important to estimate the total number of drivers for that year. The number of residents driving to work was estimated through linear interpolation between the years 1980 and 1990. Since data regarding employees and employees travel behavior was available only for the years 1960 and 2000, the number of drivers was estimated through linear interpolation between those two years.
### TABLE 2 Summary of population, employment, and commute data

<table>
<thead>
<tr>
<th>City</th>
<th>Year</th>
<th>Population</th>
<th>Residents</th>
<th>Drivers (%)</th>
<th>Employees</th>
<th>Total commuters</th>
<th>Drivers (%)</th>
<th>Vehicles per capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Haven</td>
<td>1960</td>
<td>152,048</td>
<td>55,979</td>
<td>58</td>
<td>84,541</td>
<td>64</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1970</td>
<td>137,707</td>
<td>53,748</td>
<td>68</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1980</td>
<td>126,109</td>
<td>48,144</td>
<td>69</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1990</td>
<td>130,474</td>
<td>54,954</td>
<td>73</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>123,626</td>
<td>46,592</td>
<td>73</td>
<td>73,873</td>
<td>85</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td>123,314</td>
<td>53,696</td>
<td>66</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Hartford</td>
<td>1960</td>
<td>162,178</td>
<td>66,490</td>
<td>53</td>
<td>114,399</td>
<td>66</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1970</td>
<td>158,017</td>
<td>65,730</td>
<td>59</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1980</td>
<td>136,392</td>
<td>54,662</td>
<td>67</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1990</td>
<td>139,739</td>
<td>54,470</td>
<td>71</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>121,578</td>
<td>40,320</td>
<td>74</td>
<td>105,206</td>
<td>90</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td>124,063</td>
<td>42,887</td>
<td>73</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Cambridge</td>
<td>1960</td>
<td>107,716</td>
<td>40,108</td>
<td>42</td>
<td>65,948</td>
<td>56</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1970</td>
<td>100,361</td>
<td>44,828</td>
<td>43</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1980</td>
<td>95,322</td>
<td>46,397</td>
<td>42</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1990</td>
<td>95,802</td>
<td>50,518</td>
<td>47</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>101,355</td>
<td>51,923</td>
<td>43</td>
<td>109,982</td>
<td>60</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td>108,776</td>
<td>60,234</td>
<td>41</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

#### THE THEORY OF PARKING DEMAND

Conventional models used by transportation engineers and planners throughout the U.S. are based on an underlying assumption that as the number of residents and jobs increases in a given area, transportation infrastructure must also be expanded. This seemingly common sense approach also reflects the assumptions of the policymaker (and the public) as was discussed above. Such a demand-driven approach to infrastructure provision is particularly common in regard to automobile parking. For example, the Trip Generation guide produced by the Institute of Transportation Engineers is used widely to estimate the amount of parking needed to serve many types of new development including offices, apartment buildings, schools, and retail outlets (10). This approach to parking provision has also been codified in municipal zoning codes, which usually specify the minimum amount of parking required for new development projects based on assumptions about trip generation.

The rationale described above implies that the amount of parking required to satisfy demand is reasonably predictable given the number of drivers or vehicles that there are in an area. However, this theory has not been systematically tested over a large scale or over a significantly long period of time. In this study, we have compiled data to begin this type of assessment. Our data suggests that the underlying assumption of the demand-driven approach to parking provision might be faulty.

Figure 2 shows that since 1985 the number of drivers in Cambridge has increased by a greater percentage than in New Haven or Hartford. Also, as shown in Table 2, the number of vehicles per capita increased more in Cambridge and is now higher than in either of the two
Connecticut cites. According to conventional parking demand models, Cambridge should have experienced the greatest increase in parking provision in order to accommodate the additional vehicles. As mentioned, however, Cambridge actually experienced a decrease in the number of parking spaces during this time period. This resulted in a very dramatic drop in the number of parking spaces per driver, as illustrated in Figure 2.

**FIGURE 2** Changes in drivers and parking spaces per driver between 1960 and 2000.

The size of parking facilities is usually determined at the scale of individual projects or sometimes at the scale of neighborhoods and it is often dictated by the trip generation rates and by the local zoning codes discussed above. At this scale, the primary concern is typically whether there is enough parking to meet the anticipated demand, as discussed above. However, these small-scale decisions and other large-scale urban renewal projects can lead to major increases in parking at the aggregate level of individual cities. These parking facilities are a major component in a complex system. This study reveals that the benefits of parking provision for urban growth and development may be drastically overstated, while other studies have found that increases in parking may actually contribute to a loss of urban activities (11,12).

Given the impacts of parking provision in urban environments, it is important to understand how there could be such drastic differences among cities and why there are such disparities between the number of drivers or automobiles and the number of parking spaces in
each city. The following section provides an explanation as to why the amount of parking in Connecticut cities has grown disproportionately.

**THE ESCALATION IN PARKING PROVISION**

As illustrated above, the increase in the number of parking spaces has drastically outpaced the number of drivers in some cities. This section highlights some key factors that have likely contributed to disproportionate parking provision in those places. The purpose of this discussion is not necessarily to suggest that each of these factors should be addressed on an individual basis, but instead to illustrate the many interactions between parking, land use, the built environment, and travel choices. Only by measuring parking provision and assessing parking demand can we begin to understand the role of parking within complex urban systems.

**Inefficient Use of Parking**

One reason the increase in the number of parking spaces often outpaces the increase in the number of drivers within a city is that, as individuals rely on automobiles for more types of trips, they require more parking spaces to meet their daily travel needs. In a study by Davis, Pijanowski, Robinson, and Kidwell (13), researchers used a similar approach as in this study to digitize areas used for parking and they estimated the total number of spaces in the four states of the Upper Great Lakes region – Illinois, Indiana, Michigan, and Wisconsin. They estimated that there are more than 2.5 parking spaces per vehicle in that region. This is a reasonable finding given that the average automobile commuter requires one parking space at home, one at work, and additional parking spaces anywhere else they might visit during the day.

This estimate of 2.5 parking spaces per vehicle is comparable to conditions in Hartford, where there are 2.8 parking spaces per vehicle, but somewhat higher than New Haven and Cambridge, where there are 1.9 and 1.2 parking spaces per vehicle, respectively. The lower rates in these two cities may be attributable to the mixing of land uses, as discussed below. But they are also due to the fact that the cities must be able to accommodate a daily influx of vehicles, in addition to those vehicles owned by residents. This affect would be negligible at the scale of the Upper Great Lakes region.

The disproportionate increase in parking compared to the number of drivers is often even greater when parking facilities are segregated by destination and land use type. In a study by Marshall and Garrick (14), researchers calculated the parking provision and occupancy at town centers in New England. They found that at centers with mixed land uses and with parking lots that were shared among businesses, there were half as many parking spaces per square foot of building space, compared to sites with segregated parking. They attribute this difference to the fact that at mixed-use centers visitors can park once to reach many destinations and the built environment is more conducive to walking. They also point out that, at peak usage, there were 25 percent more parking spaces occupied per square foot of building space at the sites with segregated parking than at mixed-use centers – suggesting a much lower efficiency of use of the existing parking. Overall, as the Connecticut cities in this study become more spread out and more segregated, there is a greater need for parking at each individual destination, as opposed to lots that are shared among many destinations.

**Urban Fabric**

A disproportionate increase in the number of parking spaces is also tied to changes in the urban built environment of cities as automobile use increases. As automobiles become the
predominant mode of travel in a city, the necessary changes to the urban fabric can make it more
difficult or less appealing for individuals to choose other modes of travel. As the data in this
study shows, increases in parking can be quite dramatic. This is due to the fact that automobiles
require more space for movement and storage than other modes of transportation (11). These
drastic changes to the built environment can make biking and particularly walking less appealing
(15). This means people will be more likely to use automobiles even for shorter trips that could
easily have been served by these other modes, thus inflating the demand for parking. The data in
shown in Figure 3 illustrates that point.

