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Pushed from the Curb

OPTIMIZING THE USE OF CURB SPACE BY RIDE-SOURCING VEHICLES

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16. Abstract

Ride-sourcing has experienced tremendous growth in the past five years. Despite growing interest among policymakers in creating short-term loading space for ride-sourcing and other shared-mobility vehicles, researchers have largely ignored the implications of ride-sourcing on curb management policies, which traditionally favor long-term vehicle occupancy. Observing two corridors with characteristics conducive to ride-sourcing, I found that on the busier corridor, passenger loading space served four times as many passengers per hour as the equivalent space used for parking. On corridors with high ride-sourcing activity, cities can increase the productivity of curb space and discourage double-parking by converting curb parking to passenger loading spaces and charging market prices for curb use. On commercial corridors that currently lack heavy ride-sourcing usage, planners and policymakers can prioritize transit and ride-sourcing as a means to improve the curb's transport capacity and reduce the externalities of driving.

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Abstract

Ride-sourcing has experienced tremendous growth in the past five years. Despite growing interest among policymakers in creating short-term loading space for ride-sourcing and other shared-mobility vehicles, researchers have largely ignored the implications of ride-sourcing on curb management policies, which traditionally favor long-term vehicle occupancy. Observing two corridors with characteristics conducive to ride-sourcing, I found that on the busier corridor, passenger loading space served four times as many passengers per hour as the equivalent space used for parking. On corridors with high ride-sourcing activity, cities can increase the productivity of curb space and discourage double-parking by converting curb parking to passenger loading spaces and charging market prices for curb use. On commercial corridors that currently lack heavy ride-sourcing usage, planners and policymakers can prioritize transit and ride-sourcing as a means to improve the curb's transport capacity and reduce the externalities of driving.

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Introduction

In the last five years, smartphone-based "ride-sourcing" platforms such as Lyft and Uber have revolutionized on-demand transportation in American cities (Taylor 2016). Using data-driven mobile software and GPS technology to swiftly adjust the supply of drivers to meet changes in demand (through surge pricing) and to electronically dispatch drivers to riders based on geographic proximity, such platforms have not only gained a competitive edge over traditional taxi services in most American cities but likely substitute--in major markets--for a significant share of private automobile trips (National Academies of Sciences 2016, Murphy 2016, Henao 2017, Zhen 2015). Henao (2017) suggests that, in replacing private automobile trips, ride-sourcing vehicles have probably reduced the need for parking at certain destinations.[1] However, both academics and policymakers have ignored ride-sourcing vehicles' curbside pickup and drop off needs. Lu (2016) indicates that long-term parking at the curb by private vehicles impedes ride-sourcing vehicles from picking and dropping off passengers and encourages extensive double-parking activity by ride-sourcing vehicles at periods of peak demand.

Accordingly, my thesis examined use of the curb by ride-sourcing and other motorized vehicles along stretches of Santa Monica Blvd in the city of West Hollywood, CA and Melrose Avenue in the Fairfax neighborhood of the city of Los Angeles. These two arterial corridors possess characteristics conducive to ride-sourcing but have differing allocations of curb space, with the majority of curb space on Santa Monica Blvd designated for curb parking, and curb space on Melrose Avenue more evenly divided between curb parking and short-term loading. Through manual collection of data on every vehicle that stopped at or near the curb on each corridor, I sought to assess how ride-sourcing vehicles utilize curb space compared to other vehicles, and whether providing loading space can reduce the frequency of double-parking incidents and increase the productivity of curb space.

Significance

The rapid ascendance of on-demand ride-sourcing platforms has had a substantial impact on urban transportation in American cities in the past five years. As of 2015, 12 of the country's 15 largest ride-sourcing markets had at least twice as many UberX drivers (alone) as taxi drivers (Lu 2016, see **Table 1**). With passenger fares often significantly lower than those for traditional taxi services, these platforms have not only spurred drastic reductions in taxi patronage in many cities (Nelson 2016) but have likely replaced private vehicle trips-- according to studies conducted both nationally (Murphy 2016) and in cities ranging from Pittsburgh to San Francisco (Zhen 2015, Hampshire, et. al. 2015, Rayle, et. al. 2014). [2] Traditionally, curb space allocation in American cities has favored long-term occupancy by private vehicles, with cities tending to price vehicle curb parking below its market value and to designate comparatively little curb space for

[1] Also referred to as "private vehicles" in this paper. Category comprises non-hire trips made by owner-occupied passenger vehicles.
[2] http://www.businessinsider.com/uber-vs-taxi-pricing-by-city-2014-10

short-term loading, as conducted by ride-sourcing vehicles (e.g. Nourinejad 2014, Shoup 2006). To the extent that current curb allocation policies encourage long-term occupancy, they may induce ride-sourcing vehicles to pick up or drop off passengers in general traffic or in spaces designated for non-automobile purposes (e.g. bicycle lanes), impeding traffic flow and increasing the likelihood of collisions (Lu 2016).

The growth of both ride-sourcing and online commerce has recently led urban planners and policymakers to re-evaluate the parking-centric forms of curb management. A January 2018 brief by the Eno Institute proposed the establishment of "Shared-Use Mobility Zones (Rodgers 2018) on commercial corridors at periods of high ride-sourcing activity, to accommodate ride-sourcing pickups and drop offs. Interestingly, Rodgers (2018) noted the double-parking phenomenon described in Lu (2016) as a justification for such zones. Last October, Washington D.C. converted 60 parking spaces along a bustling nightlife corridor into temporary short-term loading spaces, on weekend evenings, primarily intended for Lyft and Uber vehicles (Schneider 2017). Fort Lauderdale (Las Olas Boulevard Association, 2018) and San Francisco have since implemented and proposed similar loading zone programs (McFarland 2017).

Despite the increased attention to ride-sourcing vehicles in curb management at a policy level, however, the author is not aware of any academic or policy studies which examine *how* ride-sourcing vehicles use curb space differently from other road users, and whether short-term loading zones effectively reduce illegal parking activity by ride-sourcing vehicles. By observing actual differences in vehicle stopping behavior by vehicle type and curb zone along corridors with different allocations of curb space, I hope to glean data that can assist planners, policymakers, and ride-sourcing companies in devising strategies to accommodate ride-sourcing vehicles at the curb. In the academic realm, my study contributes to the growing body of literature on land use and curb parking policy as well as to literature that examines loading space as a strategy for managing goods movement.

Table 1 Comparison of the number of Taxi and UberX Drivers in 15 major markets

City	Taxi vehicles (Staley and Douglas 2014)	UberX Drivers (Hall and Krueger 2015)
Los Angeles	**2,361**	**21,000**
San Francisco	**1,604**	**17,000**
New York	**13,420**	**16,500**
Chicago	**6,955**	**13,000**
Washington	**6,205**	**12,500**
Boston	**1,825**	**10,000**
Miami	**2,123**	**7,000**
Dallas	**2,022**	**4,500**
San Diego	**1,222**	**4,000**
Houston	**2,238**	**3,000**
Austin	**756**	**2,900**
Denver	**1,262**	**2,500**
Seattle	**336**	**2,500**
Baltimore	**1,074**	**2,000**
Minneapolis	**937**	**1,500**
Total	***44,340***	***119,900***

Background

Ride-sourcing

Ride-sourcing services such as Lyft and Uber operate through digital platforms that customers download to their smartphones.[3] Passengers request a ride by tapping a button on the mobile application, which uses a digital algorithm to match them with a for-hire driver based on the driver's distance from the passenger and availability. The applications are connected to navigational software which then directs drivers to the location of the request. Once the driver arrives at the pickup location for which the passenger entered his or her request and has "confirmed" his or her arrival (by pressing an arrive button), the passenger has a limited amount of time, depending on the service requested (as discussed below) to approach and enter the vehicle before the driver departs.

When the platforms detect that the number of requests in a certain area exceeds the number of available drivers, they institute "surge pricing" (or an increase in price), both to incentivize more drivers to drive in the area and to discourage requests from those who lack a high willingness to pay (National Academies of Sciences 2016). In this way, the platforms ensure that there are usually a sufficient number of drivers available within a short distance to service rider demand. According to Rayle (2014), the services' quick response times (compared to taxis) have been a factor in passenger satisfaction.

On-demand point-to-point transportation has been provided by taxi and limousine services for more than a century. However, the first digital ride-sourcing company, UberCab, launched as a mobile application for hailing luxury black cars in San Francisco in June 2010(McAlone & Hartmans 2016). Lyft and Sidecar, which both permitted (from the start) non-commercially-licensed drivers to drive passengers in their personal vehicles, debuted in San Francisco in May and August 2012 (Flores Dewey & Rayle 2016). In July 2012, Uber introduced its UberX service (also using non-commercially-licensed drivers and non-luxury vehicles) to compete with Lyft and Sidecar (Flores Dewey & Rayle 2016). Ride-sourcing arrived in Los Angeles at an early stage. Uber launched in the city in March 2012, before the existence of UberX, and Lyft began operations in January 2013 (Kalanick, 2012, Yeung, 2013).

In August 2012, shortly after the services launched, the California Public Utilities Commission (CPUC) – the agency responsible for regulating limousine services in the state – issued cease-and-desist letters to Lyft and Sidecar (a now-defunct ride-sourcing company) for operating without standard commercial insurance (Flores Dewey & Rayle 2016). The CPUC issued a similar letter to Uber in November of that year. However, during the following seven months, the

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[3] Several different terms have been used to describe these services, with "ride-sharing" commonly employed in popular media and the term "Transportation Network Company" used in legislation. Academic studies starting with Rayle (2014) have tended to adopt the term "ride-sourcing," to differentiate commercial platforms that "source" for-hire driving to non-commercially-licensed drivers from genuine non-profit "ride-sharing" (in which passengers share trips to reduce environmental impacts).

CPUC reversed course after holding public workshops, ultimately creating the new category of Transportation Network Company to accommodate these services in September 2013 (Flores Dewey & Rayle 2016). The CPUC would give licenses to ride-sourcing companies to operate on the condition that new companies conduct criminal background checks, establish driver education programs and carry pre-determined levels of insurance coverage ($1 million for incident insurance, $5,000 for medical payment, $50,000 in comprehensive and collision coverage, and $1 million uninsured/underinsured motorist coverage).

Since legalization, ride-sourcing companies have grown rapidly in Los Angeles. As of August 2015, Los Angeles had emerged as one of the largest ride-sourcing markets in the country--boasting more than 21,000 UberX drivers alone, almost 11 times the number of taxi drivers (Krueger and Hall 2015). A statewide survey administered the same year found that, within the boundaries of Los Angeles's regional Metropolitan Planning Organization, 44 percent of households in urban neighborhoods had used ride-sourcing (Circella, et. al. 2018).[4]

As in the rest of America, the ride-sourcing market in Los Angeles is dominated by Uber and Lyft.[5] Both companies offer standard private vehicle services (UberX/Lyft), that provide direct point-to-point transport for a customer (like a taxi), and shared-ride services (UberPool and Lyft Line), that "match" two or more different customers with a driver headed in the same direction. Since the driver has to pick up multiple passengers, UberPool and Lyft Line services limit the time a driver can wait for a passenger to 1 minute.[6] UberX and Lyft drivers can wait for passengers for no more than 4 minutes.[7] These restrictions mean that ride-sourcing vehicles use the curb for a brief amount of time when picking up and dropping off passengers.

Curbside Loading problem

In my experience as a former Lyft driver, streets with a high volume of ride-sourcing pickups and drop offs frequently have a greater number of ride-sourcing vehicles wanting to stop than available curb space. A study I conducted on a Saturday evening in West Hollywood in the fall of 2016 (Lu 2016) found that, over the course of one hour, 39 pick-ups and drop-offs by ride-sourcing vehicles occurred in traffic lanes, while a handful of parked private vehicles occupied the adjacent curb space (as illustrated by the photo in **Figure 1**). Farther afield, a three-month study of traffic violations by the San Francisco Police Department showed that ride-sourcing

[4] The Southern California Association of Governments (SCAG), Los Angeles' federally-designated Metropolitan Planning Organization (MPO) comprises Imperial, Los Angeles, Orange, Riverside, San Bernardino and Ventura Counties.
[5] Sidecar also operated in Los Angeles before it declared bankruptcy in 2016. See: https://www.theverge.com/2015/12/29/10685050/sidecar-rideshare-delivery-uber-cease-operations
[6] Determined from Application usage.
[7] Determined from Application usage.

drivers accounted for 77 percent of the department's citations for "obstructing the traffic or bicycle lane," with this being the second most common grounds for a citation of ride-sourcing drivers, after "driving in a transit lane" (Brinklow 2017). A Reddit post on double parking Uber and Lyft drivers received more than 200 comments, with one of the top comments stating that "This is a really great post. About an important problem". [8]

Figure 1 Ride-sourcing Pick up in West Hollywood. (Source: Ryland Lu)

In Los Angeles, anecdotal evidence of unsafe pickups by ride-sourcing vehicles on the UCLA campus prompted the university's transportation department to limit pickups by ride-sourcing vehicles to designated "pick up" locations at the beginning of the 2017-2018 school year (D. Karwaski, Personal Communication, October 31, 2017). Outside of UCLA, several venues with a high volume of ride-sourcing activity in the Los Angeles area have established similar pickup operations. [9] At UCLA and other venues, platforms restrict pick-up activity to designated locations by "geofencing" the sites, establishing a virtual barrier within which the platforms direct requesting passengers to walk to these locations.[10] The most sophisticated of these pick up management schemes is at the Los Angeles International Airport, where ride-sourcing drivers can only take pick up requests from a geofenced staging area to the northwest of the airport.[11]

Curbside Loading Policies

In the city of Los Angeles, allocation of curb space is regulated by the Los Angeles Department of Transportation's Manual of Policies and Procedures. Section 343 of the Manual provides guidelines for establishing commercial and passenger loading zones. In the latter zones, any vehicle can stop to pick up or drop off passengers for up to five minutes. In the former zones, vehicles with commercial licenses can stop for up to 30 minutes to load and unload goods, while other vehicles can stop for only five minutes (MPP section no. 343).

[8] https://www.reddit.com/r/sanfrancisco/comments/4adv86/double_parking_uber_and_lyft_drivers
[9] For instance see: https://www.uber.com/drive/los-angeles/where-to-drive/
[10] For further information, read: https://www.cio.com/article/2383123/mobile/geofencing-explained.html
[11] See: https://www.uber.com/drive/los-angeles/airports/los-angeles-international-airport/

The Manual's criteria for commercial loading zones include use by at least five commercial vehicles a day and a lack of alternative loading facilities for commercial vehicles. The criteria for passenger loading zones limit their siting to locations in proximity either to meeting halls with a capacity for at least 90 persons; restaurants with a capacity for at least 90 persons whose only entrance is from the street and which have less than 20 off-street parking spaces; and other land uses that service at least 150 persons a day and lack an adjacent off-street parking facility. Since the city of Los Angeles requires the construction of off-street parking spaces for all new land uses, these criteria can prove difficult to meet. With a requirement of ten parking spaces per 1000 square feet for restaurants, a restaurant with a seating capacity for 90 or more persons will have to provide a minimum of 18 parking spaces for by-right zoning approval (as shown in **Table 2**), assuming it allocates typical dimensions for seating, storage and kitchen space.[12]

Table 2. Number of Parking Spaces required by the City of Los Angeles for a 90-seat restaurant[13]

(1) Seating Capacity	(2) Feet^2 per seat	(3) Feet^2 for storage, deliveries and kitchen	(4) Feet^2 Total ((1)*(2))+(3)	(5) Parking requirement (spaces per 1000 ft^2)	(6) Total spaces required ((4)/1000)*(5)
90	11.5	689	1724	10	17.24

On the other hand, the city of West Hollywood has off-street loading space requirements for commercial and industrial uses. Except for hotels, however, the city only requires loading space for commercial uses greater than 10,000 square feet. The city requires one loading space for parcels between 10,000 and 20,000 square feet and requires one loading space per 20,000 square feet for parcels larger than 20,000 square feet.[14] By contrast, the city requires three-and-a-half off-street parking spaces per 1,000 square feet (or 70 spaces per 20,000 square feet) for general retail stores and 15 parking spaces per 1,000 square feet for nightclubs and bars.[15] The lopsided nature of these requirements (shown in **Table 3**) illustrates how the city's priorities focus on parking rather than short-term loading. The loading space requirements pertain specifically to

[12] Los Angeles Planning and Zoning Code, Pub. L. No. 77,000, § 21, City of Los Angeles Municipal Code (2018). Retrieved from http://library.amlegal.com/nxt/gateway.dll/California/lapz/municipalcodechapteriplanningandzoningco?f=templates$fn=default.htm$3.0$vid=amlegal:lapz_ca

[13] Typical restaurants require 9 to 14 feet per chair—an average of 11.5 feet--, 525 square feet in kitchen space, 100-150 square feet in dry food storage space and 64 feet for receiving deliveries, in addition to space for management offices and employee lockers. I use the more conservative estimate for storage space in my calculation. (see https://bizfluent.com/info-12010139-much-room-need-restaurant.html)

[14] 19.28.160 Off-Street Loading Space Requirements., West Hollywood Municipal Code § Title 19 Zoning Ordinance (2000). Retrieved from http://qcode.us/codes/westhollywood/view.php?topic=19-19_3-19_28-19_28_160&frames=off

[15] 19.28.040 Number of Parking Spaces Required., West Hollywood Municipal Ordinance § Title 19 Zoning Ordinance. Retrieved from http://qcode.us/codes/westhollywood/view.php?topic=19-19_3-19_28-19_28_040&frames=off

off-street loading spaces. They recommend that spaces be "limited to the rear two-thirds of a parcel and "screened from adjacent streets and residential uses as much as possible."[16] The city currently has no formal application process or routine consideration for on-street passenger loading zones (D. Chan, Personal Communication, 5/1/2018).

Table 3. Off-street Parking and Off-street Loading Space Requirements for Commercial Uses in West Hollywood

Spaces per 20,000 square feet		
	General Retail	Nightclub/Bar
Off-street Loading[17]	2	2
Off-street Parking	70	300

Over the past six years, ride-sourcing platforms providing on-demand, for-hire travel using non-commercially-licensed vehicles have developed a large presence in the Los Angeles area. In Los Angeles, as in area other cities, these services have been observed to engage in frequent illegal parking activity, that could presumably result from a lack of curb space. Although large venues such as the airport have established geofenced pick-up locations, cities like Los Angeles and West Hollywood retain stringent criteria for establishing curbside or off-street loading zones, while requiring generous provision of long-term off-street parking. This incongruity speaks to a general trend, noted in academic literature, of cities prioritizing long-term curb parking in their management of curb space.

Literature Review

Scholarship on curb parking and commercial loading indicates that curb regulations in American cities favor long-term vehicle parking over short-term loading, resulting in a scarcity of short-term loading space (particularly for trucks) and underpriced curb parking. At the same time, recent academic literature on ride-sourcing shows that ride-sourcing, like other forms of shared mobility, replaces a certain quantity of vehicle trips and reduces the demand for parking at destinations.

[16] 19.28.160 Off-Street Loading Space Requirements., West Hollywood Municipal Code § Title 19 Zoning Ordinance (2000).

[17] The City of West Hollywood Zoning ordinance (Section 19.28.160) provides minimum dimensions for loading spaces similar to those for the typical off-street parking place., stipulating a minimum width of 10 feet and a minimum length of 20 feet. The city additionally requires spaces to provide at least 14 feet of vertical clearance, presumably to accommodate large commercial vehicles.

Ride-sourcing and Travel Behavior

Many of the existing studies on ride-sourcing indicate that it can reduce demand for driving, and by extension, parking, in certain circumstances. A 2016 survey conducted for the American Public Transportation Association by the Shared Use Mobility Center (Murphy 2016) in seven major American cities (including Los Angeles) found that ride-sourcing trips substitute most frequently for trips by carsharing (24%), followed by driving alone (20%). Zhen (2015) found that a plurality of ride-sourcing users he surveyed in Pittsburgh would have made their trip by automobile if the service had not been available. Hampshire et. al. (2017) observed that nine percent of ride-sourcing users bought a new vehicle after Uber and Lyft temporarily pulled out of Austin.

By contrast, Rayle et. al.'s (2014) and Gehrke, Felix, and Reardon's (2018) surveys of ride-sourcing trips in downtown San Francisco and in the Boston metropolitan area showed that the largest share of trips substitute for taxi and transit usage (39 percent and 33 percent of trips in the former survey and 31 percent and 39 percent of trips in the latter survey substituted taxi and transit modes). However, the urbanized cores of both San Francisco and Boston have a compact, walkable, transit-oriented urban form distinct from that of most American cities (Ewing, Schmid, Killingsworth, Zlot, & Raudenbush 2008). Circella, et. al.'s (2018) survey of ride-sourcing users and non-users across California revealed that ride-sourcing replaced driving (37 percent of trips) less frequently than taxi use (51 percent of trips) but more frequently than transit use (33 percent of trips) among respondents who frequently use the service. More than 70 percent of frequent-user respondents stated that ride-sourcing enabled them to drive less (Circella, et. al. 2018).

Henao's (2017) study of ride-sourcing in Denver finds that, on average, Vehicle Miles Traveled (VMT) per Passenger Mile Traveled doubled following the introduction of ride-sourcing, because a significant number of passengers used ride-sourcing to replace more spatially-efficient public transit.[18] Likewise, Schaller (2017) shows that vehicle miles traveled without a passenger by taxis and ride-sourcing vehicles in Manhattan's Central Business District rose drastically between 2013 and 2017 (the period that corresponds to the growth of ride-sourcing and decline in taxi service in the city). Schaller attributes this increase to ride-sourcing drivers' frequent "deadheading", making return trips to the Central Business District after dropping off passengers in outlying neighborhoods. Such a phenomenon could be attributed to New York's uniquely monocentric urban form. Cramer and Kruger's (2016) study of taxi and ride-sourcing trips in Boston, Los Angeles, New York City, San Francisco and Seattle found that, on average ride-sourcing trips had a 50 percent higher share of miles driven with a passenger than taxis.

Regardless of whether ride-sourcing vehicles induce vehicle traffic in the aggregate, their substitution for private vehicle trips is more relevant for assessing their effect on use of curb

[18] Responses to Henao's survey indicated that a plurality of ride-sourcing trips substituted for Public Transportation (22%), followed by Drive alone (19%) and Wouldn't have Traveled (12%).

space. Ride-sourcing, transit and taxi trips presumably use curb space in a relatively analogous fashion (i.e. brief loading and unloading of passengers), that differs from the curb usage of single-occupant vehicles (for long-term parking). [19] Furthermore, to the extent which ride-sourcing substitutes for public transit, it may compensate for gaps in transit service which (in the absence of ride-sourcing) would induce vehicle ownership. In Los Angeles County, Brown (2018) shows a positive correlation between census tracts with high per capita ride-sourcing and a high percentage of zero-vehicle households, for whom ride-sourcing use may facilitate a car-free lifestyle. Difficulty locating parking at a destination is commonly cited in the survey studies as a rationale for ride-sourcing use (Circella, et. al. 2018, Clewlow and Mishra 2017, Henao 2017), suggesting that ride-sourcing directly mitigates parking demand.

Shared Mobility and Vehicle Use

Carsharing services (which allow members to rent vehicles on an as-needed basis rather than purchase them) have also been shown to reduce vehicle ownership and parking demand.[20] A national survey of members of carsharing services (Martin and Shaheen 2011) estimated that each carsharing vehicle replaces or averts the purchase of 9 to 13 non-carshare vehicles. Lane's (2005) study of Philadelphia's City CarShare program concluded that each carshare vehicle replaced 23 private vehicles. Zhang and Guhathakurta (2017) suggest that, in the near future, shared-use autonomous vehicles could reduce the demand for parking in Atlanta by 4.5 percent with only a five percent market penetration. Ma, Kockelman and Segal (2015) discuss the effects of autonomous vehicles on parking demand in Austin, Texas in more detail. Going off the assumption that Shared Autonomous Vehicles would relieve the need for 6,246 parking spaces in the city, the authors portray a scenario in which the city replaces on-street parking with bus lanes, bike share locations and shared parking (allowing for the quick removal and alighting of passengers from cars).

Curb Parking Pricing

A growing body of literature addresses the inefficient allocation of curb parking in American cities. Shoup (2006) notes that many cities price curb parking significantly below its market value. This leads to a situation of full occupancy, as drivers intending to park for a long period of time find it rational to "cruise" circuitously to the point where they find a remaining available space (Shoup 2006). Shoup (1995) recommends that cities address spillover parking impacts (from a proposed termination of employer-subsidized parking at workplaces) by pricing curb parking such as to ensure a vacancy rate of one out of seven spaces. Shoup's proposal that cities

[19] The term "trips" should be distinguished from services. Since transit vehicles often have specialized facilities for waiting and servicing between trips and taxi and ride-sourcing vehicles do not, the latter are more likely to park at the curb for pro-longed durations between trips.

[20] Carsharing | TSRC - Transportation Sustainability Research Center. (n.d.). Retrieved May 20, 2018, from http://tsrc.berkeley.edu/carsharing

price curb parking at a variable rate throughout the day (based on parking demand) to ensure such a fixed vacancy rate have inspired experimental demand-priced parking systems in the central business districts of Los Angeles and San Francisco.[21] Pierce and Shoup (2013) find that latter program (SFPark) increased vacancy rates, in the area of implementation, on most blocks with over 90 percent occupancy.

Commercial Loading Problems

A significant body of literature addresses how curb allocation policies impede commercial loading activity. Morris, et. al. (1999) and Amer et. al. (2017) indicate that, in cities such as New York and Toronto, insufficient curb space is available for short-term loading and unloading by trucks, leading trucks to double park in traffic. Private vehicle parking, Amer et. al. (2017) notes, cannot accommodate trucks because they take up more space than the standard dimensions allocate and (like ride-sourcing vehicles) park for a shorter period of time than private automobiles. According to Nourinejad et. al. (2014), more than $2.5 million of fines were collected from trucks for parking violations in downtown Toronto in 2009. Jones et. al. (2009) depicts trucks competing for limited curb space with taxis and parking cars along a frontage road in Washington D.C., a scene which closely parallels what Lu (2016) observed in West Hollywood.

Chatterjee (2004) states that providing more curbside loading space is an important strategy for truck planning in urban areas. Nourinejad et. al. (2014) mention Shoup's proposals for pricing curb parking and enforcing parking restrictions as indirect ways of increasing curb loading space for trucks. Although certain aspects of truck operations in dense urban areas may differ from those for ride-sourcing vehicles (e.g. trucks require larger parking spaces), the apparent effect of curb space allocation for vehicle parking on loading and unloading by the two modes appears surprisingly similar.

Taxis as a Precedent?

To the extent traditional taxi services have experienced problems with pickups and drop offs, these have stemmed more from information discrepancies (in the taxi market) than from curb space allocation. As Schaller (2007) notes, the taxi market can be subdivided – based on pick up and drop off arrangements – into "street hail," "taxi stand," and" dispatch" operations. In the first type of taxi operation, taxi drivers pick up passengers who wave them down ("hail" them) on the street. The second type of operation requires that drivers wait for rides in a queue at a taxi stand, where customers walk up and order rides directly (Cambridge Systematics 2007). Only "dispatch" operations, which require a substantial investment of resources in marketing and call center facilities, involve prearranged rides (Sun and Edara 2015).

[21] See "LA ExpressPark" (link) and "SFPark" (link).

Because traditional taxi firms lack information on ridership demand (indicated to ride-sourcing vehicles through the demand-based pricing mechanism), taxi markets have historically suffered from both a geographically-imbalanced distribution and over-supply of taxis in some areas, and under-supply in others. Drivers working in “street hail” markets (which have the lowest barriers to entry among the three types of operation) tend to congregate in areas with a high-level of demand (e.g. and airports) in a quantity exceeding the number of willing customers (Schaller 2007). These market inefficiencies have prompted most cities to institute strict controls on market entry. Los Angeles, for instance, has had a taxi franchising system since 1934 (Eckert 1970) that restricts taxi service to nine companies, and delineates their service areas into distinct geographic “zones.”[22] Such quotas have led to taxi services having a low volume and presence in cities like Los Angeles relative to potential demand (refer back to **Figure 1**), a factor that enabled cities to overlook taxi vehicles’ curb needs. For example, until 2009, Los Angeles city law prohibited taxis from stopping in a red zone or parking space without paying for a meter (Morrison 2009).

Conclusion

A growing body of literature indicates that ride-sourcing trips replace single-occupancy vehicle trips and thereby reduce the demand for long-term curb parking in urbanized areas. At the same time, the literature shows that cities have traditionally prioritized long-term curb occupancy in commercial areas by underpricing curb parking and by under-supplying short-term loading space. Such policies have long impeded commercial loading activity, although they historically mattered less to the taxi operations which preceded ride-sourcing due to taxis’ limited presence. Increasing ride-sourcing travel not only conflicts with parking-oriented curb use (as observations of double-parking by ride-sourcing vehicles attests to) but reduces the importance of curb parking as a means of delivering passengers to and from the curb.

Research Questions and Hypotheses

My literature review implies that traditional curb allocation policies favoring long-term parking deprive ride-sourcing trips of curb space and overlook the reduction of vehicle parking demand by ride-sourcing travel. Accordingly, my thesis examines how curb designations affect ride-sourcing pick-ups and drop-offs and whether designation of curb space for ride-sourcing vehicles can improve the curb’s service of passenger transport. The thesis will address the following research questions:

[22] LADOT Bureau of Franchise and Taxicab Regulation. Los Angeles Taxicab Review and Performance Report. April 2015.

1. How do pick-ups and drop-offs by ride-sourcing vehicles utilize curb space on arterial corridors relative to other modes of passenger vehicle transport (e.g. parked private cars).

2. How does curb space allocation that favors long-term vehicle parking impede pick-up and drop-off activity by ride-sourcing vehicles? And how, in turn, does this affect traffic congestion?

3. How many passengers do ride-sourcing vehicles serve in areas where these services are frequently used compared with the number of travelers using other transport modes?

In regard to the first question, I hypothesize that ride-sourcing vehicles cumulatively utilize less curb space per passenger than any other type of vehicle (besides public transit) given the limited time frame drivers have to pick up passengers, as well as the quick turnaround times between drop-offs and new ride requests. In addition, ride-sourcing platforms' use of surge pricing to signal demand obviates the need for drivers to cruise or hold for lengthy periods of time to wait for passengers when the number of drivers exceeds the number of passengers (as traditionally is the case for taxi drivers). As to the second question, I predict that allocating curb space for long-term vehicle parking, as opposed to short-term loading, impedes ride-sourcing vehicles from picking up and dropping off passengers at the curb. Because private vehicles typically occupy the curb for lengthy periods of time, ride-sourcing vehicles must double park in the street adjacent to parked cars or park in nearby undesignated areas (e.g. no stopping zones), where they can impede traffic flow, interfere with emergency vehicle access, and create safety hazards.[23] I expect my analysis to show that curb segments designated for vehicle parking have a higher vehicle occupancy and a higher frequency of ride-sourcing pickups and drop offs in traffic lanes than curb segments designated for loading or no stopping and that a corridor with a higher percentage of curb space designated for vehicle parking will, overall, have a higher curb occupancy and more ride-sourcing pick-ups and drop-offs in traffic lanes.

Finally, I anticipate that ride-sourcing vehicles transport a greater number of passengers to and from a curb segment than parked private vehicles do, at periods and on corridors with high travel demand. Accordingly, allocating curb space for short-term pick-ups and drop offs might amount to a "higher and better use" of the curb than allocating the curb space for vehicle parking.

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[23] As categorized according to the classification system standard in California: e.g. parking = long-term parking, loading = commercial or passenger loading zones (with 5-minute limits) and no stopping= no stopping. See. Esurance. Do You Know Your Colors? http://blog.esurance.com/do-you-know-your-curb-colors/

Data and Methodology

I evaluated my research questions by observing curbside activity by ride-sourcing and other vehicles along segments of Santa Monica Boulevard in the city of West Hollywood and Melrose Avenue in the city of Los Angeles. Both are arterial corridors possessing urban form characteristics conducive to ride-sourcing but have different allocations of curb space. Whereas most curb space that is not designated as a “no stopping zone” is allocated for curb parking on Santa Monica Boulevard, on Melrose Avenue, short-term loading zones (both commercial and passenger loading) receive over half as much curb space as curb parking. I used data I obtained on use of the curb by ride-sourcing vehicles along each corridor to assess the relationship between curb zone designations, curb occupancy and the frequency of double parking.

Site Selection

I located my corridors of study by identifying corridors with urban form characteristics conducive to ride-sourcing. I sought two corridors that had the potential for high levels of ride-sourcing activity but had different proportions of curb space allocated for curb parking and short-term loading, in order to compare the effects of curb zone allocation on illegal parking activity.

Studies of ride-sourcing both nationally (Clewlow and Mishra 2017) and in California (Circella, et. al. 2018) indicate that ride-sourcing trips are geographically concentrated in urban neighborhoods with a mixture of land uses. Clewlow and Mishra (2017) find that ride-sourcing is most widely used for trips to and from nightlife and dining destinations, mirroring findings by Murphy (2016) and Henao (2017) that a majority of ride-sourcing trips are for social purposes. Thus, I chose to focus on streets in urban neighborhoods with a concentration of recreation-related retail, nightlife and/or dining uses.

Since Ewing (1996) finds that buildings lose their connection to the street when setback more than 25 feet from the curb, I anticipated that ride-sourcing vehicles would pick-up and drop-off at the curb more frequently on corridors where uses directly front the street. I also expected pickups and drop offs to concentrate on arterial and collector streets, streets that, in function-based street classification systems provide access between cities and suburbs as well as to intercity roadways (FHWA 2013). Within a particular commercial district, these streets would tend to attract pickups and drop offs given both riders’ familiarity with the streets and the access they provide to other neighborhoods and cities.

Table 4. Calculation of Ride-sourcing Street Index.

Variable	**Meaning (Ramsey and Bell 2014)**
D1c5_ent	Number of jobs per acre of unprotected area in NAICS sectors 71 (Arts, Entertainment and Recreation) and 72 (Accommodation and Food Services).
D1c5_Off	Number of jobs per acre of unprotected area in NAICS sectors 51 ((Information), 52 (Finance and Insurance), 53(Real Estate and Rental and Leasing), 55 (Management of Companies and Enterprises) and 91 (public Administration).
D1c5_Ret10	Number of jobs per acre in NAICS sector 44-45 (Retail Trade).
D1c5_Svc10	Number of jobs per acre of unprotected area in NAICS sectors 54 (Professional, Scientific, and Technical Services), 56 (Administrative and Support and Waste Management and Remediation Services), 61 (Educational Services), 62 (Health Care and Social Assistance) and 81 (other services, excluding public administration).
Pedmm= D3amm + D3apo	Sum of density, per acre of land, of multi-modal (D3amm) and pedestrian (D3apo) street links. • Multi-modal street links: 2-way streets with speed limits between 54 and 40 mph, 1-way streets with speeds between 40 and 21 mph. • Pedestrian Street links: 2-way streets with speed limits under 30 mph, 1-way streets with speed limits under 20 mph.
Ride-sourcing Street Index (RSI) = $\frac{(1.2*D1c5\_ent + .8*D1c5\_ret + .5*(D1c5\_off + D1c5\_))}{3} + Pedmm$	

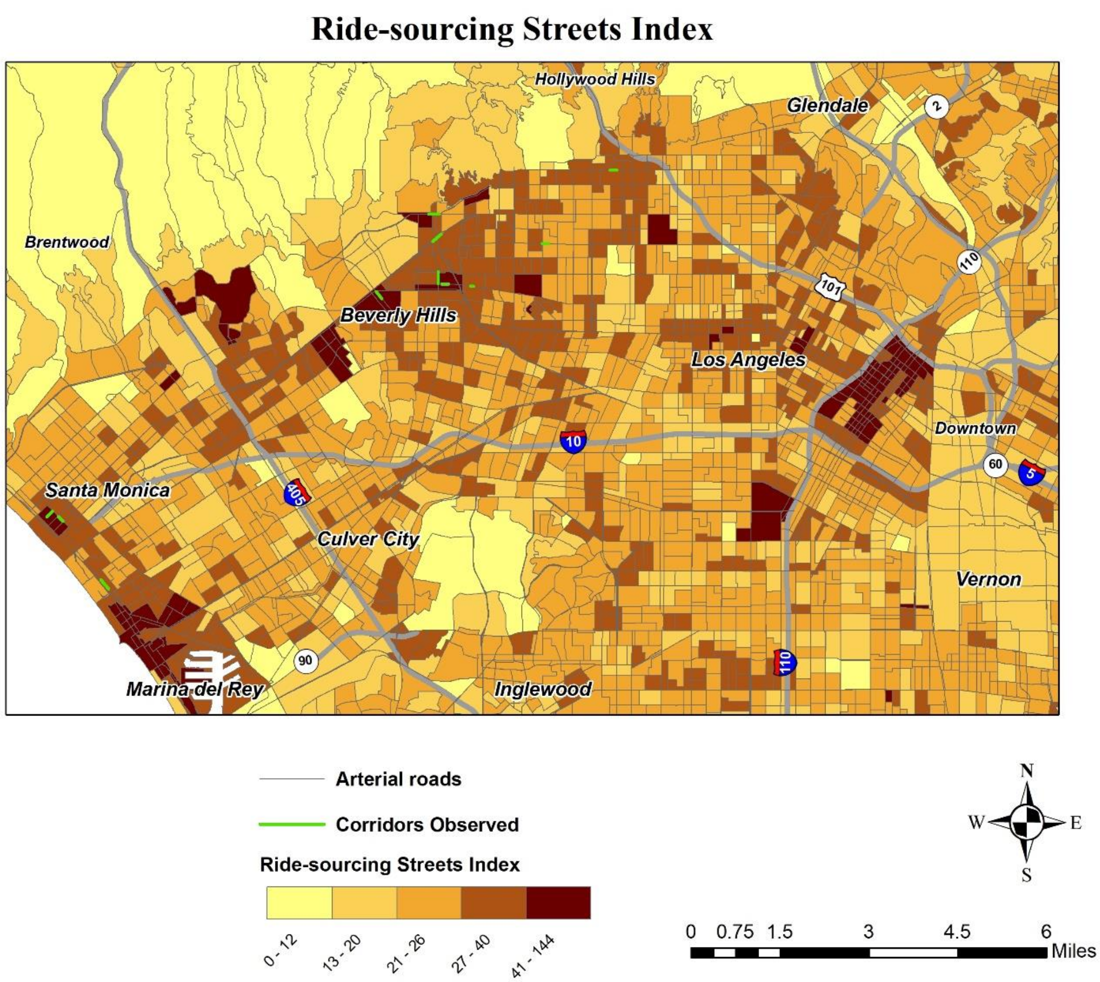
I began my site selection process by creating a "Ride-sourcing Street Index" using variables from the Environmental Protection Agency's Smart Location Database (**Table 4**) and by geocoding data on retail businesses in the cities of Los Angeles, Santa Monica and West Hollywood. The first metric combined variables from the Smart Location Database measuring employment density and street network density. I included street network density as a proxy measurement for buildings' tendency to front the street--since a denser street network would correspond to smaller lot sizes--, as well for a street's urban character.[24] For employment density, I created a weighted

[24] Street network density has been shown to correlate with population density at a metropolitan level (Manville and Shoup 2005)

average of entertainment, retail, office and service employment densities. The first two variables can reflect recreation-related and nightlife trip generators with which ride-sourcing use is associated (thus receiving higher weights), while density of the latter businesses could provide further indication of a neighborhood's urban quality.

The resulting map (**Figure 2**) shows that many of the high-scoring census blocks concentrate in neighborhoods noted for their walkable, compact urban form—including Downtown Santa Monica, Downtown Beverly Hills, West Hollywood and Downtown Los Angeles. However, some high-scoring census blocks, such as those around the Century City commercial district, seem to reflect employment centers with few street-fronting uses. At the same time, a few corridors which I recognized as having street-fronting retail and dining concentrations did not score prominently in the Ride-sourcing streets Index.

Figure 2. Ride-sourcing Streets Index derived from Smart Location Database



To more thoroughly gauge street-fronting retail and dining concentrations, I supplemented the Ride-sourcing Streets Index map with a map showing locations of active business licenses for recreational-related retail and entertainment businesses in the cities of Los Angeles, West Hollywood and Santa Monica (the specific business categories corresponding to the general classification are shown in **Table 32** in the **Appendix**).[25] I geocoded the businesses and created a heat map displaying business density in the three cities. The map (**Figure 3**) reflects some of the patterns of the Ride-sourcing Streets Index, with dark colors (indicating high business density) in Downtown Santa Monica, West Hollywood and in Hollywood. The map also shows concentrated business density along several of the arterial corridors in the Beverly Grove and Fairfax districts, particularly along 3rd Street and Melrose Avenue.

[25] Unfortunately, I could not obtain business license data for Beverly Hills, so it is excluded from the map.

Figure 3. Kernel Density of Retail and Recreation-related businesses in central Los Angeles

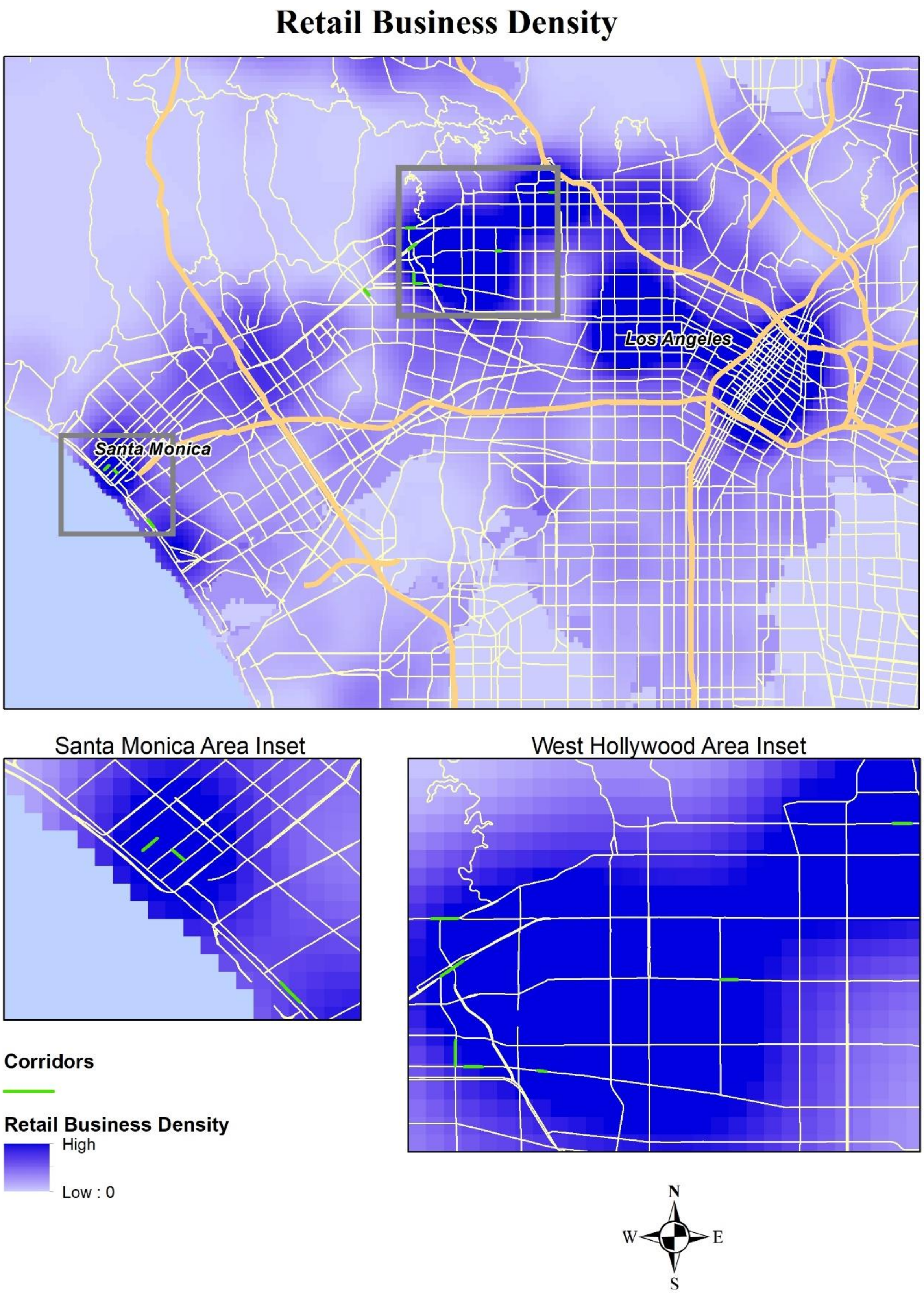


Table 5. Corridors Considered for Study

Street	Segment	Number of ride-sourcing pick-ups/drop-offs (per 15 minutes)*	Number of ride-sourcing vehicles passing by	Date and Time of Observation*	Primary Curb Designation	Secondary Curb Designation(s)
Canon Drive	Santa Monica Blvd to Rite Aid (1302 ft)	2	6	Thurs. 12/21, 5:15 to 5:45	Parking (65%)	
3rd Street	Arnaz Drive to Willaman Drive (933 ft)	5	10	Fri. 12/29, 4:25 to 4:40, 4:48 to 5:03	Parking* (52%)	Loading (26%)
3rd Street	Croft Avenue to Orlando Avenue (549 ft)	2	13	Fri. 12/22, 5:50 to 6:05	Parking (50%)	No Stopping (42%)
Hollywood Blvd	Whitley Avenue to Wilcox Avenue (1028 ft)	7	22	Fri. 1/19, 9:10-9:25, 9:30-9:45	No Stopping (58%)	Parking (32%)
Melrose Ave	Martel Street to Gardner Street (1020 ft)	5	16	Sat. 1/20, 2:39-2:54, 3:14-3:29	No Stopping (40%)	Parking (37%), Loading (23%)
Robertson Blvd	West Hollywood boundary to 3rd Street (1696 ft)	5	8	Sat. 12/30, 3:15-3:30, 3:32 to 3:47	Parking (74%)	No Stopping (22%)
Sawtelle Blvd	La Grange Avenue to Mississippi Avenue (987 ft)	2.5	1.5	Thurs. 12/28, 6:33 to 6:48, 7:30 to 7:45	Parking (53%)	No Stopping (47%)
4th Street	Broadway to Santa Monica Blvd (1113 ft)	0	7	Sat. 12/23, 4:25 to 4:50PM	Parking (71%)	No Stopping (29%)
Arizona Avenue	2nd Street to 4th Street (892 ft)	3	3	Sat. 12/23, 5:20 to 5:27	Parking (86%)	Loading (14%)
Main Street	Hill Street to Pier Street (1744 ft)	6	6	Sat. 12/23, 6:45 to 7:15	Parking (76%)	No Stopping (20%)
Santa Monica Blvd (north side only)	Robertson Boulevard to Palm Avenue (north side: 792 ft)	21	37	Sat. 12/23, 11:30 to 11:45	Parking (60%)	No Stopping (36%)
Sunset Blvd	Hilldale Avenue to Horn Avenue (944 ft)	7	>13	Sun. 1/14, 12:05-12:20AM, 12:25-12:40AM	Parking (63%)	No Stopping (33%)
		*For corridors where I observed segments for two or more periods, I derived this figure from the average of the figures for the 2 segments (e.g. Sawtelle).		*All hours are PM unless noted		* Before 4pm

I overlaid both the Ride-sourcing Streets Index and business license maps with a shapefile containing streets classified as arterials in the Los Angeles County Address Management System.[26] I selected a series of corridors, ranging from 500 to 1500 feet long that scored highly on one or both metrics (shown in **Table 5** and highlighted on both **Figures 2** and **3**) and that were located at a convenient distance from the UCLA campus.[27] During December 2017 and January 2018, I conducted 15-minute observations of ride-sourcing pick-up, drop-off and pass-by activity on each corridor at the time listed in **Table 5**. I simultaneously recorded information on curb zone lengths along each corridor, distinguishing between curb parking, short-term loading and no stopping zones (which I discuss more in depth below). Overall, I sought to obtain two corridors that had at least a moderately high level of ride-sourcing activity (for the purposes of obtaining a statistically-significant sample) but differing breakdowns of curb space—with one corridor predominantly containing curb parking and the other having a more even mix of curb parking and passenger loading.

Based on these two qualities, I selected a four-block segment of Santa Monica Boulevard in the city of West Hollywood and a two-block segment of Melrose Avenue in the Fairfax District of Los Angeles as my observation areas (see **Figures 4 and 5**). Of the corridors I observed, both corridors had among the highest levels of ride-sourcing—with Santa Monica the leader in this regard: I counted 22 ride-sourcing vehicles on a Saturday afternoon on Melrose and 60 ride-sourcing vehicles on a Saturday evening on Santa Monica.[28] More generally, both corridors have visible concentrations of street-fronting dining, nightlife and retail activity (as the photos in **Figures 4** and **5** illustrate). The bars and restaurants along the north side of the segment of Santa Monica Blvd. comprise one of the largest concentrations of nightlife activity in the region, while the segment of Melrose Avenue is situated amid a cluster of trendy boutiques and restaurants that is popular with tourists and locals alike.[29]

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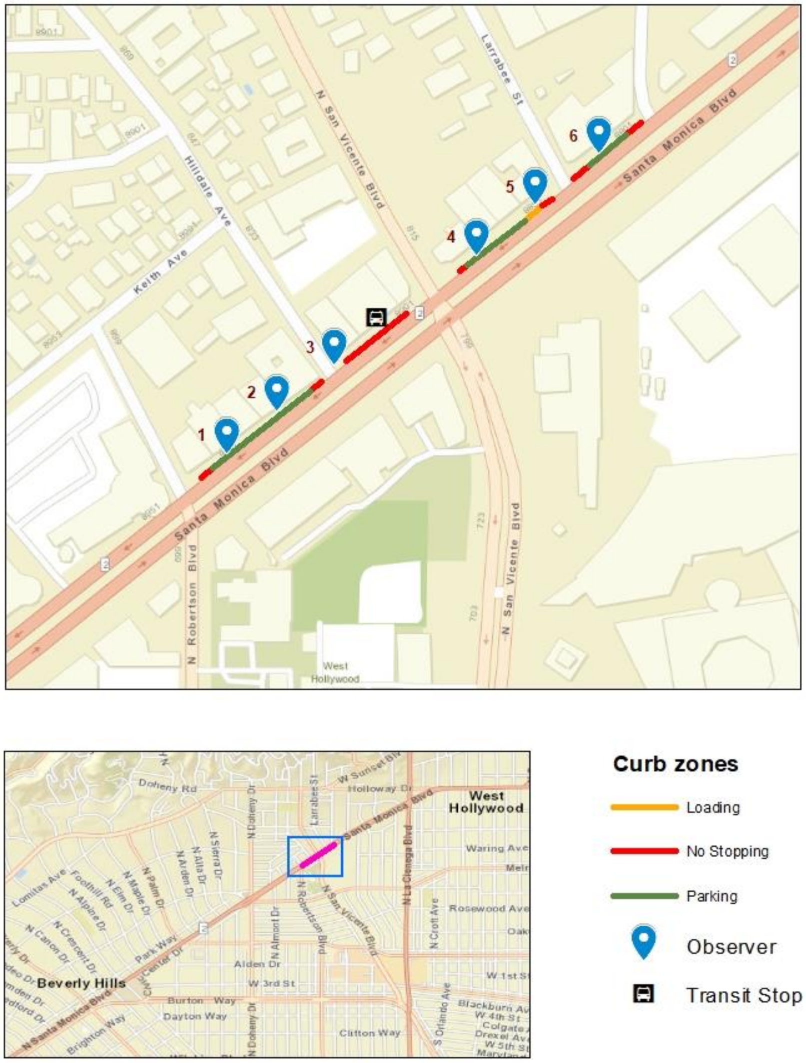
[26]Unfortunately, the spreadsheet accompanying the shapefile does not elaborate on how the arterial and major collector categories corresponding to the primary and secondary street classifications were determined, making it unclear whether the CAMS classification scheme to that of the FHWA. See "Final Draft of Street Type Codes" at https://egis3.lacounty.gov/dataportal/2014/06/16/2011-la-county-street-centerline-street-address-file/

[27] I sought to locate corridors within a 45-minute bus ride, to alleviate issues with hiring research assistants.

[28] Although I observed discrepancies in volume between the two corridors, they were not as high as they ultimately turned out to be.

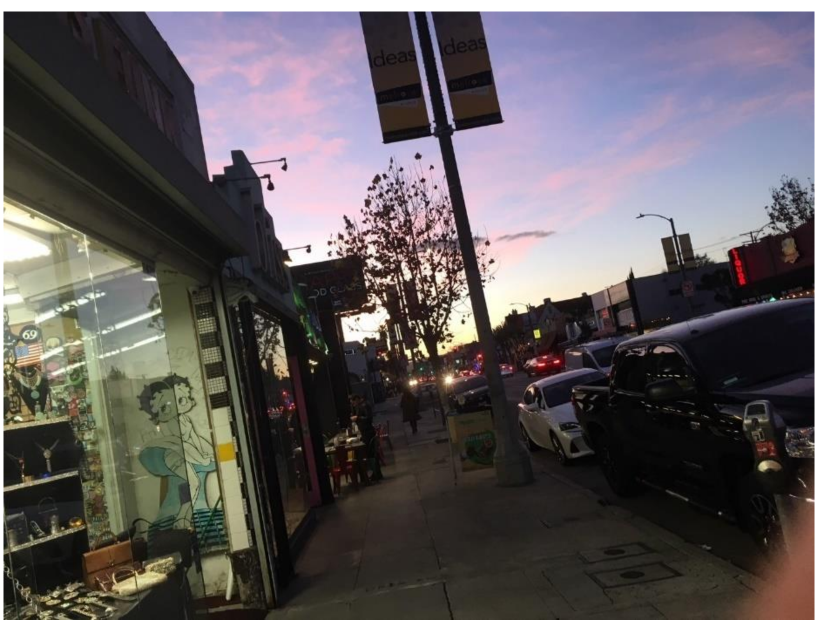
[29] See Juliano, Michael. "The Best of Melrose Avenue." *TimeOut*. December 14, 2016. https://www.timeout.com/los-angeles/things-to-do/melrose-avenue#tab_panel_2

Figure 4. Map of Santa Monica Blvd segment.



*Observer positions marked by blue pinpoints (and labeled with the observer number), designations marked according to the legend.

Figure 5. Map and Street-level Views of Melrose Ave. segment.



On Santa Monica Blvd (see **Table 6**), almost 60 percent of curb space not taken up by the intersection right-of-way comprises metered curb parking, with most of the remainder designated as a "no stopping" zone. By contrast, loading zones span over 20 percent of the curb space on Melrose. Slightly more than half of the loading zone on Melrose Avenue is designated as general passenger loading, in which passenger vehicles can stop to pick up or drop off passengers for up to five minutes, and slightly less than half of the zone is designated as commercial loading, in which vehicles with commercial licenses can stop for up to 30 minutes to load and unload but passenger vehicles can stop for only five minutes (MPP Section 343). As I mentioned earlier, I observed considerable double-parking activity in the vicinity of the Santa Monica study location in the fall of 2016 (Lu 2016), which seemed to result from the presence of curb parking.

Table 6. Breakdown of curb space on Melrose Avenue and Santa Monica Boulevard.

	Melrose (Gardner to Martel)		Santa Monica (Robertson to Palm--North Side)	
	Length (ft)	**%**	**Length (ft)**	**%**
Parking	**381**	**37%**	**462**	**58%**
No Stopping	**406**	**40%**	**290**	**37%**
Loading	**233**	**23%**	**40**	**5%**
commercial (yellow)	***102***	***10%***		
passenger (white)	***131***	***13%***	***40***	***5%***
Total	**1,020**	**100%**	**792**	**100%**

The Los Angeles Department of Transportation's "Manual of Policies and Procedures" requires no stopping zones along curb segments 25 to 30 feet in advance of intersections or mid-block crosswalks (to provide visibility and clearing room for turning cars), at transit bus zones (where transit vehicles can stop adjacent to transit stops), as well as where needed to create an extra lane. On Melrose Avenue, the no stopping zones correspond to three segments around bus stops, segments adjacent to intersections, and to a sightseeing bus zone for tour buses (west of the bus stop at the corner with Martel). As with passenger loading zones, West Hollywood has no formal criteria governing the establishment of no stopping zones.

Despite this, the no stopping zones on Santa Monica Blvd seem to follow the logic stipulated by the LADOT Manual, including one segment adjacent to a bus stop and several segments (ranging from 17 to 30 feet) adjacent to intersections (see **Figure 4**). The Manual justifies no stopping zones as mechanisms to avert vehicle conflicts (e.g. in the case of transit zones) and ensure adequate visibility (e.g. around intersections). Particularly in the latter instance, no stopping zones primarily serve a safety function. However, I expected that vehicles may stop in these zones, nevertheless, when the remainder of curb space has a high occupancy. Overall, my choice of the Santa Monica and Melrose corridors as observation sites allows me to assess how the designation of curb space on the corridors affects illegal parking activity by ride-sourcing and other types of vehicles.

Data Collection

I collected data through manually recording statistics, with the help of a team of research assistants, on vehicles that stopped along my corridors of study. On both corridors, we collected data on each vehicle which stopped outside of the flow of traffic, either at the curb or in traffic lanes.[30] [31] Data collection took place between 7pm and 11pm on Friday and Saturday evenings on Santa Monica Blvd and between 2pm and 6pm on Friday and Saturday afternoons on Melrose Avenue over the course of three weekends, between January 26-27 and February 9-10, 2018 (**Table 7**).[32] The timing of the 4-hour shifts on the two corridors align with what I perceived as the periods of peak demand for ride-sourcing, based on orientations towards retail, dining and entertainment-based trips. On Melrose Avenue, I also sought to observe at a time during which the commercial loading zones were in effect, between 7 am to 6pm on Monday through Saturday (which ruled out the option of observing on this corridor during the evening). The observations were conducted over the three-week period to account for variation in ride-sourcing demand or curb access specific to a particular week.

Table 7. Observation Study Characteristics

	Melrose	Santa Monica
Time and Day	2-6pm, Friday and Saturday	7-11pm, Friday and Saturday
Weeks	3	3
Total hours	24	24
Observers	3	6

Using spreadsheets, my assistants and I collected data on five primary variables (listed in **Table**

[30] The observations utilized 3 observers on Melrose and 6 observers on Santa Monica, stationed at the positions shown in Figures 10 and 11 (see pinpoints in Figures 10 and 11). Staff shortages resulted in the use of only 5 observers on Santa Monica on the night of February 3rd.

[31] For instance, a vehicle that stopped a slight distance behind another vehicle in a travel lane adjacent to the curb but moved as soon as the other vehicle moved forward would not be recorded as double-parking.

[32] I conducted three make-up observations to account for changes in the schedule after the first night on Santa Monica Blvd (which was scheduled for 8 to 12pm) and gaps in the data collected during the first two afternoons on Melrose. I conducted the make-up observations on Saturday, February 17 (on Melrose) and Friday, February 23 (on Melrose and Santa Monica).

8 on page 30) for each vehicle that stopped at or adjacent to the curb during the period of observation (including vehicles already parked or stopped at the curb prior at the beginning of the shift). We denoted the curb zone in which vehicles stopped according to the categories (loading, no stopping and parking) presented in **Table 6**. We also recorded the vehicles' type according to one of ten categories shown in **Table 8** and indicated whether vehicles stopped at or adjacent to the curb. In order to measure the duration for which vehicles stopped, I had observers account for the time vehicles arrived and departed. Finally, we recorded information on the number of passengers that alighted from and entered vehicles.[33]

Collectively the variables helped me distinguish the curb usage patterns and occupancy of ride-sourcing vehicles and other types of vehicles in different curb zones; assess the frequency with which ride-sourcing vehicles stopped in traffic lanes by curb zone (and occupancy); and quantify which types of vehicles (and curb zones) transported the most passengers to and from a curb segment. Thus, the data would help address each of my primary research questions. I also used information on the duration for which vehicles stop to pick up and drop off passengers in the street to determine how (if at all) ride-sourcing affects traffic flow along the corridors.

I initially considered mounting time-lapse cameras along my corridors, which could record complete footage of curb usage at each segment, without requiring paid assistants, but changed course after learning that this would require obtaining a permission from a city traffic engineer (W. Okitsu, Personal Communication 12/10/2017), a process too lengthy and cumbersome for the purposes of this study.

[33] We counted arriving and departing passengers separately even where the same people alighted from or entered a vehicle.

Table 8. Explanation of Variable Categories

Variable	Category	Explanation	Standard Vehicle Length (ft)*
Curb Zone	Commercial Loading	Commercial vehicles can stop for up to 30 minutes and private cars for up to five minutes. In effect Monday-Saturday from 7am-6pm.	
	Passenger Loading	Permits any vehicle to stop for up to five minutes.	
	No Stopping	No stopping permitted anytime except for transit or tour bus vehicles (in transit or tour bus zones).	
	Parking	Metered parking (2-hour on Melrose; 2-hour and 20-minute on Santa Monica).	
	Right-of-way	Stopped in right-of-way of intersecting street.	
Vehicle Type	Black Car	Luxury or limousine services, including UberBlack/SUV and equivalent luxury ride-hailing services.	20
	Private Car	Private automobile not employed for commercial purposes.	20
	Commercial	Standard vehicles employed for commercial purposes (e.g. delivery vans, UberEats).	20
	Other	All other types of vehicles that use the curb, including police cars and government vehicles.	20
	Motorcycle	Motorcycles	7.2
	Transit	Vehicles designed for fixed-route mass transit, including buses and trolleys.	45
	Ride-sourcing	Vehicles associated with a Transportation Network Company[1] (e.g. Uber, Lyft) driving for a non-luxury service.	20
	Taxi	Vehicle with taxi livery associated with franchised taxi.	20
	Truck	Standard diesel trucks (medium and heavy-bodied).	45
Parked at Curb	Yes	Parked within roughly 18 inches of curb.	
	No	Double-parked (more than 18 inches away, or noticeably outside markings)[2].	
Time	Time In	Time vehicle stops outside of the flow of traffic.	
	Time Out	Time vehicle moves away from stopped position.	
	Duration	Difference between Time Out and Time in, in seconds.	
Passengers	Passengers In	Passengers that vehicle transports away from the curb[3].	
	Passengers Out	Passengers that vehicle transports to the curb[4].	
		1. Technically any company defined as a TNC by the California Public Utilities Commission, though for the purposes of our analysis, I instructed observers to watch for Uber, Lyft, Opoli, Wingz and Socialdrv.	*Used to calculate curb occupancy.
		2. Determined during observations through eyeballing based on parking space markings, position relative to other vehicles.	
		3. Counted once they have stepped into the vehicle *and* the vehicle has left the curb.	
		4. Counted once the vehicle has arrived at the curb *and* they have stepped out of the vehicle.	

Analysis

My analysis finds that the volume of ride-sourcing vehicles (and passengers) differed significantly between the two corridors, with ten times as many vehicles on Santa Monica as on Melrose. On both corridors, cars occupy a share of curb space disproportionate to the number of vehicles and passengers they transport. A combination of high ride-sourcing activity and low turnover by private cars results in ride-sourcing vehicles double-parking or loading in the no stopping zones along Santa Monica Blvd. Increasing the supply of short-term loading space on the corridor could result in more passengers transported per available curb space.

Breakdown of Vehicles by Category

My analysis reveals disparities in the level of ride-sourcing activity along the Melrose and Santa Monica corridors. On Santa Monica Blvd, 64 percent of the 3,000 vehicles that stopped along the corridor during the 24-hour study period were ride-sourcing vehicles, and the majority of the remainder (25%) were cars. This figure amounts to a rate of 54 ride-sourcing vehicles per 500 feet of curb space per hour. On Melrose Avenue, by contrast, cars comprised over 75 percent of vehicles that stopped at or adjacent to the curb during the study period, while ride-sourcing vehicles comprised the second-largest quantity (14%) of vehicles (**Table 9**).

Table 9. Vehicles Stopping along the Melrose and Santa Monica Corridors by Category

	Melrose			Santa Monica		
Vehicle Type	**(1) Vehicles (Study Period)**	**(2) Percent (total)**	**(3) Per 500 ft per hour** $(1)/24*(500/1020)$	**(4) Vehicles (Study Period)**	**(5) Percent (total)**	**(6) Per 500 ft per hour** $(4)/24*(500/1020)$
Black car	8	1%	0.2	48	1%	1
Commercial	26	2%	1	13	0.4%	0.3
Motorcycle	29	2%	1	5	0.2%	0.1
Other	2	0%	0	5	0.2%	0.1
Private car	928	75%	19	879	27%	23
Ride-sourcing	174	14%	4	2,067	64%	54
Taxi	1	0%	0.02	41	1%	1
Transit	30	2%	1	176	5%	5
Truck	28	2%	1	4	0.1%	0.1
Unknown	11	1%	0.2	15	0.5%	0.4
Total	**1,237**	**100%**	**25**	**3,253**	**100%**	**86**

Twice as many vehicles stopped on Santa Monica Boulevard as on Melrose Avenue during the study period (despite the former corridor being 200 feet shorter), while 11 times as many ride-sourcing vehicles stopped on the former corridor as on the latter. Indeed, most of the difference in the vehicle volumes between the two corridors stems from ride-sourcing vehicles, with the number of private cars stopping per 500 feet of curb in an hour on Santa Monica only 20 percent higher than on Melrose. Still, on Melrose, ride-sourcing vehicles stopped four times more frequently (per 500 feet per hour) than transit vehicles, trucks and commercial vehicles—the next largest vehicle categories.

The different levels of ride-sourcing activity on the two corridors likely reflect on the different times of observation and concentrations of nightlife and bars. Murphy (2016) finds ride-sourcing use concentrated in evenings, while Henao (2017) and Clewlow and Mishra (2017) note that events and activities involving the consumption of alcohol (which tends to occur later in the day) are a prominent factor in individuals' use of ride-sourcing. Although the lower volume of entertainment and nightlife on Melrose likely contributes to less late-evening travel (compared to Santa Monica), the afternoon observation period adds an element of temporality to differences in ride-sourcing and vehicle activity.

Time Stopped by Vehicle Category

Table 10. Average Duration Stopped by Vehicle Type (in minutes).

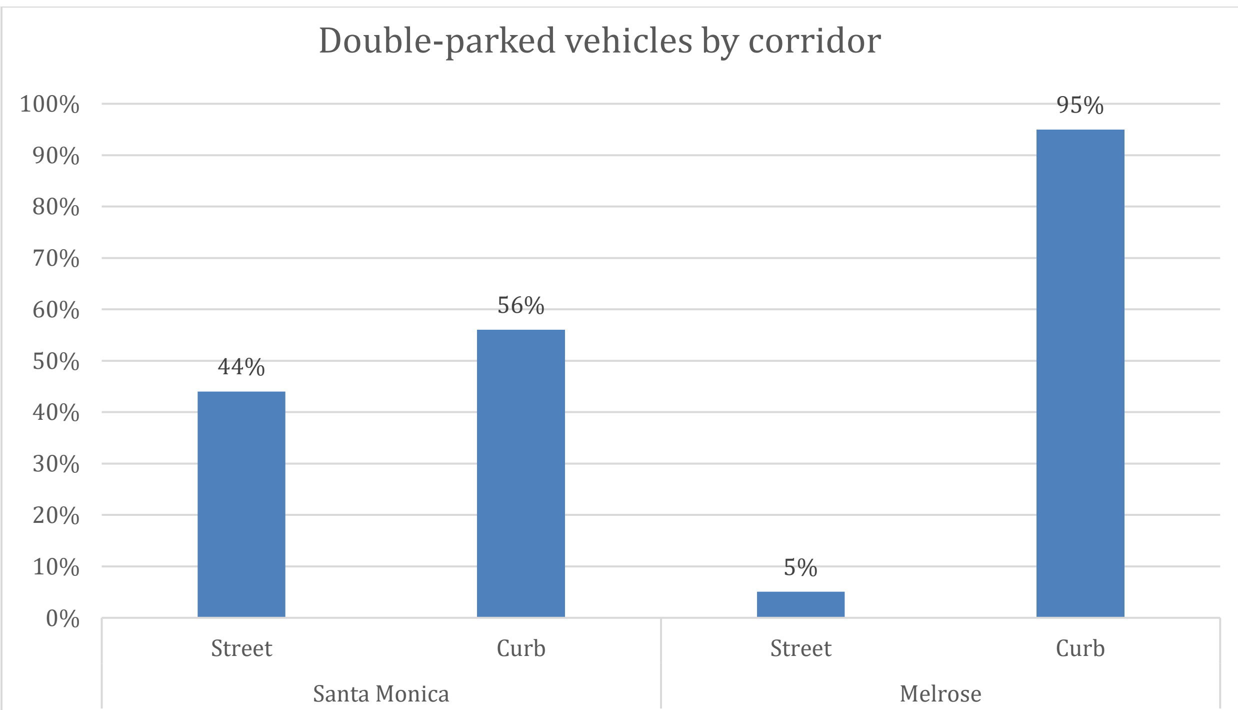
Vehicle Type	Melrose	Santa Monica
Black car	1.6	2.4
Commercial	13	34
Motorcycle	92	9
Other	145	3.8
Private car	28	30
Ride-sourcing	1.6	0.8
Taxi	2.6	8
Transit	0.7	0.4
Truck	17	40
Unknown	6.7	0.9
Total	**24**	**9**

My data confirm that ride-sourcing vehicles stop for brief durations. On average, ride-sourcing vehicles stopped for 1.6 minutes on Melrose and for .8 minutes on Santa Monica (**Table 10**). On both corridors, only transit vehicles had a shorter mean stopping time. In contrast, private cars stopped for almost 30 minutes on average. Commercial vehicles and trucks stopped for intermediate durations, of 13 and 17 minutes, on Melrose (on Santa Monica, the small sample size of both categories likely skews the average figures). Interestingly, on Santa Monica (where all but one of the taxis stopped), taxis stopped for 8 minutes on average—a considerably higher figure than the average for ride-sourcing vehicles or black cars. This high average stopping time might result from long waits between dispatches or "street hail" requests, due to the loss of customers to ride-sourcing.

Double-Parking on Santa Monica

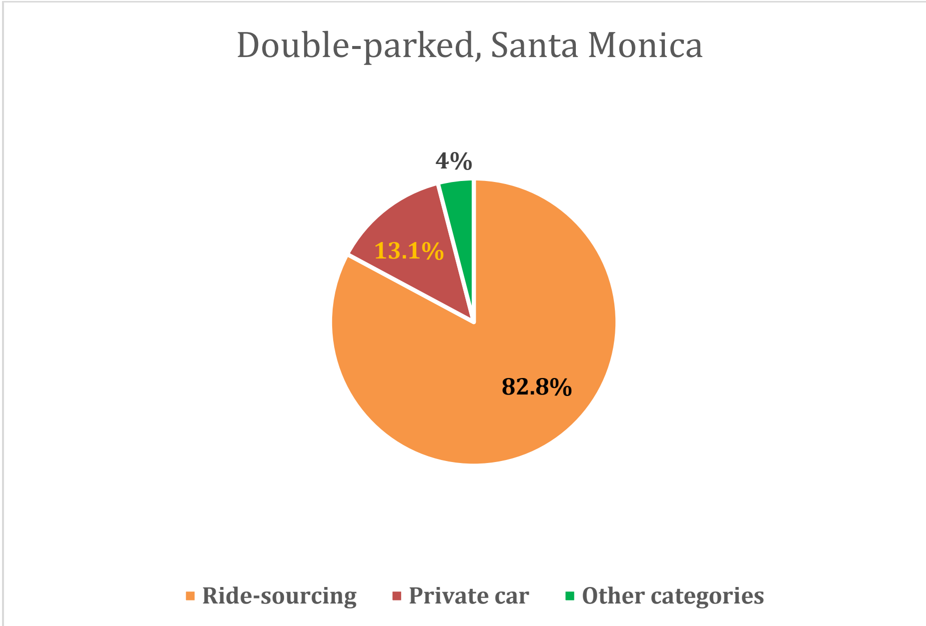
As I had hypothesized, double parking occurred more frequently on Santa Monica than on Melrose. 44 percent of vehicles stopping along Santa Monica during the study period double-parked (see **Figure 6**), compared to only five percent of vehicles stopping on Melrose.

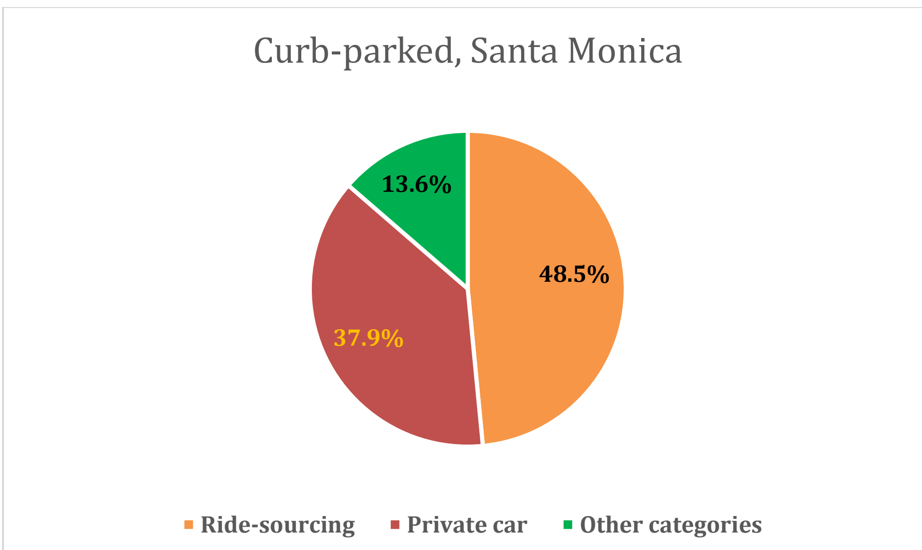
Figure 6. Vehicles Stopped by Location (relative to the curb), Melrose and Santa Monica



Around 83 percent of vehicles that double-parked on Santa Monica during the study period (1157 out of 1400 vehicles) were ride-sourcing vehicles (**Figure 7**). By contrast, ride-sourcing vehicles accounted for only 48 percent of vehicles that parked at the curb, with 38 percent of vehicles parked at the curb being private vehicles.

Figure 7. Double-parked and Curb-parked Vehicles on Santa Monica Blvd. by Category





Perhaps unsurprisingly, vehicles double-parked on both corridors for brief periods, with an average duration of only 1 minute (see **Table 11**). On average, ride-sourcing vehicles double-parked for only .7 minutes (on Santa Monica) and .5 minutes (on Melrose) while private cars double-parked for 2.5 minutes (on Santa Monica) and 1.2 minutes (on Melrose).[34] Vehicles stopping at the curb on Santa Monica stopped for slightly longer times (**Table 12**) than the overall set of vehicles (refer back to **Table 9**), with private cars having a mean duration of close to 40 minutes. The disparity between mean durations for double-parked and curb-parked vehicles

[34] The longer average stopping times for commercial vehicles and taxis are likely skewed by these categories' small sample sizes.

is greater for private cars (the mean time for the latter is 15 times higher than for the former) than for ride-sourcing and transit vehicles (the average for the latter is only a fraction of a minute higher than for the former).

Table 11. Average Duration for Double-parked Vehicles (minutes).

Vehicle Type	Melrose	Santa Monica
Black car	0.2	1
Commercial		8.4
Other		6.1
Private car	1.2	2.5
Ride-sourcing	0.5	0.7
Taxi		4.8
Transit	0.3	0.5
Unknown		0.7
Total	**0.9**	**1.0**

Table 12. Average duration for Vehicles Parked at the Curb (minutes).

Vehicle Type	Melrose	Santa Monica
Black car	2.4	4.3
Commercial	13	43
Motorcycle	95	9
Other	145	2.2
Private car	29	38
Ride-sourcing	1.7	1
Taxi	2.6	9.5
Transit	1	0.4
Truck	17	31
Unknown	6.7	1.2
Total	**26**	**15**

Thus, double-parking activity on Santa Monica Boulevard primarily involves brief pick-ups and drop offs by ride-sourcing vehicles. Private cars are more likely to stop at the curb for extended periods of time.

Despite individually stopping for brief stints, vehicles double-parked frequently enough on Santa Monica to cumulatively affect traffic flow. In an average hour (**Table 13**), vehicles double-parked for 1 hour and 2 minutes. Ride-sourcing vehicles alone double-parked for 37 minutes per hour on average. According to Portilla et. al. (2009), a vehicle "badly-parked" in a traffic lane for 15 minutes causes a 14 percent reduction in hourly flow of vehicles on a two-lane road. Assuming a constant ratio of double-parking duration to traffic flow reduction, total double-parking activity on Santa Monica reduced hourly traffic flow (**Table 13**) by 58 percent, with double-parking by ride-sourcing vehicles reducing the traffic flow by 34 percent.[35] It should be noted that although cars comprise less than 12 percent of the double-parked vehicles on Santa Monica Blvd., they cumulatively accounted for one-third of the minutes of double-parking per hour, and (based on Portilla et. al.'s ratio) reduced hourly traffic flow by 19 percent.

Table 13. Traffic Impacts from Double-parked Vehicles on Santa Monica.

Vehicle Type	(1) minutes total	(2) Minutes/hour (1)/24	(3) Percent Traffic flow reduction ((2)/15)*.14
Black car	25	1	1%
Private car	495	21	19%
Commercial	17	0.7	1%
Other	12	0.5	0.5%
Transit	3	0.1	0.1%
Ride-sourcing	878	37	34%
Truck	0.1	0.004	0.004%
Taxi	63	3	2%
Unknown	5	0	0.2%
Total	1,498	62	58%

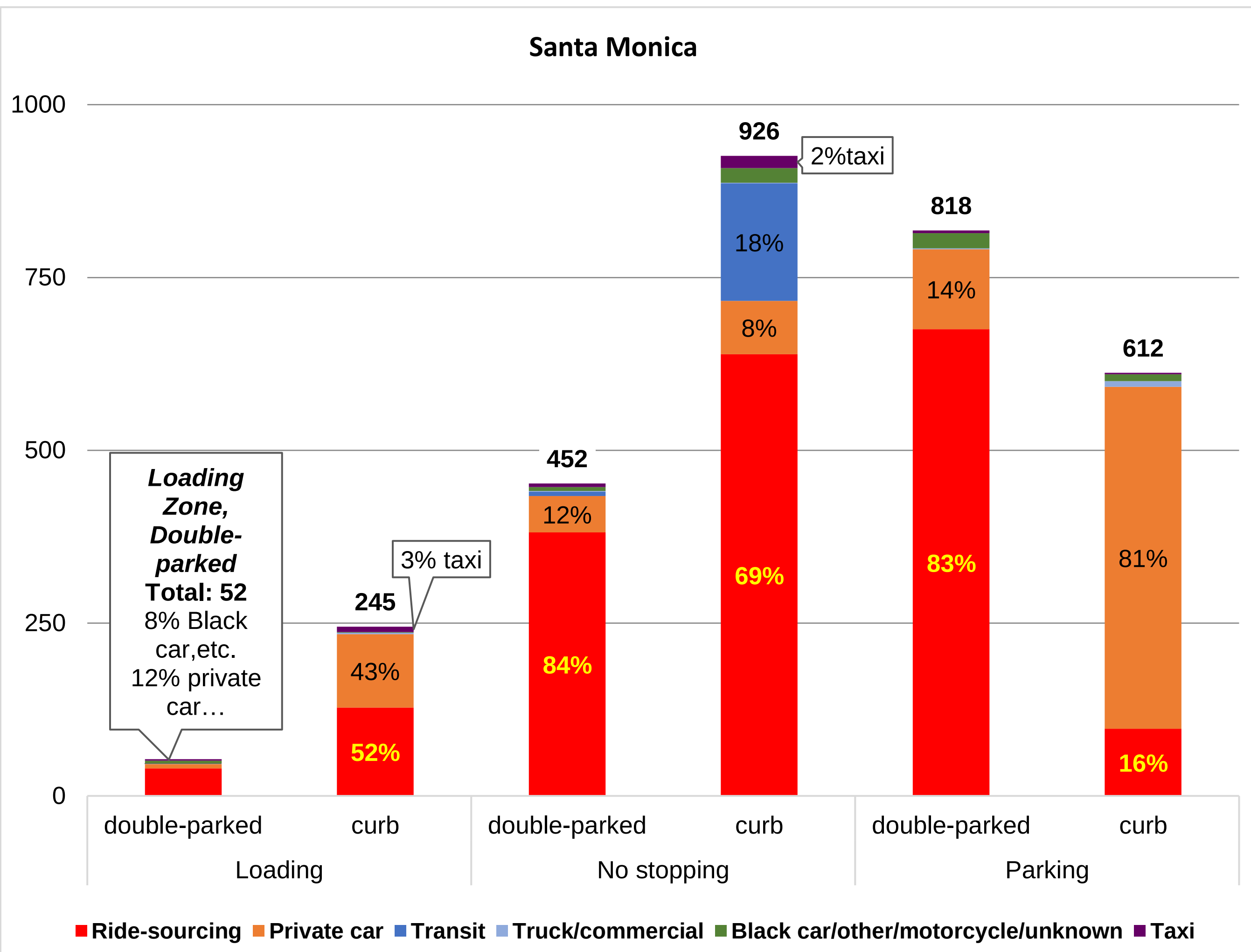
Illegal Parking and Curb Zone occupancy

Much of the double-parking activity on Santa Monica Boulevard can be attributed to the paucity of curb space for short-term loading. Dominance of the curb by high-occupancy curb parking and frequent loading activity, help explain the prevalence of vehicles' stopping on traffic on Santa Monica, as compared to Melrose.

[35] Portilla, et. Al. note that the marginal reductions in flow increase the longer the event lasts, suggesting an exponential function. For the sake of simplicity, however, I use a linear function to calculate the traffic flow impacts. Since the cumulative stoppage comprises a series of events, rather than a single event, it is unlikely how much Portilla, et. al.'s exponential snowball effect would apply.

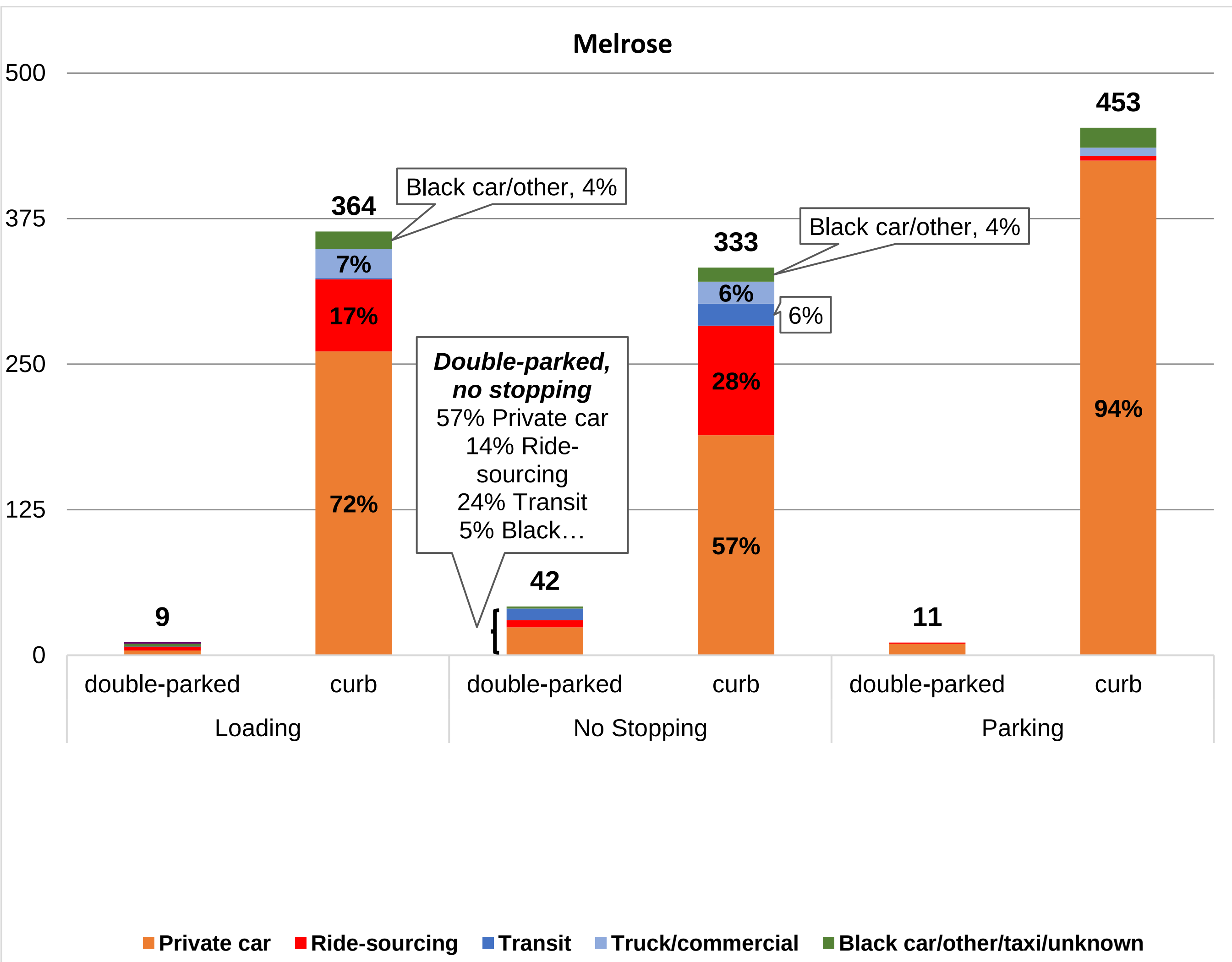
Figures 8 and **9** show how parking and double-parking activity varies by curb zone and vehicle type over the 24-hour period of the study. On Santa Monica Boulevard (**Figure 8**), the majority of double-parking occurs in the curb parking zone, in which around 60 percent of vehicles double-park. Over 80 percent of the double-parked vehicles in the parking zone are ride-sourcing vehicles and a similar proportion of vehicles parking at the curb in the zone are private cars. By contrast, in the no stopping and loading zones, ride-sourcing vehicles comprise 67 percent and 52 percent of vehicles which park at the curb. Even though ride-sourcing vehicles comprise a higher percentage of double-parked vehicles in these zones than of vehicles stopped at the curb, the number of double-parked ride-sourcing vehicles is roughly one-half to one-third of that stopping at the curb. Overall, the greatest number of vehicles stop at the curb in the no stopping zone, the majority ride-sourcing vehicles. Since the no stopping zone is supposed to avert vehicle conflicts at bus stops and around intersections, ride-sourcing vehicles stopping in this zone pose as much of a safety risk as those which double-park.

Figure 8. Vehicle Stopping Location by Curb Zone and Vehicle Type, Santa Monica.



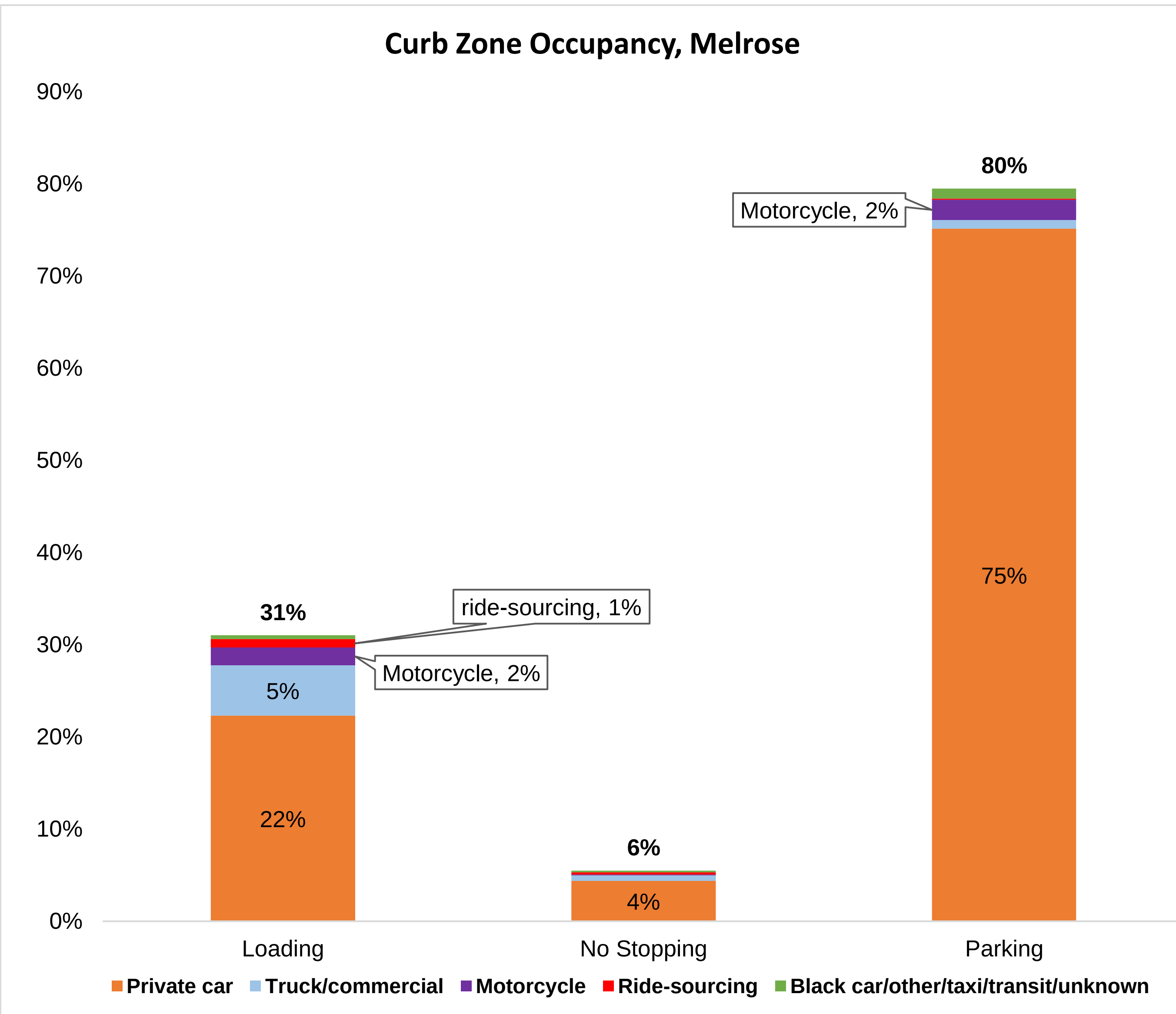
On Melrose Avenue (**Figure 9**), only the no stopping zone has noticeable double-parking activity, mainly caused by private cars (likely maneuvering for parking, in the author's experience). The category of vehicles parked at the curb varies by curb zone similarly to on Santa Monica. Over 90 percent of vehicles parking in the parking zone are cars, while ride-sourcing vehicles, transit vehicles and trucks comprise 25 percent to 40 percent of vehicles which use the no stopping and loading zones. Interestingly, more ride-sourcing vehicles stop in the no stopping zone than in the loading zone, although the distribution of ride-sourcing vehicles between the two zones is more balanced than on Santa Monica. Overall, the curb use patterns on both corridors indicate that curb parking spaces incentivize long-term occupancy by private cars. Without sufficient loading space, vehicles stopping for brief durations will gravitate towards no stopping zones or double park, impeding traffic and reducing safety.

Figure 9. Vehicle Stopping Location by Curb Zone and Vehicle Type, Melrose.



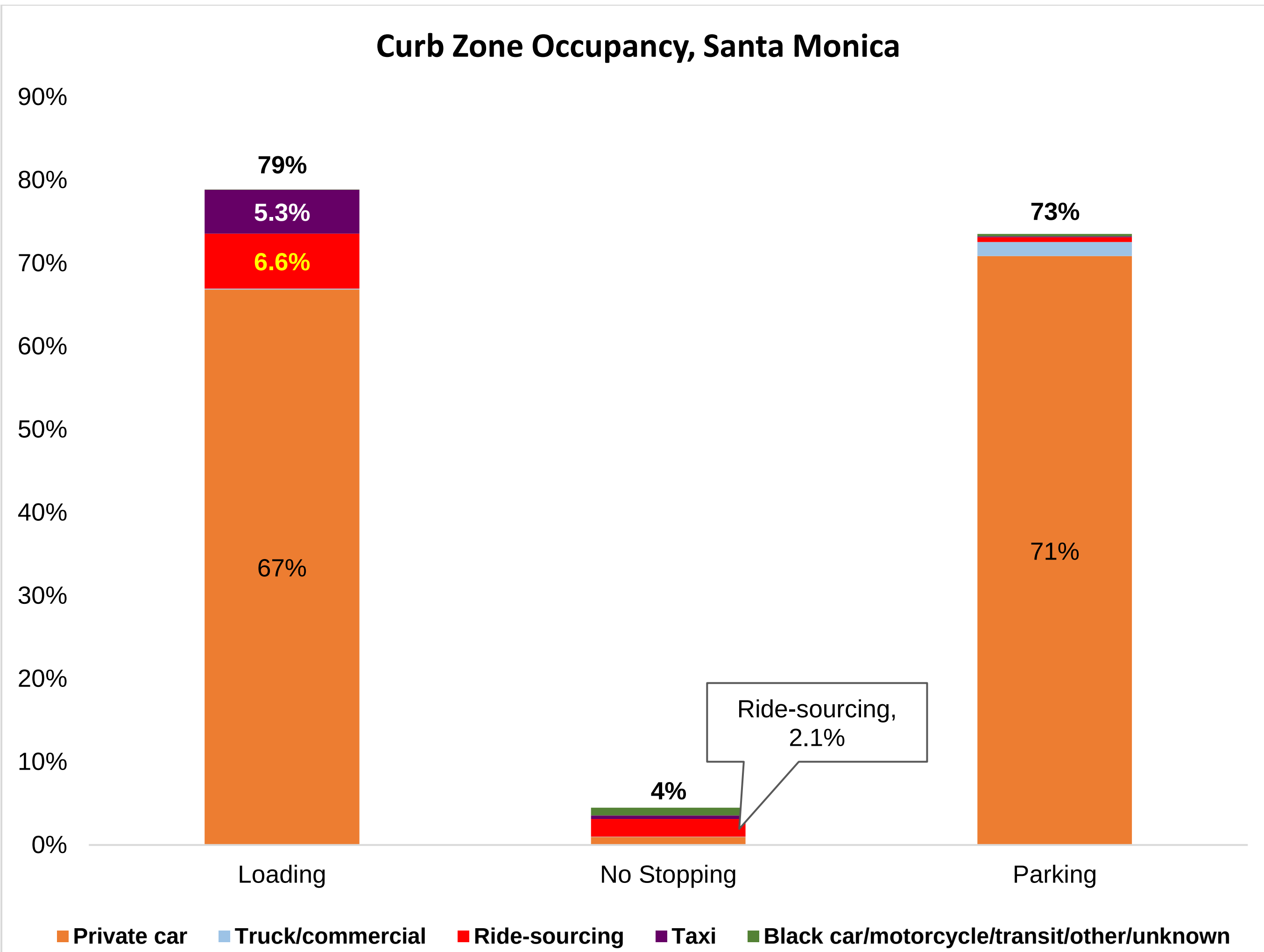
I tested this explanation by examining vehicle occupancy of curb zones over the period of the study. I calculated curb zone occupancy as a ratio of the space and time vehicles occupy in a curb zone to the total space and time available in the zone over the study period (see *Equation 1*). **Figure 10** shows that on Melrose Avenue, the curb parking zone had an 80 percent occupancy rate over the study period, in comparison to a 32 percent occupancy rate in the loading zone and 6 percent occupancy rate in the no stopping zone. At first glance, it is surprising that the zone on Melrose with the lowest occupancy has the greatest frequency of double-parking. Based on what I saw, much of the double-parking in the no stopping zone involved vehicles waiting for other cars to leave adjacent parking spaces.

Figure 10. Occupancy of Curb Space by Curb Zone on Melrose Avenue



By contrast, on Santa Monica Blvd. (**Figure 11**), the passenger loading zone's occupancy (78%), exceeds that of the curb parking zone (73%). While the high occupancy of curb parking on both streets reflects extended stays by private cars, the occupancy of the loading zone on Santa Monica suggests, in part, that private cars abuse the loading zone's time limits. Private cars occupy 66 percent of the curb space and time in the loading zone (ride-sourcing vehicles occupy a noticeable yet small share of 7 percent) while comprising less than 40 percent of the vehicles that use the loading spaces. The no stopping zone, once again, has the lowest occupancy (4%). The prohibitive mandate communicated by the red curb may discourage drivers from lingering in this zone, despite frequently using the space.

Figure 11. Occupancy of Curb Space by Curb Zone on Santa Monica Blvd.



Equation 1. Curb Occupancy (Curb zone)

$$\text{Curb Occupancy (curb zone)} = \sum_{0}^{nvtype} \frac{(T_{vehicletype} * l_{vehicletype})}{(l_{curbzone}) * S}$$

Where:

$T_{vehicletype}$= cumulative duration for which vehicles of a certain type stop at the curb, in curb zone, in seconds.

$l_{curbzone}$= length of curb zone-in feet

$l_{vehicletype}$= average length of vehicle, based on category.

S= total time spent observing, in seconds, over course of study (24 hours or 86,400 seconds).

$nvtype$ = number of vehicles of different lengths occupying the segment.

Table 15 provides further evidence that private cars tend to abuse the loading zone time limits on Santa Monica. Private cars park at the curb in the loading zone for 18 minutes on average, 13 minutes over the five-minute time limit. Likewise, private cars parked for 14 minutes on average on Melrose (**Table 14**). Taxis in the Santa Monica loading zone[36] have an even higher average duration than cars.

Table 14. Mean Duration of Vehicles (minutes) Stopped at the Curb, Melrose

Vehicle Type	Loading	No stopping	Parking
Black car	0.1	2	9
Commercial	18	6	17
Motorcycle	112	13	119
Other	63	0	227
Private car	14	7	48
Ride-sourcing	2	0.8	10
Taxi	3	0	0
Transit	0.1	1	0
Truck	20	5	71
Unknown	1	1.3	31

[36] All but one of the taxis observed in the study stopped on Santa Monica making the corridor's taxi data more representative than that from Melrose.

Table 15. Mean Duration of Vehicles (minutes) Stopped at the Curb, Santa Monica

Vehicle Type	Loading	No stopping	Parking
Black car	1	0.9	19
Commercial	2	1.4	61
Motorcycle	0	12	7
Other	0	1	4
Private car	18	3	48
Ride-sourcing	1.5	0.7	2
Taxi	19	5	11
Transit	0	0.4	0
Truck	0.5	0	62
Unknown	0	2	0.5

Taxis' extended stays (which the author personally witnessed) could reflect on the dramatic decline in patronage of these services in the aftermath of the rise of ride-sourcing. Alternatively, larger more deep-rooted, structural shortcomings with taxi service could be at fault. As mentioned previously, street-hail taxis' lack of information on actual demand leads them to oversupply service in perceived hot spots that would limit matching with customers. However, even dispatch services lack the seamless coordination of rider and driver matching provided by ride-sourcing platforms as well as a surge pricing mechanism and flexible employment that can adjust driver supply levels to meet changes in demand (National Academies 2016). Indeed, Cramer and Krueger (2016) found that across the five cities they studied, UberX drivers had a 50 percent higher utilization rate (or percent of total miles driven with a passenger) than taxi drivers on average. In Los Angeles, the authors found that taxi drivers' low utilization rate (of around 40 percent) remained consistent from 2009 to 2015 indicating that taxis' low matching efficiency, and the curb use patterns which derive from them, predate ride-sourcing-related service drops (Cramer and Kruger 2016). Although many Los Angeles-area taxi companies have adopted mobile applications modeled on ride-sourcing platforms, most riders still seem to request rides through traditional dispatch and street-hailing operations (Brown 2018).[37]

Thus, the prevalence of double-parking activity on Santa Monica Blvd results largely from the prioritization of curb parking over passenger loading in allocating curb space. As loading zone time limits are ineffective at forcing quick turnover by private cars and taxis, these vehicles hoard the limited loading space on Santa Monica to the detriment of ride-sourcing pickups and drop-offs. By contrast, on Melrose, the more generous supply of loading space accommodates both time abusers and actual short-term loading.

[37] At least one of the taxi drivers I observed parking approached passengers every so often apparently to negotiate fares.

Parking's inducement of prolonged occupancy on Santa Monica manifests in **Figure 12**, which shows that the higher proportion of curb parking space on Santa Monica results in a higher occupancy of the corridor (relative to Melrose). Deriving an occupancy statistic for the entire length of each corridor from the equation for curb zone occupancy (see *Equation 2*) reveals that Santa Monica has a ten percent greater occupancy than Melrose, with curb parking occupying a 14 percent higher share of available space and time on the former corridor.

Equation 2.

$$\text{Curb Occupancy (corridor)} = \sum_{0}^{nvtype} \frac{(T_{vehicletype} * l_{vehicletype})}{(l_{corridor}) * S}$$

Where:

$T_{vehicletype}$= cumulative duration for which vehicles of a certain type stop at the curb, in seconds.

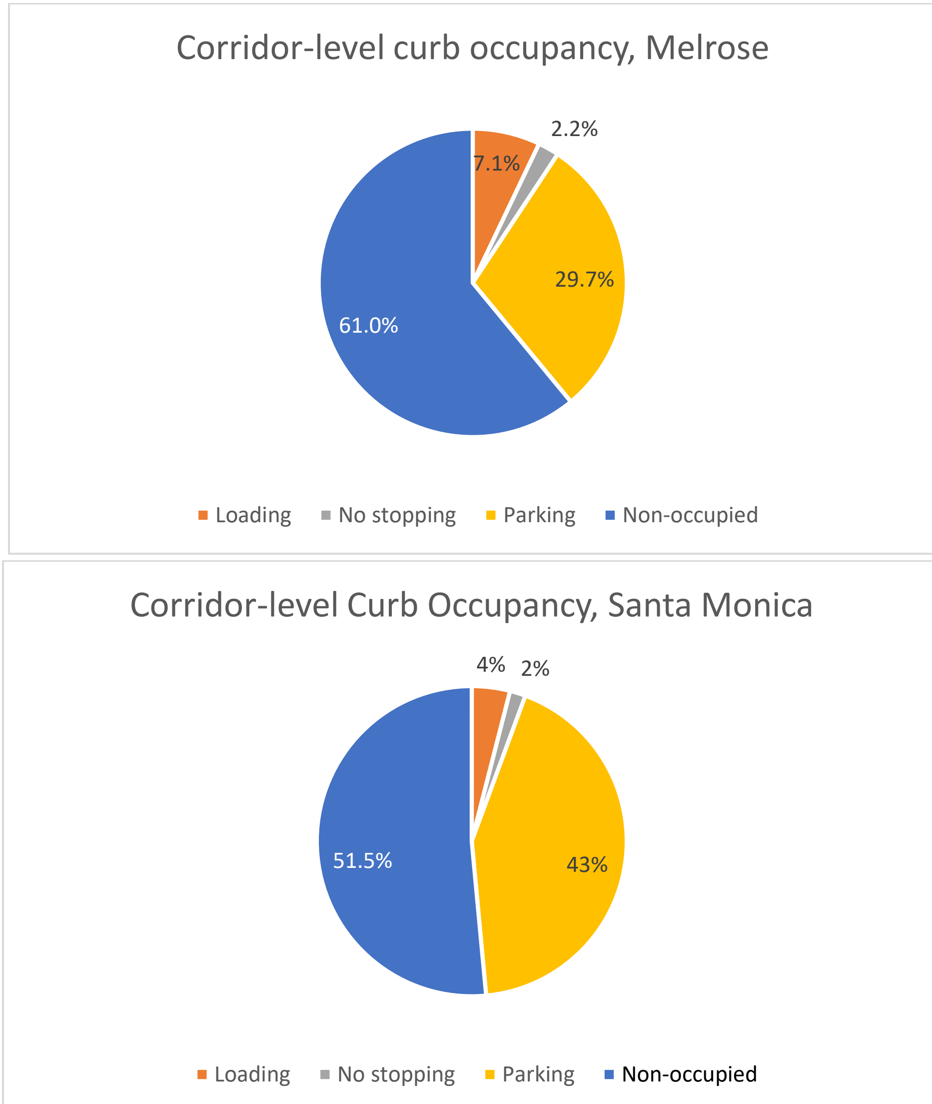
$l_{corridor}$= length of corridor-in feet

$l_{vehicletype}$= average length of vehicle, based on category.

S= total time spent observing, in seconds (24 hours or 86,400 seconds).

$nvtype$ = number of vehicles of different lengths occupying the segment.

Figure 12. Corridor-level Curb Occupancy, Melrose and Santa Monica.



Passenger Transport and Curb Productivity

Curb space ultimately serves as a "terminal" for road vehicles, at which vehicles deliver passengers to and from roadside destinations (Weinberger 2012). Thus, I analyze the productivity of curb space on Santa Monica and Melrose in terms of the number of passengers which different types of (non-commercial) vehicles deliver to and from the curb.

Vehicles transported passengers in frequencies proportionate to which they stopped at the curb (refer back to **Table 9**). During the hours of study, ride-sourcing vehicles delivered 65 percent of passengers to and from the 792-foot long Santa Monica Blvd corridor, while private cars transported over 80 percent of passengers to and from the 1020-foot long Melrose corridor (**Table 16**). On average, ride-sourcing vehicles transported 292 passengers per 500 feet of curb space per hour on Santa Monica, while private cars transported only 111 passengers on Santa Monica Boulevard and 53 passengers on Melrose Avenue in the same interval of space and time. On both corridors, transit vehicles transported the third-largest category of passengers Over the span of the study period, ride-sourcing vehicles delivered 17,102 passengers to and from the curb in the Santa Monica Boulevard study area, a figure greater than the estimated weekday ridership along the entire route of Metro's 4 local bus[38] (which runs along the same corridor).

Table 16. Passengers Delivered to and from the Curb by Vehicle Type

	Melrose			Santa Monica		
Vehicle Type	(1) Passengers Total	(2) Percent Total	(3) Per 500 ft per hour $(\mathbf{1})/\mathbf{24} * (\mathbf{500}/\mathbf{1020})$	(4) Passengers Total	(5) Percent Total	(6) Per 500 ft per hour $(\mathbf{4})/\mathbf{24} * (\mathbf{500}/\mathbf{1020})$
Black car	20	1%	0.4	308	2%	8
Motorcycle	41	1%	1	21	0.1%	1
Other	7	0.2%	0.1	14	0.1%	0.4
Private car	2,613	81%	53	4,226	25%	111
Ride-sourcing	427	13%	9	11,100	65%	292
Taxi	6	0.2%	0.1	120	1%	3
Transit	82	3%	2	1,241	7%	33
Unknown	15	0.5%	0.3	72	0.4%	2
Total	**3,211**	**100%**	**66**	**17,102**	**100%**	**450**

Individual vehicles on Santa Monica Boulevard tended to carry more passengers to or from the corridor than on Melrose (**Table 17**). On Melrose Avenue, private cars, ride-sourcing vehicles, black cars and transit each transported around three passengers per vehicle on average. On Santa Monica Boulevard, the average private car and the average ride-sourcing vehicle each transported around five passengers per vehicle. Black car and transit vehicles transported even more passengers per vehicle (between six and seven) on average during the evening study period on Santa Monica Boulevard. The median (or 50th percentile) vehicle served only one passenger less than the average for private cars and ride-sourcing vehicles, indicating minimal skewing effects. Given the nightlife and entertainment traffic on Santa Monica, the higher mean and median figures of passengers transported per private car may reflect persons carpooling with a designated driver. The number of passengers per ride-sourcing and black car vehicle on Santa

[38] As of March 2018, the line had an average weekday ridership of 14,628 persons. http://isotp.metro.net/MetroRidership/IndexAllBus.aspx

Monica suggests passengers' willingness to carpool to save money on high fares.[39] For all categories, a custom of persons "going out" to nightlife destinations in groups could contribute to the increases in passengers per vehicle.

Table 17. Average and Median number of Passengers Transported by Vehicle Type

Vehicle Type	Melrose		Santa Monica	
	Average	**Median**	**Average**	**Median**
Black car	2.5	2	6.4	5
Motorcycle	1.9	2	4.2	4
Other	3.5	3.5	2.8	2
Private car	2.8	3	4.8	4
Ride-sourcing	2.5	2	5.4	4
Taxi	6	6	2.9	2
Transit	2.7	2	7.1	8
Unknown	1.4	1	4.8	2
Total	**2.7**	**2**	**5.3**	**2**

On Santa Monica Blvd., double-parked vehicles delivered 41 percent of passengers transported to and from the curb (**Table 18**). In an average hour, double-parked vehicles on Santa Monica delivered twice as many passengers to and from the curb as were delivered in total on Melrose. Most of the passengers transported by double-parked vehicles on the former corridor alighted from or entered ride-sourcing vehicles. Double-parked ride-sourcing vehicles delivered 40 more passengers per hour than ride-sourcing vehicles parked at the curb and over 100 more passengers per hour than private cars parked at the curb. By encouraging ride-sourcing vehicles to double-park (as discussed previously), the allocation of curb space on Santa Monica for long-term parking seems to diminish the curb's effectiveness in accommodating passenger transport.

[39] Ride-sourcing companies' "surge pricing" typically goes into effect on weekend evenings.

Table 18. Passengers Served per Hour (total divided 24) by Vehicle Parking Status

Double-parked vs. Curb	Melrose		Santa Monica	
	Double-parked	Curb	Double-parked	Curb
Black car	0	1	6	6
Private car	2	106	26	149
Motorcycle	0	2	0	1
Transit	1	3	1	50
Ride-sourcing	1	17	256	202
Taxi	0	0	2	4
Unknown	0	1	1	2
Total	**4**	**129**	**293**	**413**

Indeed, **Tables 19** and **20** show that private cars on the two corridors transport only one-tenth of a passenger to and from the curb per minute of curb space occupied. Even on Melrose, where private cars transport the highest quantity of passengers, cars occupy a share of time (equivalent to around 430 hours or over 17 days) disproportionate to the number of passengers they transport. This contrasts with ride-sourcing vehicles, which transport one-and-a-half passengers per minute occupied on Melrose and almost six passengers per minute occupied on Santa Monica. Ride-sourcing vehicles served more passengers per minute of occupancy on both corridors than any category of (non-commercial) vehicle other than transit. Transit vehicles served roughly twice as many passengers per minute as ride-sourcing vehicles on Melrose and three times as many passengers per minute on Santa Monica.

Transit's more productive use of the curb implies that when passengers substitute transit trips for ride-sourcing, they may inadvertently decrease curb efficiency (Circella, et. al. 2018). As I noted earlier, however, ride-sourcing trip substitution for inconvenient transit trips can relieve transit-dependent households from having to obtain private vehicles, the least productive means of travel. The low frequency of service on Melrose (recall **Table 9**) during the study hours, in particular, suggests that transit can more effectively service travel to and from the corridor when complemented by ride-sourcing.

While ride-sourcing and transit vehicles transport two to three times as many passengers per minute on Santa Monica as on Melrose (corresponding to the increase in the number of passengers per vehicle), the number of passengers private cars transport per minute remains constant. Because private cars occupy curb parking zones on the two corridors for a similarly lengthy duration, their passenger throughput relative to their occupancy of the curb barely changes, even though their absolute passenger throughput doubles.

Table 19. Passengers Transported on Melrose per Minute Spent at the Curb

Vehicle Type	(1) Total Passengers	(2). Seconds at curb	(3). Minutes (2)/60	(4) Passengers per minute (1)/(3)
Black car	14	720	12	1.2
Motorcycle	39	159,512	2,659	0.01
Private car	2,551	1,548,131	25,802	0.1
Ride-sourcing	396	16,024	267	1.5
Taxi	6	158	3	2.3
Transit	62	1,162	19	3.2
Total	**3,090**	**1,793,333**	**29,889**	**0.1**

Table 20. Passengers Transported on Santa Monica per Minute Spent at the Curb

Vehicle Type	(1) Total Passengers	(2) Seconds at curb	(3) Minutes (2)/60	(4) Passengers per minute (1)/(3)
Black car	142	5,394	90	1.6
Motorcycle	21	2,697	45	0.5
Private car	3,564	1,548,963	25,816	0.1
Ride-sourcing	4,847	50,492	842	5.8
Taxi	84	15,918	265	0.3
Transit	1,209	4,513	75	16
Total	**9,867**	**1,627,977**	**27,133**	**0.4**

Just as transit and ride-sourcing are more productive than private cars, a 20-foot passenger loading space is more productive than a curb parking space of the same length.[40] On Melrose Avenue (**Table 21**), curb parking spaces and passenger loading spaces transported the same number of passengers per hour, although vehicles occupied the former spaces for almost three times as many minutes per hour (**Table 23)**.

[40] The Federal Highway Administration's Manual on Uniform Traffic Control Devices recommends a length of 20 feet for parking spaces at the end of a block and 22 to 26 feet for parking spaces in the middle of a block (section 3b-19). However, parking spaces on the corridor whose lengths I measured ranged from 16 to 22 feet in depth. Thus, I obtained a count of passenger loading and no stopping spaces (the former were only marked on Santa Monica) by dividing the curb zones' length by an average of 20 feet per space. However, because the curb parking zone has gaps between spaces at certain points, applying this formula to the parking zone yields figures slightly in excess of the actual number of parking spaces on both corridors. Thus, I take the existing number of parking spaces as an estimate of parking spaces for the parking zone, regardless of whether it matches the output of the equation.

On Santa Monica Boulevard, passenger loading spaces transported four times as many passengers per hour as parking spaces (**Table 22**), although vehicles occupied them for four fewer minutes per hour. No stopping spaces along the corridor transported twice as many passengers per hour as parking spaces.

While a curb parking space on Santa Monica served twice as many passengers as on Melrose, passenger loading and no stopping spaces on Santa Monica served eight times as many passengers. With higher vehicle turnover, passenger loading spaces can more readily expand passenger throughput in response to increasing volumes of passengers. The scarcity of available passenger loading space results in many ride-sourcing vehicles utilizing no stopping space for pickups and drop offs, inadvertently generating a high level of passenger transport activity in no stopping spaces as well.

Because parking comprises a majority of curb space on Santa Monica, the average number of passengers transported per 20 feet of curb space remains is only 11 passengers per hour even if passenger throughput at the curb is high in the no stopping and loading curb zones.

Overall, ride-sourcing and transit vehicles serve at least fifteen times as many people per minute at the curb as private cars do on the Melrose and Santa Monica corridors, while on Santa Monica, passenger loading spaces serve four times as many people per hour as curb parking spaces. This suggests that allocating more curb space to accommodate short-term pickups and drop offs by ride-sourcing vehicles, on the latter corridor, could increase the productivity of curb space in its role of transporting passengers.

Table 21. Passengers Served per Curb Space per Hour, Melrose.

Melrose

Curb Zone	(1) Passengers	(2) Length (feet)	(3) Parking Spaces (2)/20*	(4) Hours	(5) Passengers per space per hour (1)/(3*4)
Loading	845	233	12	24	3
No stopping	787	406	20	24	2
Parking	1,555	381	18	24	3.6
Total	**3,187**	**1,020**	**50**	**24**	**3**
*Except for spaces in parking zone: number based on existing marked spaces.					

Table 22. Passengers Served per Curb Space per Hour, Santa Monica.

Santa Monica

Curb Zone	(1) Passengers	(2) Length (feet)	(3) Parking Spaces (2)/20*	(4) Hours	(5) Passengers per space per hour (1)/(3*4)
Loading	1,142	40	2	24	24
No stopping	5,356	290	15	24	15
Parking	3,394	462	20	24	7
Total	**6,498**	**792**	**37**	**24**	**11**
*Except for spaces in parking zone: number based on existing marked spaces.					

Table 23. Minutes Vehicles Parked at the Curb per Space per Hour.

Corridor	(1) Curb Zone	(2) Seconds vehicles stopped	(3) Minutes vehicles stopped (2)/60	(4). Minutes per space per hour (3)/(no. spaces)
Melrose				
	Loading	320,180	5,336	19
	No stopping	93,997	1,567	3.2
	Parking	1,367,655	22,794	53
Santa Monica	Loading	136,289	2,271	47
	No stopping	51,538	859	2.5
	Parking	1,463,108	24,385	51

Limitations

While my chosen methodology offers numerous insights, no research design is without flaws. One problem with my methodology is the use of a limited number of locations and dates. Characteristics unique to my corridors and periods of observation could have affected the results. I sought to limit bias resulting from the arrangement of curb zones by choosing corridors that had curb zones distributed across different locations rather than clustered by a particular site. Still, on both Santa Monica and Melrose, a large proportion of the no stopping zone lies adjacent to particular transit stops, while the curb parking on Santa Monica Boulevard abuts some of the more popular nightlife destinations. Unlike Melrose, Santa Monica is a divided roadway. By restricting U-turns and left turns to large intersections, divided roads often have increased through traffic flow in each direction—potentially explaining differences in observed volume between the corridors (Harwood 2000) Observing only one side of the street (and thus one direction of traffic) on Santa Monica should have mitigated this effect. Melrose and Santa Monica each have two signalized intersections in the observation area. Since Santa Monica intersects arterial streets and Melrose intersects local streets, the signals likely cause more delay per cycle on the former corridor (as the signal gives more time to the intersecting street).[41]

Although the three-week observation period limited influence by activities specific to a particular day, projects or events specific to the time of year could still have affected my results: for instance, my assistants and I noted reduced activity on Santa Monica on February 9th and 10th, the first two nights of the 2018 Winter Olympics. Nevertheless, traditional traffic engineering studies frequently examine a handful of locations for a limited number of tests or trial runs to determine travel times along corridors (Quiroga and Bullock 2016) or estimate parking demand (Shoup 2005). Since my study is the first of its kind, I anticipated that it would serve as a gateway to academic inquiry rather than offering a final conclusion. Future researchers can address the constraints in my study's site and time of observations by reduplicating my study in different contexts.

Even more significantly, the different times of day at which I conducted my observations on Melrose and Santa Monica likely account for the extensive variation in ride-sourcing activity between the two corridors—which, in turn, affected their curb occupancy metrics. Several studies (e.g. Murphy 2016, National Academies of Sciences 2018) suggest that ride-sourcing usage is temporally concentrated late on weekend evenings, in Los Angeles and other cities. Different times of day might also be associated with differences in weather and perceived safety that could affect ridership. Although, I anticipated that the land uses on Melrose would result in an earlier period of peak ride-sourcing activity, the different time at which I observed on Melrose (compared to Santa Monica) prevents me from attributing the different levels of ride-sourcing activity exclusively to characteristics of the corridor.

Since my assistants and I identified ride-sourcing vehicles by their "trade dress," we may have mistaken ride-sourcing vehicles conducting personal trips (e.g. parking to run errands) for vehicles engaged in ride-sourcing activity. Moreover, some vehicles observed during the study seemed to engage in ride-sourcing activity without displaying the trade dress. I instructed observers to use nuances in driver behavior (for instance, tapping a phone when passengers depart) to distinguish ride-sourcing and private vehicles. Ride-sourcing vehicles whose drivers appeared to conduct personal trips were classified as private vehicles.

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[41] Signal cycling or "phasing" refers to the number of movements a signal alternates between to accommodate movement in all directions at an intersection. See: https://ops.fhwa.dot.gov/publications/fhwahop08024/chapter4.htm#4.0

Generally, my analysis was limited by the difficulty I had obtaining data ride-sourcing companies (Henao 2017). If I had concrete data on ride-sourcing pick-ups and drop offs in Los Angeles, for instance, I could have more easily determined sites with a high volume of ride-sourcing on which to focus for my study. Studies of truck loading and unloading tend to use trip generation and travel demand models derived from data on existing trips in a region to estimate the demand for loading space across the region's entire geography (e.g. Jaller, et. al. 2013). Because I did not have the data necessary to devise such a model, I had to rely on the less precise method of manual recording.

Finally, some of the data my assistants collected were incomplete or difficult to classify. During one of the shifts on Melrose, an assistant failed to record data on vehicles parked at the curb on arrival, while on one of the shifts on Santa Monica, an assistant did not attend to a space in her position's viewing area for the first 45 minutes of the study. During three out of the six observation periods on Santa Monica, an assistant did not distinguish 20-minute from 2-hour parking, while on one of the observation dates on Melrose, an assistant likewise failed to differentiate commercial and passenger loading. [42] Thus, I had to evaluate curb parking on Santa Monica and loading zones on Melrose as single categories, although doing so likely concealed differences in use of the sub-categories of the two curb zones.

Findings

My study finds that ride-sourcing vehicles make productive use of curb space, serving more passengers per minute of curb space occupied than any vehicle category other than transit. Allocating curb space for cheap, long-term curb parking prioritizes the storage of private automobiles over passenger transport. At the same time, lack of effective enforcement of passenger loading spaces facilitates (illegal) long-term stays by private cars and taxis at the expense of brief ride-sourcing pickups and drop offs. On corridors with a high volume of ride-sourcing activity, use of most available curb space for parking, together with high occupancy of the limited passenger loading zones, forces many ride-sourcing vehicles to double-park or park in red curb zones to pick up or drop-off passengers. Such activity not only degrades the flow of traffic and public safety but fails the curb's role as a terminal for passenger transport.

[42] Only 3 of the 19 marked parking spaces on Santa Monica have 20-minute time limits: the remainder have 2-hour time limits. Thus, curb parking characteristics in this study mainly reflect on the 2-hour parking.

Recommendations

Based on my findings, I recommend that cities convert curb parking and transit zones to short-term loading space on commercial corridors at periods with high volumes of ride-sourcing activity. Cities could fund such conversions by charging a market price for curb parking and by metering the use of loading space (similar to short-term parking space) for periods of more than five minutes. The latter measure would have the added effect of disincentivizing over-use of the loading space by private cars and taxis.

1). Convert curb parking and transit zones into general-purpose short-term loading space at times with high ride-sourcing activities

Increasing the supply of passenger loading space on corridors with high levels of ride-sourcing, like Santa Monica Boulevard, can prevent or reduce the incidence of ride-sourcing vehicles double-parking or stopping in no stopping zones. Cities like West Hollywood can increase the supply of loading space through converting curb parking space. Because passenger loading spaces have higher turnover and transport more passengers per space, such conversion would increase the productivity of the converted spaces as road transport terminals. Recent pilot programs in Fort Lauderdale, Florida (which converted 18 parking spaces to ride-share loading zones during evening hours in January 2018 (Las Olas Boulevard Association, 2018)) and in Washington D.C. (which converted 60 parking spaces to night-time pickup and drop-off zones in October 2017 (Schneider 2017)) provide a potential model for such a process.

As an example, **Table 24** shows that based on the current rate of 25 passengers per loading space per hour, converting 12 of the 19 curb parking spaces on Santa Monica to passenger loading spaces could accommodate the total number of passengers delivered to and from by double-parked vehicles (87 percent of which would be delivered by ride-sourcing vehicles). [43]

Table 24. Number of Loading Spaces Needed to Accommodate Passengers Transported in Double-parked Vehicles

(1) Passengers per loading space per hour (1)/(3*4)	(2) Passengers per double-parked vehicle per hour	(3) Number of loading spaces to accommodate double-parked passengers (2)/(1)
24	293	12

Transit and tour bus stopping zones currently designated as no stopping space can likewise permit loading by ride-sourcing and other shared-mobility vehicles at off-peak hours. Although

[43] This assumes of course that passenger throughput and vehicle turnover remain the same. As the analysis section shows, private cars stay in the loading spaces for periods of time well over the legal time limit. Ensuring better compliance with time limits can improve turnover and passenger throughput at the curb.

the no stopping segments adjoining intersections are justified for safety purposes, as much as one-third (94 feet) to three-fifths (231 feet) of the no stopping space on Santa Monica and Melrose respectively consists of a transit zone to accommodate bus loading. Another 27.9 feet of no stopping space on Melrose comprises a “sightseeing bus zone” to accommodate stopping by tour bus vehicles. Transit buses on both corridors provide make the most efficient use of curb space, and it would likely be undesirable to permit stopping activity that would interfere with vehicle operations.

However, data from observer positions (refer back to the maps in **Figures 2** and **3**) that aligned with transit zones in each study area shows heavier utilization by ride-sourcing vehicles. On Melrose, the two transit zones and one tour bus zone corresponding to the third observer position served only one transit vehicle carrying two passengers per hour, as compared to three ride-sourcing vehicles carrying eight passengers per hour (**Table 25**). If we generously assume tour buses correspond to the vehicles categorized as “other” and “unknown”, then they consumed a negligible share of curb space in the vicinity of the tour bus zone. Although the transit zone aligning with the third observer position on Santa Monica Blvd registered more robust transit service, with seven vehicles per hour, ride-sourcing vehicles still utilized curb space more than twice as frequently as transit and delivered slightly less than twice as many passengers (**Table 26**). Cities should work with transit agencies to develop shared-use curb space arrangements at transit and tour bus zones on corridors or at times of day with low transit or tour bus use and high ride-sourcing activity. Such arrangements could take the form of the “commons” curb zone proposed in Klein, et. al.’s (1997) *Curb Rights*, a zone which would permit stops by both private, on-demand “jitney” services and public, fixed-route transit operators.

Figure 13. Infographic advertising the pilot ride-sharing loading zone program along Las Olas Boulevard in Fort Lauderdale, Florida.[44]

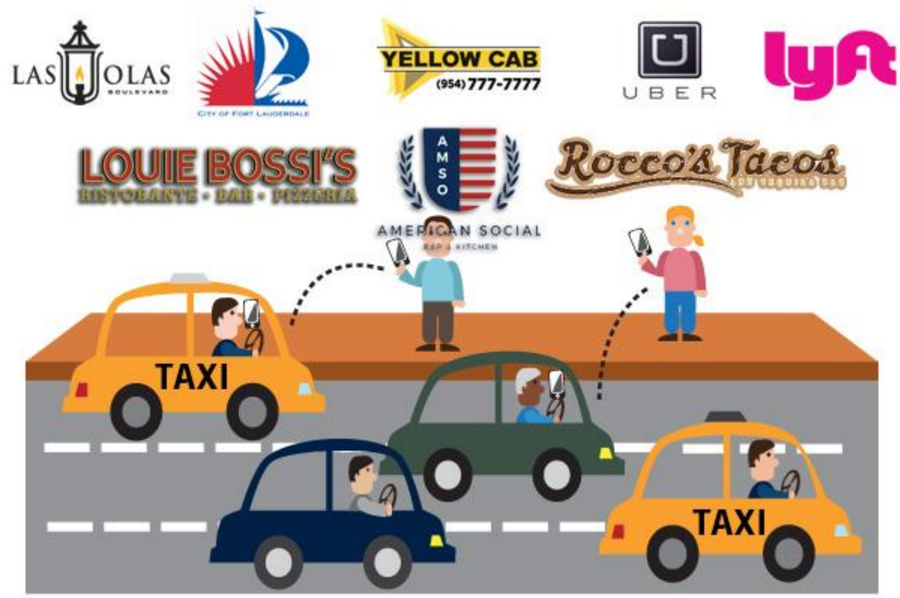


Table 25 Vehicles and Passengers Utilizing the Transit Zone and Tour Bus Zone areas (Observer Position III) on Melrose Avenue

Vehicle Type	(1) Vehicles (Study Period)	(2) Passengers (Study Period)	(3) Vehicles per hour (1)/24	(4) Passengers per hour (2)/24
Black car	1	12	0.0	0.5
Commercial	7	15	0.3	0.6
Motorcycle	7	12	0.3	0.5
Other	2	7	0.1	0.3
Private car	188	452	8	19
Public transit	18	55	1	2
Ride-sourcing	75	199	3	8
Taxi	1	6	0.04	0.3
Truck	2	6	0.1	0.3
Unknown	1	2	0.04	0.1
Total	**331**	**820**	**13**	**34**

[44] The city designated 18 parking spaces for passenger loading (with a time limit of 5 minutes) by taxis, ride-sharing and private vehicles along a popular nightlife corridor. The loading zones are in effect between 5pm and 3am on from Monday through Thursday and from 11am on Friday to 3am on Monday. Source: https://lasolasboulevard.com/city-fort-lauderdale-launches-designated-rideshare-pickup-drop-off-zones-e-las-olas-boulevard/

Table 26. Vehicles and Passengers Utilizing the Transit Zone area (Observer Position III) on Santa Monica Boulevard

Vehicle Type	(1) Vehicles (Study Period)	(2) Hourly (1)/24	(3) Passengers (Study Period)	(4) Passengers per hour (3)/24
Black car	8	0.3	62	3
Commercial	1	0	2	0.1
Other	2	0	6	0.3
Private car	51	2	108	5
Ride-sourcing	443	18	2,118	88
Taxi	5	0.2	14	1
Transit	175	7	1,209	50
Truck	1	0.04	0	0
Total	**686**	**29**	**3,519**	**147**

One implication of my research is that use of the curb by ride-sourcing vehicles varies by the time of day. The ten-fold differential between ride-sourcing vehicles stopping at or near the curb on Melrose and Santa Monica suggests that, even on weekends, ride-sourcing activity at the curb is much lower during the afternoon (and morning) periods than in the evening. This substantiates previous studies indicating that avoiding driving while intoxicated is a common factor for use of ride-sourcing (Murphy 2016, Henao 2017). A breakdown of ride-sourcing activity on Santa Monica by the hour at which vehicles arrived (**Figure 14** on page 56), shows a dramatic increase within the course of the four-hour study period, with over half of ride-sourcing vehicles arriving during the final hour of observation. Double-parking activity increases commensurately with the growth in ride-sourcing (**Table 27**). Curb usage characteristics reversed over the study period, with private cars comprising the majority of vehicles arriving during the first hour and ride-sourcing vehicles comprising the prominent share during the last two hours.

Curb space uses already vary temporally to an extent. Parking meter enforcement in most cities expires after a certain hour (e.g. midnight on Santa Monica), while commercial loading zones in both Los Angeles and West Hollywood are effective only between 8am and 6pm. [45] The pilot ride-sharing loading zone programs in Fort Lauderdale and in Washington D.C. both go into effect exclusively during the evening hours and daytime hours on weekends (the loading zones in Fort Lauderdale are effective from 5pm to 3am on evenings, Monday through Thursday and on weekends from 11a m on Friday to 3am on Monday; the loading zones in Washington are in

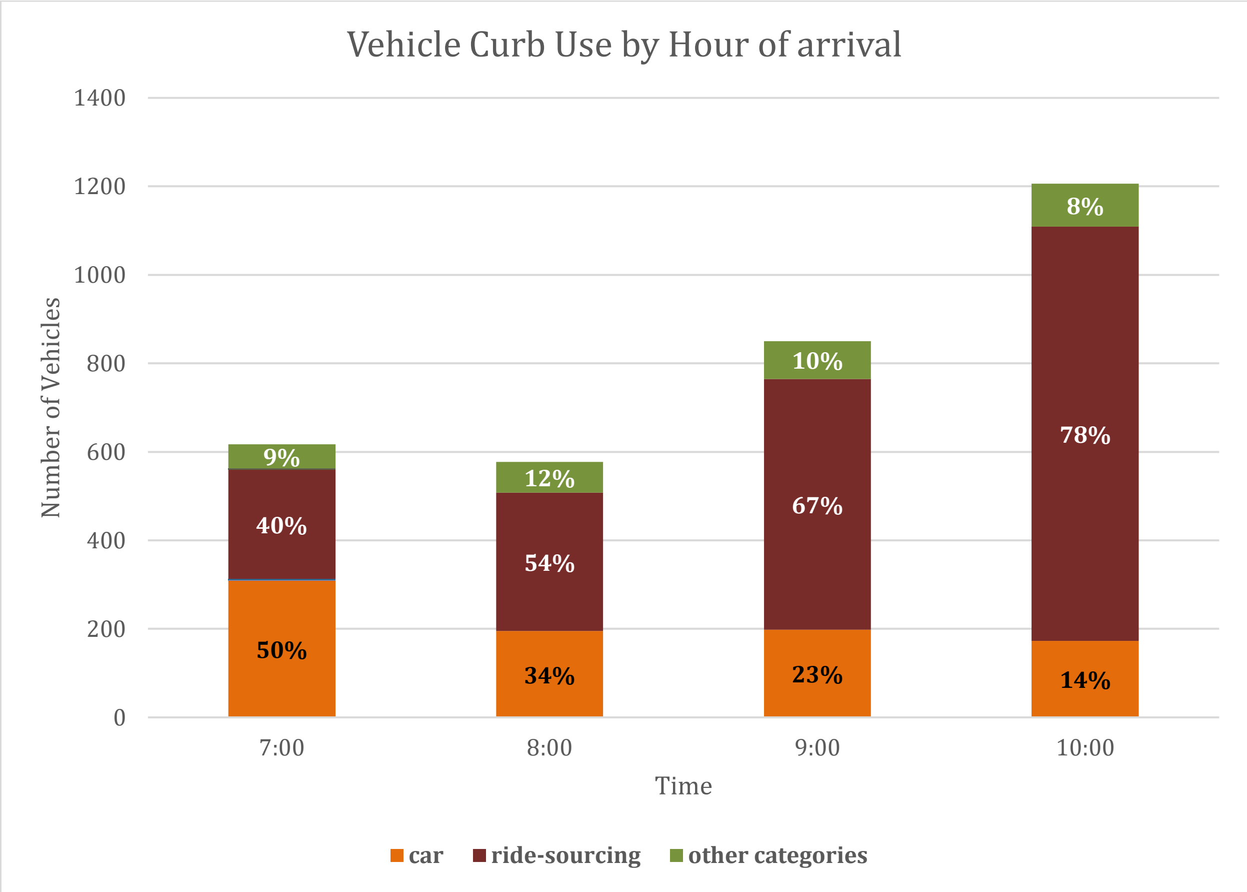
[45] See: https://www.weho.org/city-hall/city-departments/public-works/parking-services/parking-meters/rates-hours-of-operation for West Hollywood. For Los Angeles, see: Colored Curb Zones | City of Los Angeles Department of Transportation. (n.d.). Retrieved May 29, 2018, from http://ladot.lacity.org/what-we-do/parking/can-i-park-there/colored-curb-zones

effect from 10pm to 7am, Thursday through Saturday). However, the hourly variation of activity on Santa Monica suggests that adjustments should be made on a more fine-grained basis, with hourly changes in curb zones based on composition of vehicle traffic to and/from the curb.

Table 27. Double-parked Vehicles on Santa Monica Blvd. by Hour of Vehicle Arrival.

Hour of arrival	**7:00-8:00**	**8:00-9:00**	**9:00-10:00**	**10:00-11:00**	**Total**
Double-parked	196	241	383	562	1,382
Curb	406	325	450	615	1,796
Total	**602**	**566**	**833**	**1,177**	**3,178**

Figure 14. Vehicles Stopping at the Curb by Hour of Arrival. (*Times shown on the x-axis mark beginning of the hour*).



Ride-sourcing companies can enable accurate and routine assessments of demand (and reallocation of curb space) by simply sharing their extensive data with municipal governments. Cities can complement these data through use of remote camera technologies (which already allow the remote cataloging of vehicle traffic on city streets) and sensors such as those used by demand-responsive parking programs (Pierce and Shoup 2013), that can assess the changes in occupancy in different curb zones. [46]

2). Charge the Right Price for the Curb

One obstacle to converting a curb space from parking to loading is that it will result in the loss of a source of public revenue. In most cities, curb parking provides substantial revenue to the city's general fund. In cities like San Diego, this revenue stream has made governments reluctant to return parking meter funds to local neighborhoods without a guarantee to a share of revenue (Shoup 2005). The manager of Fort Lauderdale's rideshare loading zone program noted that expanding the project beyond the pilot phase would require compensation for the loss of parking meter revenue (McFarland 2017).

Cities can both offset the loss of curb parking revenue and incentivize more productive curb use by charging a market-level rate for curb parking. Currently, the hourly curb parking rate on Santa Monica of $1.50 per hour is half the hourly rate for parking in the nearby public parking lots at the West Hollywood Park and the West Hollywood Library (which charge $3.00 per hour in the evenings after 6pm). [47] Since curb parking provides more convenient access to destinations on a corridor than off-street parking and is often perceived as being safer (Shoup 2005), it should be valued at a higher price than off-street parking. **Tables 28** and **29** show that the city of West Hollywood could retain 80 percent of the current average hourly revenue from metered parking on Santa Monica, following the conversion of 12 out of 20 parking spaces, if it charged the same hourly rate as the off-street public parking lots. If the city charges a slightly higher rate of $3.75 per hour, it will suffer no net loss in revenue despite having twelve fewer spaces.[48]

[46] Miovision uses mounted, remote-controlled cameras to monitor traffic flow in real-time (link). Demand-priced parking programs such as San Francisco's ExpressPark use curbside sensors to determine whether curb space is under-utilized or occupied, in order to vary the price of parking relative to demand.

[47] See https://www.weho.org/city-hall/city-departments/public-works/parking-services/parking-structure-city-lot-directory/west-hollywood-park-municipal-parking-structure-ii and https://www.weho.org/city-hall/city-departments/public-works/parking-services/parking-structure-city-lot-directory/west-hollywood-library-municipal-parking-structure-iii

[48] Rather than a fixed rate, prices should ideally vary so that they achieve a target vacancy rate, reflecting variations in the demand for parking (as suggested by Pierce and Shoup 2013).

Table 28. