Visualizing Urban Parking Supply Ratios

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ABSTRACT

This work illustrates the potential impacts of minimum parking requirements on the built environment in urban areas. For this paper, we estimated area wide parking supply ratios in four urban centers representing a range of values. We depict the differences among these four scenarios to demonstrate the magnitude of impacts on the built environment.

The existing parking supply ratios in this study range from 0.1 to 0.9 parking spaces per 1,000 ft^2 of building space. As parking supply ratios increase within this range, structures generally become taller with larger footprints. However, buildings also become more sparsely distributed and parking becomes a more dominant feature of the built environment. This work allows policymakers to visualize different parking ratios and offers valuable perspective for evaluating parking policies in terms of land use patterns and other broad policy goals.

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INTRODUCTION

Zoning codes in most cities and towns throughout the U.S. include minimum parking requirements for all new development and land use changes. These requirements are meant to ensure that there will be sufficient parking to avoid shortages and prevent spillover at adjacent properties. They are often based on estimates of parking demand from organizations like the Urban Land Institute (ULI) and the Institute of Transportation Engineers (ITE) or they are modeled after requirements in other municipalities.

Studies looking at parking utilization show that parking supplies conforming to these requirements are often underutilized, even during peak periods of use (Mackenzie & Eastman, 1992; Marshall & Garrick, 2006; Snyder, 1999). This makes these requirements particularly problematic in compact urban areas where fewer people are likely to travel by automobile and where it is more difficult to accommodate large parking facilities. Nonetheless, many compact cities still require parking supplies that are only marginally lower than those in automobile-oriented suburban areas, thereby gradually driving up citywide parking supplies over time.

This research considers the impacts of parking requirements in terms of the amount of space needed to accommodate parking and the changes in built environment that occur as parking supply ratios increase. We analyze parking supplies in four compact urban areas to depict variations in parking supply ratios and potential impacts of parking requirements with regards to urban form. This works offers a revealing perspective on parking supplies and land use at the neighborhood scale, rather than the project-level scale at which parking policies are typically implemented.

PARKING RATIOS AND THE BUILT ENVIRONMENT

Municipal parking requirements are most commonly expressed in terms of the number of parking spaces needed for a given area of useable building space, particularly for commercial uses. In other cases, such as for housing or restaurants, parking requirements are often expressed in terms of parking spaces per dwelling unit or per seat, respectively. In each of these cases, however, parking requirements can be converted reasonably in terms of parking spaces per useable area.

Moreover, a typical off-street parking space occupies a fairly consistent and predictable total area, even after accounting for additional space needed for vehicle movement and maneuvering. We analyzed more than 100 off-street parking facilities of various sizes and determined the average parking space requires an area of 350 ft^2, which is consistent with typical estimates.

For these reasons, minimum parking requirements impose specific standards on the use of space with regards buildings and parking. For example, a requirement of three spaces per 1,000 ft^2 implies that more space must be committed to parking than to useable building space. In order to meet parking requirements, therefore, developers must either reserve a larger portion of land for parking, which often means having less for useable building space, or make considerable investments in multi-level parking structures to make more efficient use of the available land.

Figure 1 depicts the relationship between building space and parking space for a series of scenarios. In all cases, the building is assumed to be three stories tall. Parking ratios ranging from 0.5 spaces per 1,000 ft^2 to 4.0 spaces per 1,000 ft^2 are shown, both as single-level surface lots and as three-story parking structures. The high end of this range represents a typical requirement for commercial properties in suburban areas, based on national standards (Ferguson, 2004).

This clearly has important implications on individual development projects, but it also has important implications for entire blocks, towns, and cities as parking requirements influence development patterns over the long term. As new development replaces older compact urban development, parking facilities become an increasingly dominant feature of the built environment and, where surface lots are common, urban areas become considerably fragmented and disconnected. This study illustrates these differences in the distribution of buildings and parking facilities in actual cities for a range of parking supply ratios.