Since before 1960, both housing and jobs have spread outward from central cities so that
the percentage of people who both live and work within a city has decreased. This is true for all
three cities in this study including Cambridge. Figure 3 shows that the percent of residents who
work within the city and the percent of employees who live within the city both dropped between
1960 and 2000 for all of the cities. As trip distances become longer and destinations become
more spread out, walking, biking, and transit become less viable travel options. Therefore, more
commuters drive in and out of each city on daily basis. In theory, however, intra-city commute
trips (trips beginning and ending within one city) could still be made easily by walking, biking,
or using transit. Nonetheless, the percent of intra-city commuters using automobiles has
increased substantially in both of the Connecticut cities. This increase in automobile use for
short trips results in a higher demand for parking. The opposite trend is true for Cambridge,
where automobiles now account for a smaller portion of intra-city commute trips than in 1960.


It is important to note that in Cambridge, where automobile use is very low for intra-city
commute trips, walking and biking make up a majority of those trips. Transit makes up the
smallest portion of intra-city commute trips. This indicates that the trends in Cambridge are due
in large part to a built environment that supports biking and walking, as opposed to a superior
transit system. This distinction is addressed more thoroughly below, where Cambridge is used to
illustrate how a more sustainable approach to parking provision can be achieved.

Impacts of Parking Increases
The factors described above are not the only factors contributing to an escalation in the number
of parking spaces in New Haven and Hartford, but they help to illustrate the complexity of the
systems that are in place. The interactions between parking, land use, the built environment and travel choices can result in dramatic changes over time. The increases in parking presented in this study are evidence of the potential scale of these changes. More importantly, these interactions can make it very difficult to identify individual causes of parking increases with great certainty.

However, two points are apparent from the discussion above. First, the approach to parking provision that is currently in place in New Haven and Hartford (and in many cities around the country) has resulted in conditions that become increasingly difficult to manage. This growth in parking is associated with a number of detrimental consequences. For some time, researchers have pointed to the environmental impacts of paved parking facilities. These impacts include the degradation of water quality and heating effects (13). More recently, however, there has been more evidence that these parking facilities are associated with negative social and economic impacts as well (12,16,17). The harmful effects of parking growth in Hartford are detailed in McCahill and Garrick (18). Based on this growing evidence, excess parking provision should be avoided.

This leads to the second point. As suggested by the evidence from Cambridge, a perpetuated growth in parking provision can be interrupted without inhibiting urban growth. This seems to have occurred there, in part, through a series of deliberate measures that the city took beginning just prior to 1985. The following section briefly describes some of these measures and offers some insight into how automobile travel is supported in the city with such a limited amount of parking, especially as compared to the Connecticut cities.

A SUSTAINABLE APPROACH TO PARKING PROVISION
This study reveals that conventional, demand-driven approaches to parking provision can result in conditions that are increasingly difficult to manage. Furthermore, the commonly held assumption that urban growth is intrinsically linked to parking provision seems to be faulty. In the city of Cambridge, this trend towards major increases in parking appears to have been interrupted, and even more striking, has been accompanied by increases in population, employment, and even the total number of drivers. The approach to parking provision in that city acknowledges the contributions of excess parking to increasing automobile use, but also serves to meet parking needs in a way that is not disruptive to the character of the city. For this reason, Cambridge serves as a case with which to illustrate the real impacts of parking and transportation demand management measures.

Based on the data from this study, the trend towards increasing parking provision in Cambridge reversed markedly after 1985. This change can be attributed in large part to a handful of policies instituted there, beginning with changes to municipal zoning code in 1981. These policies are detailed fully in McCahill and Garrick (15), but this section provides a brief overview of key points.

Prior to 1981, the zoning code in Cambridge specified a minimum amount of parking required for new development projects. This was consistent with the zoning codes in most municipalities across the nation, as discussed above. In 1981, however, the city not only lowered its minimum parking requirements for new development projects but they also imposed a maximum limit on the amount of parking that could be provided for those projects. With this move, city officials established that a more balanced approach to parking provision would be best for the future of the city.
This was followed by even more decisive actions in 1993 and 1998, which emphasized that automobiles were to play a lessened role in the city’s transportation system. A growth management document released in 1993 stated, “non auto forms of transportation” would be the “best hope for improving mobility.” In 1998, the city instituted a parking and transportation demand management (PTDM) measure requiring businesses to register their parking spaces and to develop plans for managing automobile trips – effective whenever non-residential parking facilities were built or expanded. Other actions taken during this time include a vehicle trip reduction ordinance, the establishment of a Pedestrian Advisory Committee and a Bicycle Committee, and numerous design projects for improving pedestrian and bicycle facilities.

