PARKING IN MIXED-USE U.S. DISTRICTS: OVERSUPPLIED NO MATTER HOW YOU SLICE THE PIE

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ABSTRACT

Parking is among the most discussed topics in local politics, with citizens and business owners frequently concerned about supplies being too low. However, numerous research efforts have shown that parking is routinely oversupplied in single-use districts in the United States, and others have documented the same trend in mixed-use districts. This paper looks at parking supply and usage in an additional 27 mixed-use districts around the country, the largest sample of districts examined in this type of study. Defining sufficient supply as that which would leave 15 percent of spaces open, we find that parking is oversupplied by 65% on average. Differences in oversupply are not systematically explained by commute mode share, region, type of place, or any other dimension we were able to identify. Indeed, oversupply in places that have identified parking shortages averages 45%. The finding suggests that parking is often oversupplied to such an extent that it is non-binding on travel decisions and has become unmoored from the typical relationship between supply and demand. Given the perception of shortage even where there is a documented oversupply suggests that better parking management could be a more effective tool for mitigating perceived shortages than would an increase in supply.

INTRODUCTION

Concerns about parking shortages are common in cities and towns across the United States. But with more than two spaces supplied per vehicle (*1*), there is clearly no universal shortage. As drivers move between residential and commercial areas in well-timed pulses, downtown in the daytime and back home in the evening, they may experience spot shortages, but even then, a question of scale arises. Is it a shortage because the one "best" space a driver wants is occupied, because all the spaces on the destination street or the first floors of a garage are occupied, or because there are no spaces to be found in a wider area? Even San Francisco, a city so notorious for parking shortages that the U.S. Department of Transportation invested approximately $18 million to develop a pricing system that could, in theory, redistribute and/or reduce demand, found that simply redistributing demand geographically solved the "shortage." While the city raised parking prices on many streets, it kept prices the same or lowered prices on more streets and lowered garage prices repeatedly over the two years of the pilot to attract motorists from the crowded curb into un-crowded, but nearby, garages *(2)*.

Yet, the perception of parking shortages plays an important role in discussions about planning and development in many cities. Business owners worry about losing customers because of parking shortages, visitors about the hardship of not finding parking near their destinations, and residents about increased traffic and parking on residential streets adjacent to mixed-use districts. Dynamics like the shift in housing demand from detached single-family developments on the suburban fringe toward denser developments closer in *(3)* have brought this issue to the forefront in many cities over the last 10 years. At the same time, there is a growing recognition of the downsides of providing too much parking, from the high cost of building structured parking and the opportunity costs of using prime land for surface parking lots to the environmental, social, and travel-behavior impacts of parking facilities.

This study looks at parking supply and demand in 27 mixed-use districts across the country. The 27 studies are culled from a longer list of studies completed in mixed-use town and city centers over the last 10 years. Some of those studies were initiated as updates to comprehensive plans, some as precursors to growth plans, and others were specifically due to a city's or town's desire to address a parking shortage. We summarize observed occupancy rates relative to a theoretical occupancy target that would leave 15 percent of spaces open, i.e. the amount generally believed to be necessary to ensure a smooth functioning parking system (*4*); and we look at occupancy rates in light of the main reasons cities initiated each study.

The evidence suggests that parking is routinely oversupplied in mixed-use districts, including those in which a parking study was initiated because of perceived deficiencies in supply. This finding holds regardless of the commute mode choices of local workers or the density of the surrounding area. It suggests that mixed-use districts may benefit more from robust parking management than from increasing supply and it adds to a growing body of literature that shows significant levels of oversupply in a variety of contexts, suggesting that municipalities of all kinds could require and build less parking without causing any perceptible change in parking availability or access mode choices.