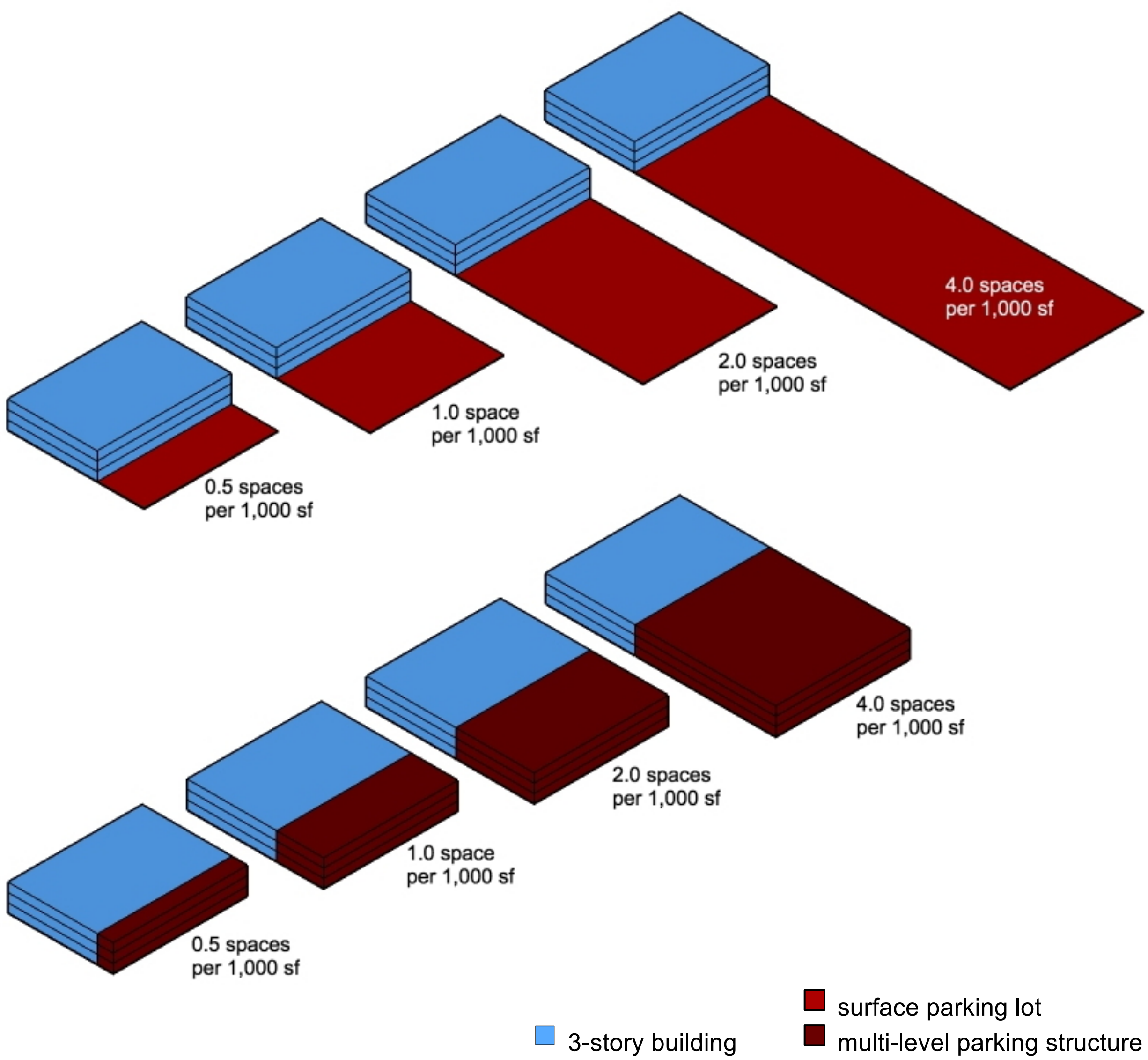

Figure 1. Land use balance corresponding with various parking ratios using surface parking (top) and structured parking (bottom) for a three-story building.

AREA WIDE PARKING RATIOS

In order to better understand the potential citywide impacts of parking requirements, we analyzed the built environment in four urban centers, employing the principles illustrated in Figure 1. The result, shown in Figure 2, reveals the distribution of buildings and parking facilities in urban centers for a range of parking supply ratios. The existing parking supply ratios are lower than typical parking requirements (as shown in Figure 1) for reasons described below. We also evaluated the cities in 1960 to assess the changes in each.

Methodology

We estimated parking supplies in fourteen cities as part of a larger body of research and subsequently estimated parking supply ratios for six of those cities using the methodology outlined below. For this paper, we consider only four of those cities – representing a full range of parking supply ratios – to visually depict the differences in built environment among them. For illustration purposes, these could be any cities with parking supply ratios within the desired range, regardless of their parking policies or other influential factors, such as their regional economies. The four cities are Berkeley, California; Cambridge, Massachusetts; and Hartford and New Haven, Connecticut.

We isolated the historical central business district (CBD) in each city (shown in Figure 2) and analyzed built environment characteristics using geographic information systems (GIS). We mapped buildings and visible off-street parking facilities with space for more than three vehicles manually in GIS based on aerial photographs[1] to estimate the total area for each. We determined the number of levels in each structure using the street view function in Google Maps[2] and aerial photographs from Bing Maps.[3] We estimated structure heights in 1960 by comparing aerial photographs to those from 2000 and noting differences in building types and shadow lengths among the structures. We estimated the number of parking spaces by dividing total areas by 350 ft^2 – the average area for a parking space based on analysis of more than 100 parking facilities.

Results

Table 1 shows off-street parking supply ratios based on GIS analysis of four urban centers. Parking ratios range from 0.09 to 0.86 parking spaces per 1,000 ft^2 of useable building space. This represents a considerable increase for Hartford and New Haven since 1960 and a moderate decrease for Berkeley and Cambridge. In 1960, parking ratios ranged from 0.10 to 0.31, a notably smaller range compared to 2000.

The existing parking supply ratios are lower than required parking ratios in each city primarily because many of the existing structures predate parking requirements, which apply only to new development. Requirements also vary depending on building use, which is not accounted for

[1] Available from the U.S. Geological Survey and libraries at the University of Connecticut and the University of Massachusetts
[2] Available at http://maps.google.com
[3] Available at http://www.bing.com/maps

here. In a related paper, we estimate that these four cities provide between 37 and 90 percent of required parking (McCahill, Haerter-Ratchford, Garrick, & Atkinson-Palombo, 2014).

Table 1. Estimates of Off-Street Parking Supply Ratios

Central Business District	Off-street parking spaces		Building area (1,000 ft^2)		Off-street supply ratio	
	1960	2000	1960	2000	1960	2000
Cambridge	1,890	2,620	19,860	28,990	0.10	0.09
Berkeley	4,160	3,880	13,450	15,650	0.31	0.25
New Haven	3,070	19,680	20,600	32,710	0.15	0.60
Hartford	10,130	39,590	36,520	46,220	0.28	0.86

Table 2 provides a summary of differences in the configuration of the built environment among the four urban centers and their changes over time. In Berkeley and Cambridge, the growth in building space occurred through somewhat larger commitments of land to buildings and marginal increases in average building height. In Hartford and New Haven, this growth occurred through considerable increases in building height, but losses of total land for buildings. Growth in parking in Hartford and New Haven occurred mostly through a greater commitment of land to parking, but also through taller parking structures. Parking changed very little in Berkeley and Cambridge. We explain these changes in more detail in a related paper (McCahill et al., 2014).

Table 2. Built Environment Characteristics

Central Business District	Buildings				Off-Street Parking			
	Percent of land		Average height (levels)		Percent of land		Average height (levels)	
	1960	2000	1960	2000	1960	2000	1960	2000
Cambridge	20%	27%	3.2	3.6	2%	3%	1.0	1.0
Berkeley	27%	29%	2.3	2.5	7%	6%	1.0	1.1
New Haven	32%	30%	2.5	4.3	4%	16%	1.0	1.6
Hartford	23%	20%	3.2	4.7	7%	18%	1.0	1.5

Together, the existing conditions in these four cities illustrate the gradual variations in built environment associated with increasing parking supply ratios from 0.1 to 0.9 spaces per 1,000 ft^2. Figure 2 depicts the built environment for each of the CBDs around the year 2000 in terms of land used for buildings versus parking and structure height for each. Through the progression of visuals, both the heights and footprints of buildings become larger and parking becomes a more prominent feature. At the high end, buildings are sparsely situated and some blocks are committed entirely to surface parking and parking structures. This progression mirrors the changes that New Haven and Hartford, among others, experienced between 1960 and 2000 (McCahill & Garrick, 2010; McCahill et al., 2014).