These policies and actions have had a major impact on overall parking provision and demand in Cambridge, largely by encouraging walking and biking for transportation. At the same time, this has facilitated growth and development in the city. Empirical evidence suggests there is a substantial trade-off between the amount of land used for infrastructure and the number of activities supported in small cities (12). In Cambridge there is more land available for productive activities because less land is needed for transportation infrastructure (namely parking).

It was suggested above that as more automobile infrastructure is provided, automobiles become a more attractive travel option, even for shorter trips. The opposite is true in Cambridge. Even while the number of commuters driving to and from the city has increased, a smaller percentage of intra-city commuters use automobiles. Since the rate of automobile ownership is higher in Cambridge than in the two Connecticut cities, this means that many residents choose to leave their vehicles at home for shorter trips. As shown in Table 3, transit accounts for 15 percent of intra-city commute trips, which is substantially lower than transit use in Hartford. On the other hand, biking and walking account for more than half of intra-city commute trips. Biking and walking account for only one-quarter of commute trips within New Haven and one-tenth of commute trips within Hartford.

### TABLE 3 Intra-city commute trips in 1960 and 2000

<table>
<thead>
<tr>
<th>City</th>
<th>Year</th>
<th>Intra-city commute mode share</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Automobile</td>
<td>Transit</td>
<td>Bike or walk</td>
</tr>
<tr>
<td>New Haven</td>
<td>1960</td>
<td>50%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>62%</td>
<td>11%</td>
<td>26%</td>
</tr>
<tr>
<td>Hartford</td>
<td>1960</td>
<td>45%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>65%</td>
<td>24%</td>
<td>10%</td>
</tr>
<tr>
<td>Cambridge</td>
<td>1960</td>
<td>32%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>27%</td>
<td>15%</td>
<td>57%</td>
</tr>
</tbody>
</table>

In New Haven and Hartford, it was shown, infrastructure intended to serve automobile trips to and from the cities have also led to more automobile use for intra-city travel. In Cambridge, there is enough parking to meet the demand of more than 66,000 commuters that use automobiles – this is more than in New Haven – but the built environment also supports and encourages a much higher rate of walking and biking within the city. Instead of automobiles serving a majority of the transportation needs in the city, they make up just a moderate portion of
a diverse transportation portfolio. This has allowed the city of Cambridge to achieve growth and development with substantially less parking.

CONCLUSIONS
Over the past fifty years, the conventional approach to parking provision in many U.S. cities has been to provide enough parking to satisfy all anticipated demand. However, there is limited knowledge regarding the citywide impacts of parking provision over time.

The data compiled for this study is necessary for understanding these impacts. Parking is an essential component in a complex urban system that involves the interaction between a large number of environmental, social, and economic factors. The data is used to characterize the role of parking within this system in order to better understand these interactions.

This study reveals that, as a consequence of long-term demand-driven parking provision, two Connecticut cities have experienced an increase in parking that has greatly outpaced the increase in the number of drivers or automobiles. This excess parking provision can be detrimental in urban environments.

City officials in Cambridge, Massachusetts, have adopted a different approach to parking provision by limiting the amount of parking allowed for new developments and improving the ability to walk and bike within the city. Since these new policies began in 1981, the total number of parking spaces has decreased, even while the number of residents and employees has increased. A large number of commuters travel to and from the city by automobile, but walking and biking account for a majority of trips within the city. This greatly reduces the demand for parking.

This study reveals a need to reassess the impacts of the demand-driven approaches to parking provision that are conventional in most U.S. cities, including New Haven and Hartford. A more balanced approach to parking provision, like the approach taken in Cambridge, would address real parking demands in a way that acknowledges that excess parking contributes to increases in automobile use, which in turn exacerbate parking issues.

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