BACKGROUND

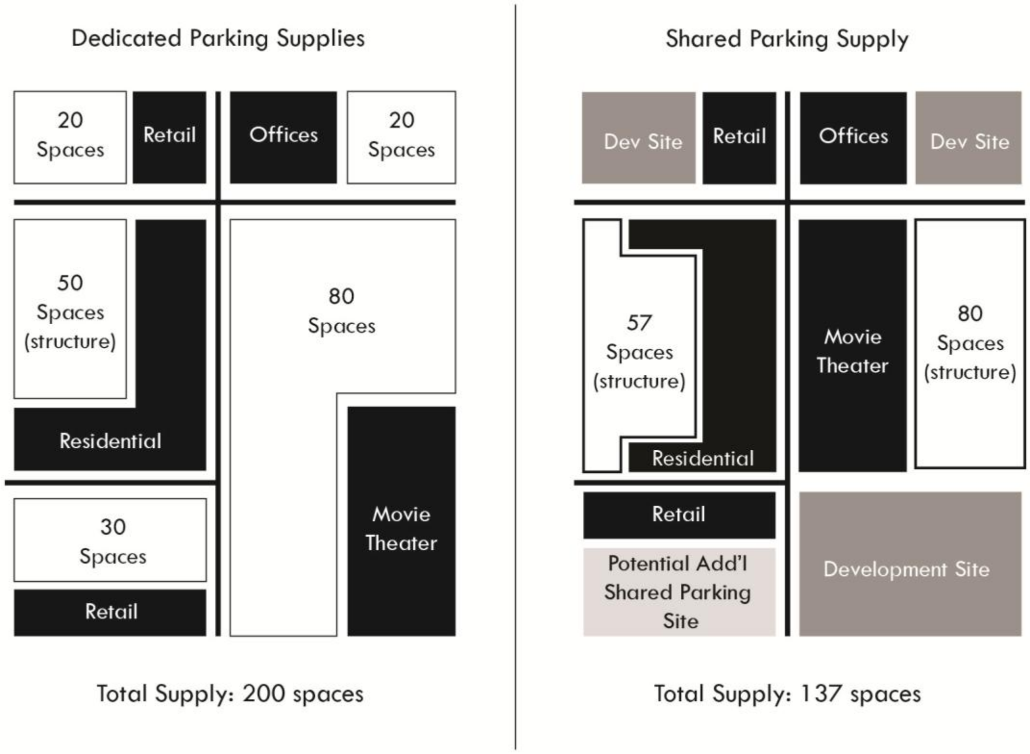
Because of public concerns about the parking and traffic impacts of new developments, parking requirements have been written into zoning ordinances for several decades. For nearly as long, planners and engineers have been trying to inform these requirements by estimating the amount of parking demand different land uses generate.

The Institute of Transportation Engineers' *Parking Generation* is perhaps the best known and most widely used example of these efforts. Now in its fourth edition, the guidebook summarizes the results of voluntarily submitted parking-occupancy studies for 106 land uses, reporting the average, 85^{th} percentile, and 33^{rd} percentile ratios of peak-period parking occupancy to built square footage or a similar measure of project size (i.e. the number of employees in an office building or seats in a restaurant) for each land use type *(5)*. Almost all parking studies included in the manual are from suburban sites with free parking and isolated single land uses, and though the manual's two most recent editions encourage studies from sites with a "variety of characteristics," the need to tie parking behavior to a particular land use has thus far limited the manual's scope. Coverage of parking generation in mixed-use environments is limited to a short appendix highlighting six examples. The same six examples appear in the manual's third and fourth editions. While the guidebook is careful to note that it is informational and does not provide authoritative findings, recommendations, or standards on parking demand, the estimates it provides are, nevertheless, frequently cited as a starting place for analyzing and understanding parking demand.

The Urban Land Institute and the International Council of Shopping Centers has attempted to correct for the lack of mixed-use sites in *Parking Generation* with their *Shared Parking* manual, now in its second edition *(6)*. The manual creates a framework for estimating parking demand in settings like shopping centers, in which parking is naturally shared. It adapts parking-generation rates from a variety of sources, including ITE, and shares its own set of recommended parking ratios for developments of different sizes and for specific land uses that might be included in a mixed-use project. Others, including the Eno Center for Transportation and the American Planning Association, have also created their own estimates of the number of parking spaces needed for different land uses *(7)(8)*. In our experience we generally see that given different time of day peaking characteristics of different land uses, sharing parking allows mixed-use districts to provide the same effective parking supply using approximately 2/3 the number of stalls that would be programmed without sharing spaces . This occurs absent any other parking or travel demand management policies.

Figure 1 illustrates why shared parking can have this effect. In the area with dedicated parking supplies, each building is required to have enough parking supply to meet the theoretical demand it generates. In the area with shared supplies, in which the buildings have the same gross floor area, uses that generate vehicle trips at different times can share parking. The residential building, which generates parking demand overnight, shares its parking supplies with the two retail uses, both of which generate demand during the day. Likewise, the movie theater, which generates demand during the evening, can share parking with the offices to the north. Putting the movie theater's parking in a structure frees a development site. If the new land use's demand profile is compatible with that of the theater, it could also share the theater's 80 spaces.

FIGURE 1 Dedicated vs. Shared Parking



Parking Generation and *Shared Parking* each recommend that local parking studies be conducted to supplement the national data included in the guidebooks. However, in a survey of planners from 138 southern California municipalities, Willson found that in determining local parking requirements, planners often neither conduct local studies nor take parking ratios directly out of the manuals; instead, they rely on requirements already codified by nearby cities *(9)*. Willson's study also found that planners are much more concerned with undersupplying than oversupplying parking, given the potential for public backlash and the financial ramifications of needing to provide additional public parking facilities if supplies prove insufficient. Shoup shows that this bias toward oversupplying parking often leads them to set parking requirements even higher than ITE parking rates would suggest *(4)*.

Shoup also notes that the ITE estimates themselves are highly inexact for many land uses, relying on just a few parking studies to yield poorly fitted parking-demand curves (*10*). The fact that most of the parking surveys included in *Parking Generation* involve sites that do not price parking and have poor access to transit, along with the book's focus on peak parking demand, leads to inflated baseline estimates, which are often the starting point for cities' requirements, but tend to be further inflated for the reasons just outlined.

A robust set of recent parking-occupancy studies, many focused on individual land uses, lend credence to the idea that parking is widely oversupplied in the United States. Fitzgerald and Halliday conducted parking occupancy studies at 42 sites with dedicated parking for a single building or a small cluster of stores and found occupancy averages for individual land uses ranging from 24.3 percent to 58.1 percent *(11)*. Looking at small shopping centers near light-rail lines in San Jose, Calif., Smith found occupancy rates ranging from 29 to 78 percent in a set of December observations and from 24 to 84 percent in February *(12)*. Gebhart found that parking occupancy at a recently built New York City shopping center with big-box tenants like Home Depot and Costco was just 39 percent full on a Saturday in December and 34 percent on a Tuesday afternoon in November *(13)*. Shoup cites a Parsons Transportation Group study that estimated parking demand on 17 Home Depot stores' fifth busiest day of the year, based on Saturday parking occupancy observations, and found parking supply to be 67 percent higher than demand *(7)*. The study also found ITE's estimates of parking demand to be 33 percent higher than those estimated by Parsons, and municipal parking requirements to be more than double the Parsons' estimates.

Other researchers have focused on residential parking demand and have likewise found significant levels of oversupply in a variety of contexts. Willson et al. found that parking use at multi-family developments in southern California's suburban Inland Empire was 1.66 spaces per unit, while supply was 1.88 and the code requirement was 1.97 *(14)*. Rowe et al. found a similar pattern at multi-family developments in the Seattle area. At several complexes in the urban First Hill and Capitol Hill neighborhoods, the researchers observed parking demand of .52 spaces per unit, versus a supply of .74, and in suburban Redmond, they observed ratios of 1.08 spaces per unit, versus a supply of 1.66 *(15)*. Wilbur Smith Associates found only two of 21 affordable housing developments in San Diego had more than 85 percent of spaces occupied overnight *(16)*. Cervero et al. looked at 31 multi-family residential developments near transit stations in Portland, Ore. and the Bay Area and found that while parking supply averaged 1.57 spaces per unit, demand averaged 1.15 *(17)*. In all cases but the Inland Empire study, observed demand came in slightly or significantly below ITE's estimate of 1.2 spaces per unit for low/mid-rise apartments *(5)*.

One might expect more significant mismatches between supply and demand in multi-use areas, which enable uses with different time-of-day peaking characteristics to share parking supplies and visitors to "park once" but visit several establishments. The literature on parking occupancy in such districts is much more limited, but it has generally borne this out. Wesley and Garrick . compared parking occupancy rates in three mixed-use areas to three single-use shopping centers, all in New England, and found that while the mixed-use areas had lower supply ratios and higher occupancy rates than the single-use centers, they were still less than 80 percent occupied at the peak of the busiest season of the year *(18)*. The authors also found that in the mixed-use areas, local regulations required 168 percent more spaces than were occupied on the busiest day of the year and 235 percent more than were occupied on the average day. In six Seattle-area mixed-use districts, Snyder found parking occupancy rates ranging from 40 to 67 percent, with little variance between December and February observations *(19)*.

This study aims to build on Wesley and Garrick and Snyder by analyzing a more robust set of mixed-use districts from across the country and comparing trends in the observed rates to the reason a given parking study was initiated. Given planners' worries about undersupplying parking documented by Willson (*9*), it in part aims to understand whether studies initiated because of a perceived undersupply did in fact yield results that confirmed planners' intuitions.

We recognize that some surplus is required for a smooth functioning parking system. A well-established rule of thumb dictates 85 percent occupancy as the level at which a curb functions well –i.e. there will be few episodes of parking shortage and the resource [curb space] will not be underutilized (*9*). Recent efforts to refine this heuristic show that 90 percent may be a more accurate breakdown threshold: A recent study modeling drivers' parking behavior by Levy et al. estimated that drivers' circling time notably increases when curbside occupancy reaches 92 or 93 percent *(20)*, and a study by Millard-Ball et al. found that the probability of finding a space goes quickly to zero when average hourly occupancy exceeds 90 percent *(21)*. San Francisco adopted an occupancy target of 80 percent and Seattle seeks to guarantee one open space per block, which roughly translates to the same. This paper uses 85 percent as a functional target, meaning that any over-supply noted is not simply in excess of demand but it is, in fact, in excess of the existing demand plus the function buffer. Hence it is in excess of 118 percent of parking demand.