DISCUSSION

Implications of Minimum Parking Requirements

As shown above, parking supply ratios correspond with visibly distinct land use patterns and built environment characteristics. Therefore, minimum parking requirements serve as de facto policies prescribing one built form over another. Of course, there are ways of meeting parking requirements without impacting the built environment so drastically, such as through underground facilities, but these methods are particularly costly and, therefore, only reasonable on large-scale projects with considerable capital funds available. For many smaller projects, surface parking may be the only cost-effective type of facility. Where space is limited but minimum parking requirements are in place, developers may be deterred from building altogether or they may buy and demolish adjacent buildings.

Minimum parking requirements in many cities are in the range of one to two parking spaces per 1,000 ft^2 or higher. For example, the City of New Haven requires more than 1.5 spaces per 1,000 ft^2 of office space and five spaces per 1,000 ft^2 of retail space, with some exemptions for small, ground level spaces in the CBD. This means that existing policies in each of the cities studied (and most cities around the nation) could easily drive up parking ratios by an additional 100 percent or more, regardless of market demand. Changes of this magnitude are certainly within the realm of possibility, given that parking ratios have increased by 300 percent in central Hartford and by 400 percent in central New Haven since 1960.

It is important for policymakers to assess their parking policies with the above visuals in mind and consider what those policies mean for the future urban form in those places. There is a great likelihood that these policies will achieve either of two things over the long run: 1) further increase the percent of land used for parking, rather than buildings, and 2) stifle development opportunities. Given that compact, well-connected development patterns are central to many urban policy goals (e.g., livability and sustainability), minimum parking requirements have great potential to undermine the success of those policies.

Opportunities to Reduce or Eliminate Requirements

If minimum parking requirements potentially degrade the urban built environment and undermine policy goals in urban areas, as suggested above, then there still remains a question as to how possible it is to reduce or eliminate those requirements. In fact, this has been the focus of numerous prior studies. Opportunities to reduce parking requirements fall into two broad categories. The first is that existing parking supplies can be managed more efficiently. The second is that parking demand can be lowered when there are comparable alternatives to traveling by automobile.

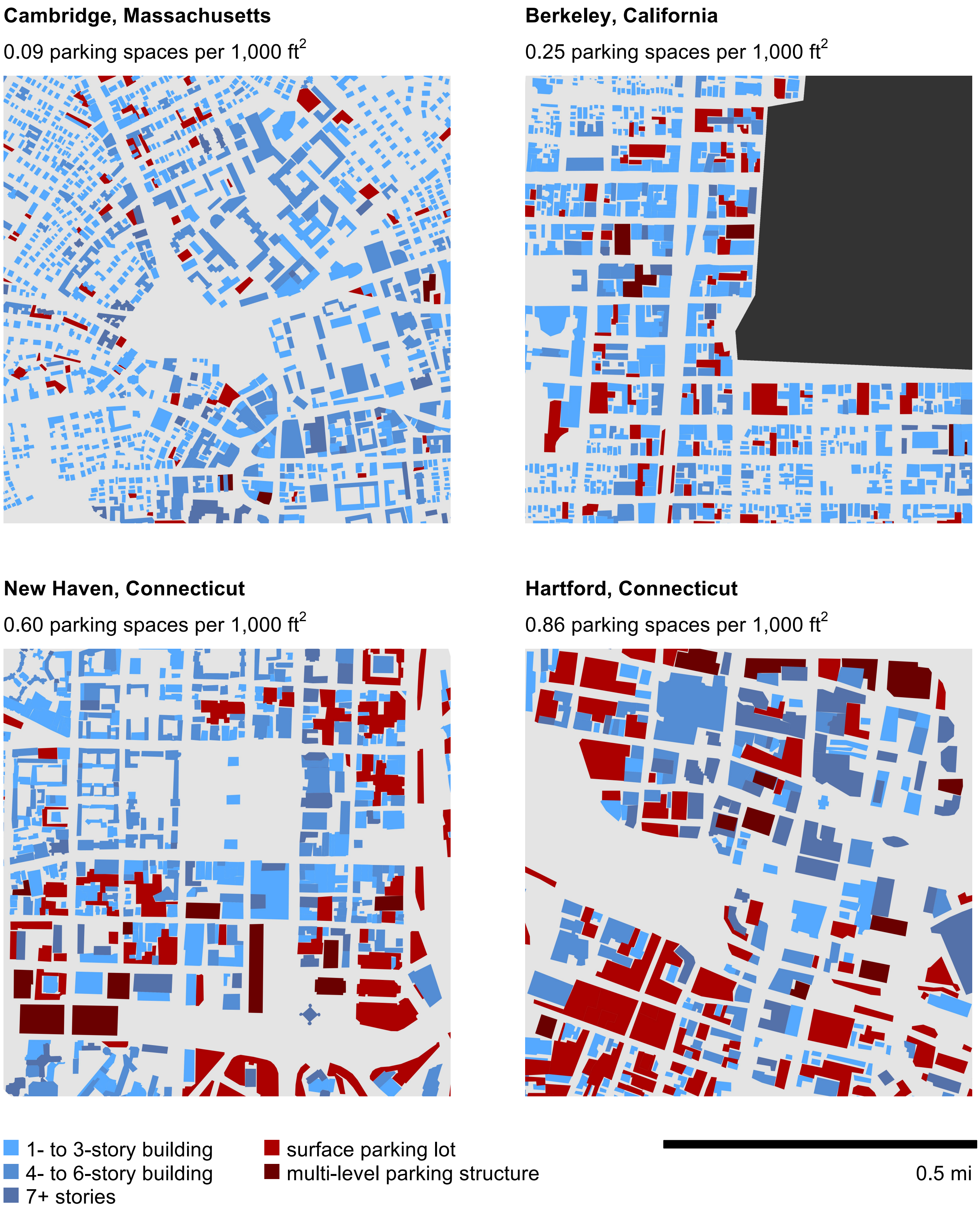

Figure 2. Distribution of buildings and parking facilities in urban centers for a range of parking supply ratios.

Existing parking supplies can be used more efficiently through appropriate pricing mechanisms, policies that encourage shared parking among different property owners and land uses, and greater reliance on on-street parking. Studies have long shown that establishing an appropriate price for parking can reduce the number of single-occupancy vehicle commuters, encourage non-automobile travel, and shift automobile trips to off-peak periods, thereby reducing peak demand (Hess, 2001; Shiftan & Burd-Eden, 2001; Shoup, 1995; Willson & Shoup, 1990). Policies that encourage shared parking facilities can reduce area wide supplies by minimizing the amount of redundant or excess parking at individual sites (Broaddus, 2009; Marshall & Garrick, 2006). Finally, on-street parking can serve an important role in meeting area wide parking supplies, given its efficient use of space and its potential to improve the walkability of a CBD (Marshall, Garrick, & Hansen, 2008), but rarely counts towards meeting parking requirements.

Parking demand also varies considerably depending on access to transit and rates of walking and bicycle use, among other factors (Rowe, McCourt, Morse, & Haas, 2013). In fact, rates of automobile use by commuters ranged from 55 percent in Cambridge to 85 percent in Hartford in 2000, according to the U.S. Census. However, our prior study focusing on those two cities suggests that the substantial increase in parking in the latter city has likely played a large role in driving up automobile use there (as in many cities), especially for local trips once made by walking, biking, and public transit (McCahill & Garrick, 2010). Similarly, parking availability was found to influence rates of driving among similar neighborhoods in New York (Weinberger, Seaman, Johnson, & Kaehny, 2008). By placing greater emphasis on policies that encourage residential development in CBDs and travel by non-automobile modes, the need for parking can be greatly reduced.

CONCLUSIONS

This research reveals the physical impacts of minimum parking requirements in urban centers through estimates of area wide parking supply ratios and visualization of parking supplies and built environment in actual city centers. This work demonstrates that parking requirements can only be met through drastic changes to the urban built environment. As parking supply ratios increase from 0.1 to 0.9 spaces per 1,000 ft^2 of building space, structures generally become taller with larger footprints. However, buildings generally also become more sparsely distributed and parking becomes a more dominant feature of the built environment. Since minimum parking requirements are typically still not fully satisfied, parking requirements will continue driving supplies up, further impacting the built environment, or they may deter potential new development. Policymakers should consider how these policies conform to broad policy goals, particularly those that emphasize compact, well-connected development patterns and non-automobile transportation.

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