METHODOLOGY

The investigation started with a pool of 42 studies of mixed-use centers across the country that Nelson\Nygaard has completed in the last 15 years. The group was then narrowed to 27 whose data included all public and private on- and off-street parking supplies in their study areas. Sixteen of the 27 projects' study areas also included spillover on-street parking in surrounding neighborhoods, and in those cases, we eliminated the spillover parking data to make these studies comparable with studies that only included a mixed-use district itself. The analysis used Google Earth satellite imagery to identify the area with contiguous commercial and office uses inside predominantly single-use residential surroundings. Roof types, tree canopy, and surface parking areas were the primary markers of this boundary – commercial areas tend to have larger, lighter-colored roofs, a thinner tree canopy, and a larger number of parking areas than seen in residential areas. The subset of on- and off-street parking facilities within this narrower area were then identified using GIS. It is important to note that this is not a random sample of cities, but rather is a group of cities all of which hired a particular firm to undertake some kind of transportation/parking study.

For each study area, the supply, peak weekday demand, and peak weekend demand (where available) were identified based on data collected by Nelson\Nygaard, subconsultants, or client cities. Most studies included a series of occupancy observations from a Tuesday, Wednesday, and/or Thursday, including late-morning, midday, mid-afternoon, and early-evening data collection times. To identify the peak period, occupancy was summed for all on- and off-street facilities in the study area; the weekday peak period is defined as the period with the highest occupancy total. The same process was used for weekend observations, universally completed on Saturdays, for studies for which weekend data was collected. Target supply was based on the observed peak demand as illustrated in equation (1). Oversupply was calculated as the difference between the actual supply and target supply, as a percentage of target supply. This is simplified as equation (2)

$$target\ supply = \frac{demand}{.85} \quad (1)$$

$$oversupply = \frac{actual\ supply}{target\ supply} - 1 \quad (2)$$

The rationale for each study was identified based on the project's initial request for proposals or the project's final report. For example, where requests for proposals were available, language like the following, from the Winchester, Mass. study, identified the project as one primarily initiated because of perceived parking scarcity in the district: "Merchants and downtown property owners regularly cite the availability, type, location, and enforcement of parking in the Town Center as a key constraint to improved business conditions and ease of use" *(22)*. Where an existing-conditions or final report was the best immediately available source, language like the following from the Newport Beach, Calif. Corona del Mar was used to identify a similar rationale: "Of particular concern has been high demand during peak periods, a perceived lack of parking supply, restrictive regulations that limit use of existing parking facilities, and spillover parking into residential neighborhoods" *(23)*.

Making room for growth or redevelopment was another common parking-study rationale, and language like that from the Landsale, Penn. RFP expressing a desire to "accommodate future growth and facilitate the redevelopment of the borough's downtown" *(24)* was used as evidence of this type of study trigger. Other studies were initiated as part of a routine planning process, as a result of a particular development or infrastructure project, or because of a general desire for more rigorous parking management.

In addition to the study rationale as a possible explanation of variability in oversupply, a series of other potential explanatory variables was identified. *Area type* was defined based on the definition the U.S. Department of Education uses to categorize school district area types because it allows for differentiation between central cities, suburbs, and towns that are less closely associated with a metropolitan area. The DOE typology defines a city as the principal jurisdiction inside a U.S. Census Bureau-defined Urbanized Area, a suburb as a "territory outside a principal city and inside an Urbanized Area," and a town as a "territory inside an Urban Cluster," as defined by the Census Bureau *(25)*.

Region was defined based on the predominant locations of the studies, most of which took place in New England and the West. New England was defined as the area north and east of New York State, the West was defined as states touching the Pacific Ocean, East was defined as states bordering the Atlantic from New York to Virginia, and Midwest was defined as the area from Minnesota to Ohio and south to Iowa and Illinois.

Existing conditions reports were used to identify whether any of a given study area's parking supply was metered at the time of the study. In many cases in which some supply was metered, parking charges applied to only a small portion of the supply, and meter rates were quite low (less than $1.00 per hour).

Population, employment, and *commute-mode* (for workers in the study area) data were identified based on the Census Transportation Planning Package-defined Travel Analysis Zone geography. While the TAZ borders never exactly matched study-area boundaries, they were, in most cases, a close approximation. All CTPP data was from the 2006-2010 American Community Survey. While the ACS data-collection period differs from the data-collection periods of many of the parking studies included in this analysis, all of the studies were completed within five years of the ACS data-collection range. This was deemed acceptable given that it is unlikely to see large swings in population, employment, or commute patterns in such a short timeframe, particularly in established mixed-use districts like many of those included in this analysis.

Finally, *Walkscores* for an address in the middle of each study area were used as a measure of density and of the commercial diversity that facilitates successful "park once" neighborhoods. Walkscores were retrieved in January 2014.

Several statistical tools were employed including linear regression, analysis of variance (ANOVA), and difference of means tests to discern relationships between parking over-supply, travel behavior, and characteristics of the built environment. Generally speaking, there are few statistical relationships to report, which is partly a function of the small data set but is also a function of the variability across samples and, we speculate, because the extent of the over-supply is so great so as to be non-binding on travel behavior and because the perception of parking problems potentially elevates the issue beyond where reality might dictate. This will be discussed more fully in the results and conclusions.

DATA DESCRIPTION

Table 1 reports parking demand, target supply (i.e. demand/0.85), actual supply and percent oversupply for each of the 27 projects included in this study, divided by the reason for undertaking each project. The studies are grouped in sub-table a, b, or c according to the study purpose. Projects are then ranked by oversupply, from greatest to least. In addition, the tables list the dimensions along which we expected to explain some differences in oversupply.

Specifically, they include the area type (city or suburb), the region (New England, East, Midwest, and West), percent of commuters who drive, walk score and if at least some parking is priced.

The sample includes nine studies for which perceived scarcity was the reason for the project's initiation (Table 1a), nine for which making room for growth or redevelopment was the reason (Table 1b), and nine for which project-initiation rationale was something else (Table 1c). The size of the study areas varies, with inventories ranging from approximately 420 spaces (Newport Beach, Calif./Balboa Village) to 6,600 spaces (Monterey, Calif.). Percent oversupply ranges from 6 percent (Hood River, Ore.) to 253 percent (Soledad, Calif.), with a median of 49 percent (Concord, Mass./Concord Center), a mean of 65 percent, and a standard deviation of 55 percent.

The sample includes districts from four towns, six cities, and 17 suburbs. The DOE criteria allow for differentiation between types of places within each category, by size for suburbs and cities and by distance from an urbanized area for towns, but given that most of the cities and suburbs included in this study would be categorized as small, the analysis only uses area type. Almost all of the studies for which "perceived scarcity" was the project trigger were located in the suburbs, while there was more variety in place type among the other project-rationale categories.

Eleven of the study areas were located in the West, 13 in New England, two in the Midwest, and one in the East. Table 2 shows how project rationales distribute among the regions. A plurality of projects in Western cities were triggered by a desire to make room for growth, while perceived scarcity was the impetus for a plurality of those in New England cities.

Drive-alone commute mode share to the TAZs most closely resembling each study area ranged from 60 percent (Newport Beach, Calif/Corona del Mar) to 89 percent (Lancaster, Calif.), with a mean of 77 percent and a standard deviation of 10 percent. Walkscores ranged from 52 (Columbus, In.) to 97 (Salem, Mass. and Oxnard, Calif.). Fifteen of the studies included in the analysis charge for a portion of their parking and 12 do not.

TABLE 1a Projects Initiated because of Perceived Scarcity – Parking Supply Data and Potential Explanatory Variables

Study City and Study Area	Area	Percent Over-supply	Parking Supply in Study Area	Parking Need for 85% Utilization	Area Type	Region	Auto Commute Share	Walk-score	Charge for Some Parking Supply
Concord, Mass.	West Concord	**82%**	1,688	927	Suburb	New England	84%	68	Yes
Wareham, Mass.	Onset Village	**74%**	441	254	Suburb	New England	75%	71	Yes
Tiburon, Calif.	Downtown	**70%**	3,216	1,894	Suburb	West	81%	65	Yes
Concord, Mass.	Concord Center	**49%**	1,498	1,007	Suburb	New England	75%	85	Yes
Columbus, Ind.	Downtown	**41%**	5,831	4,133	City	Midwest	88%	52	No
Winchester, Mass.	Downtown	**33%**	1,532	1,153	Suburb	New England	82%	85	No
Melrose, Mass.	Downtown	**28%**	1,275	993	Suburb	New England	76%	74	No
Newport Beach, Calif.	Corona del Mar	**24%**	3,024	2,429	Suburb	West	60%	83	No
Lexington, Mass.	Downtown	**6%**	1,393	1,312	Suburb	New England	79%	83	Yes

TABLE 1b Projects Initiated to Make Room for Growth – Parking Supply Data and Potential Explanatory Variables

Study City and Study Area	Area	Percent Over-supply	Parking Supply in Study Area	Parking Need for 85% Utilization	Area Type	Region	Auto Commute Share	Walk-score	Charge for Some Parking Supply
Orange, Mass.	Downtown	**178%**	776	279	Town	New England	80%	62	No
Lancaster, Calif.	Downtown	**126%**	4,076	1,802	City	West	89%	84	No
Yreka, Calif.	Downtown	**96%**	889	454	Town	West	81%	89	No
Lansdale, Pa.	Downtown	**82%**	1,828	1,006	Suburb	East	88%	82	Yes
Ventura, Calif.	West Side	**80%**	2,211	1,226	Suburb	West	83%	57	No
Oxnard, Calif.	Downtown	**57%**	2,833	1,807	City	West	70%	97	No
Reading, Mass.	Downtown	**40%**	1,532	1,096	Suburb	New England	84%	77	No
Portsmouth, N.H.	Downtown	**38%**	3,090	2,235	City	New England	76%	92	Yes
Hood River, Ore.	Downtown	**6%**	770	726	Town	West	76%	86	Yes

TABLE 1c Projects Initiated to for Other Reasons – Parking Supply Data and Potential Explanatory Variables

Study City and Study Area	Area	Percent Over-supply	Parking Supply in Study Area	Parking Need for 85% Utilization	Area Type	Region	Auto Commute Share	Walk-score	Charge for Some Parking Supply
Soledad, Calif.	Downtown	**253%**	1,135	321	Town	West	71%	65	No
Davenport, Ia.	Downtown	**133%**	4,446	1,909	City	Midwest	84%	94	Yes
Newport Beach, Calif.	Lido Village	**66%**	1,006	607	Suburb	West	68%	85	Yes
Monterey, Calif.	Downtown	**56%**	6,621	4,232	City	West	65%	92	Yes
Haverhill, Mass.	Downtown	**38%**	2,938	2,133	Suburb	New England	79%	75	No
Newport Beach, Calif.	Balboa Village	**38%**	420	304	Suburb	West	62%	71	Yes
Needham, Mass.	Downtown	**32%**	1,329	1,007	Suburb	New England	84%	71	Yes
Salem, Mass.	Downtown	**21%**	4,338	3,599	Suburb	New England	76%	97	Yes
Belmont, Mass.	Downtown	**17%**	836	713	Suburb	New England	78%	68	Yes

TABLE 2 Study Type by Area

	Perceived Scarcity	Making Room for Growth	Other Reasons
West	2	5	3
Midwest	1		1
East		1	
New England	6	3	4

RESULTS

Table 3 reports the results of difference of means tests for each of the explanatory variables. Despite apparently large raw differences between the means, no groupings yielded statistically significant differences at $\alpha = .05$, though the difference between oversupply in cities versus suburbs is statistically significant at $\alpha = .1$. Curiously, oversupply is greater in urban locations than in suburban ones. Though sample size plays a role, the lack of statistically significant differences is likely because of large variances within each sample. This finding lends support to the claims that parking supply is not necessarily determined in a rigorous scientific way or based on sound engineering principles. This will be discussed further in the "discussion" section of this paper.

TABLE 3 Difference of Means Test Results

Test	Groups	Oversupply % Means	Standard Deviation	T-Stat (2-tailed significance)
Project Rationale	Perceived Scarcity All Others	45.2% 75.4%	25.5% 63.2%	-1.366 (.184)
Pay Parking	Yes No	51.3% 82.9%	34.3% 71%	-1.522 (.141)
Place Type	City Suburb	75.3% 45.9%	42.8% 24.8%	2.059 (.052)
Region	West New England	79.4% 48.9%	66.4% 44.1%	1.344 (.193)
Walkscore	80 and Above Below 80	56.6% 74.8%	40.5% 67.7%	-.853 (.402)
Drive-Alone Rate	At or above median Below median (78%)	74% 56%	47.5% 62.6%	.848 (.404)

For project rationale, projects triggered because of perceived scarcity had oversupply ranging from 6 percent to 82 percent, while those triggered because of questions about how to make room for growth ranged from 6 percent to 178 percent oversupplied. In other words, the normal curves around the means for each project rationale overlap significantly. While the data used in this study is too limited to create smoothed curves, Figure 2 illustrates how smoothed curves might look. Figure 3, showing inter-quartile ranges for oversupply along all the potentially explanatory dimensions, shows the extent to which oversupply ranges overlap.

FIGURE 2 Theoretical Overlapping Distributions

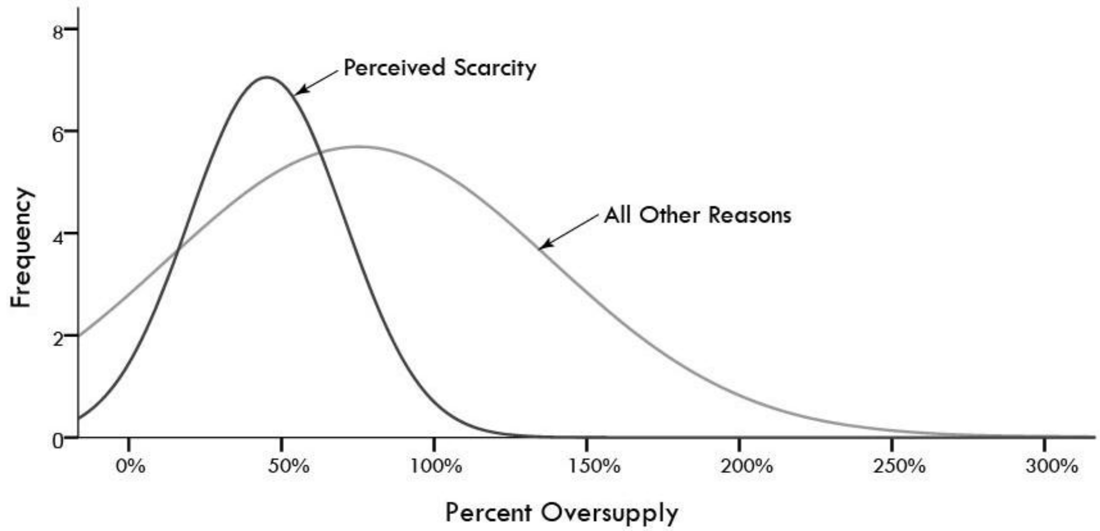
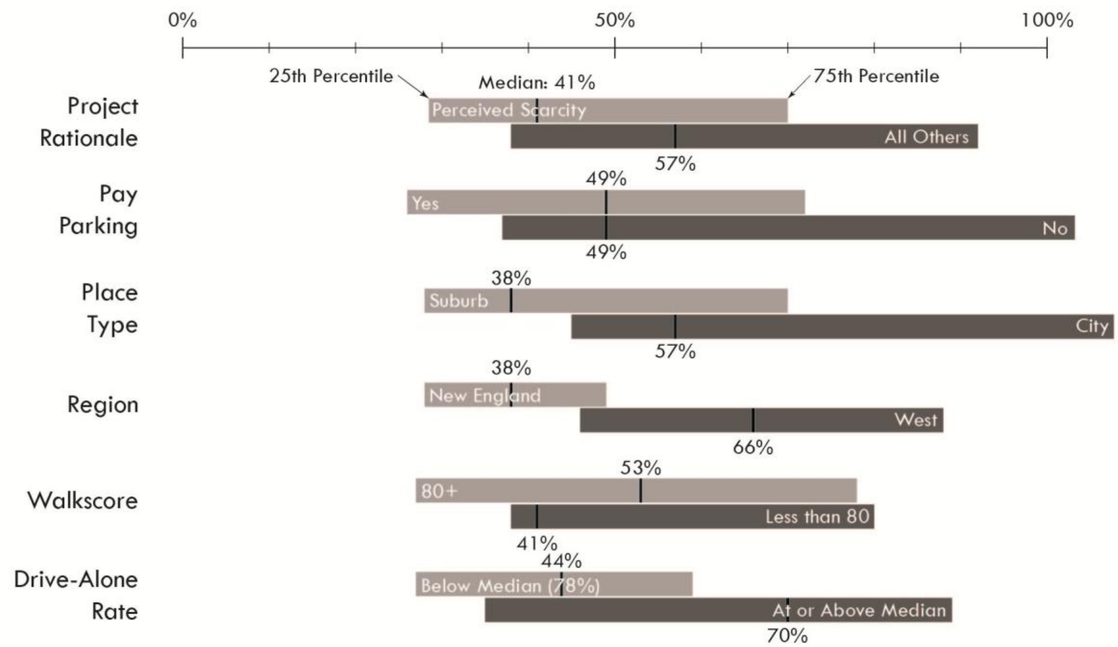


FIGURE 3 Overlapping Inter-quartile Ranges for Potential Explanatory Variables



For town centers with paid parking, oversupply ranges from 6 percent to 133 percent, while it ranges from 24 percent to 253 percent for those who do not charge. Percent oversupply in cities included in the study ranges from 38 percent to 133 percent, while it ranges from 6 percent to 82 percent in suburbs. Oversupply ranges from 6 percent to 178 percent in New England cities included in this analysis and from 6 percent to 253 percent for western cities. It ranges from 6 percent to 133 percent for areas with a Walkscore over 80, while it ranges from 17 percent to 253 percent for areas with Walkscore under that threshold. Finally, it ranges from 6 percent to 133 percent for areas with drive-alone commute mode shares above the median for areas included in the analysis and from 6 to 253 percent for those below the median.

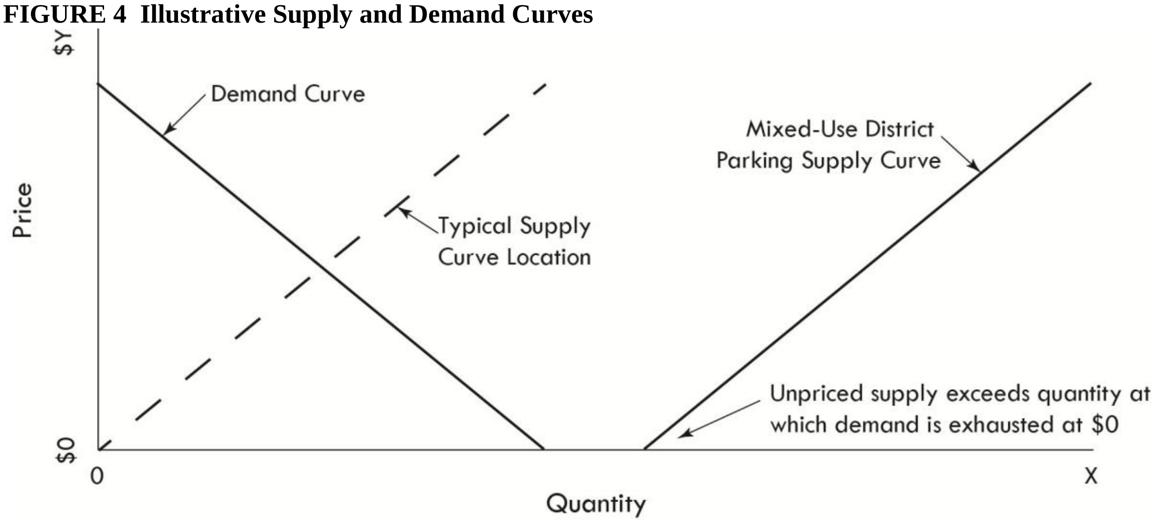
DISCUSSION

The variability in the sample shows that parking supply and demand may not depend on the exogenous factors that one might expect to be influential. Areas with both high and low rates of driving show extensive overlap in rates of oversupply and statistically indistinguishable averages. Districts in the West, where most commercial areas were originally designed with car use in mind, and in New England, where mixed-use districts often first developed around other modes, both show high rates of variability; again, average rates of oversupply along this dimension are indistinguishable. Even in comparing districts where some portion of the parking supply has a cost associated with it against areas where all parking is free, there is no measurable difference in levels of parking oversupply.

Though it would be appealing to have a "scientific" or "engineering" basis for determining appropriate parking supply, the evidence here suggests that levels of parking provision are unmoored from demand, travel behavior, pricing or other dimensions where theory suggests there would be a relationship. As suggested by Willson (*9*) and by Shoup (*4*) it seems highly plausible that decisions with respect to parking supply are made according to an implicit principle of risk aversion. Because under-supply is perceived to be a more costly error, over-supply becomes the default proposition. This may be an important artifact of the incentive structure that planners and policy-makers face. While there is a potentially significant cost to their professional reputations if they undersupply parking, the costs of oversupplying parking are distributed over a much larger and more diffuse population – either taxpayers or local businesses included in a special-assessment district and, ultimately, local consumers.

As a result, parking supplies tend to be so large that parking demand is satisfied well before parking capacities have been reached. In other words, demand for parking, even when it is free, is not infinite, and the areas included in this study have supplied parking such that the demand rates shown in the data are effectively maximum demand, in many cases not mediated by price. This can be illustrated with the supply and demand curves shown in Figure 4, in which the supply curve begins to the right of where the demand curve ends. Parking can be compared to pizza consumption. Though most people like pizza, there is a theoretical maximum amount of pizza people can consume even when pizza slices are free. Producing pizza beyond that theoretical maximum would simply mean wasting pizza.

FIGURE 4 Illustrative Supply and Demand Curves



The wide variation in parking oversupply rates and the resultant overlaps between groups are particularly telling for the project-initiation-rationale variable. While the average oversupply rate among areas with perceived scarcity was lower than it was in other places, there are a number of examples in the dataset of places with similar rates of oversupply but very different perceptions of whether scarcity was a problem. This may be explained by uneven demand for parking, particularly when cities do not manage supplies through metering or other approaches, which leads to full block faces and off-street lots on the blocks with the most popular businesses and significant vacancy just a short walk away. Regardless, in these cases, city officials have misidentified the problem, and the data included in this analysis shows that the default remedy – building more parking – will be expensive and, likely, unnecessary, further pulling the supply curve away from the point at which maximum demand is satisfied.

CONCLUSIONS

In this analysis, we were unable to find correlations between parking consumption and a variety of potential explanatory variables, including area type, region, commercial density and diversity, commute habits, or existing parking charges. In the parking studies used in this analysis, parking was universally oversupplied, in many cases quite significantly. The normal relationship between supply and demand seems to be irrelevant – parking is supplied at such levels that many places have over-accommodated maximum demand even when that demand is unmediated by price. Communities considering building additional parking in mixed-use districts might do well to adopt parking-management and information strategies that distribute demand before considering strategies to augment the supply.

There is a real cost to providing excessive parking. The construction of parking facilities has a large financial cost *(4)*, in addition to significant opportunity costs. Space is at a premium in many mixed-use districts, and every parking lot or garage represents a missed opportunity for additional shops, restaurants, and housing. As McCahill showed, this also comes at a large cost to city coffers, in the loss of tax ratables *(26)*.

While this analysis shows that parking supplies exceed maximum demand in many cases, we have not addressed the determinants of parking demand in mixed-use districts. Given policy-makers' documented concerns about undersupplying parking, estimating parking demand in mixed-use areas is an important subject for future research so policy makers have an alternative to the tools they have been using for decades: guidebooks with parking-demand estimates generated in contexts that are quite different from mixed-use districts or, just as unscientific, the requirements of the next town over.

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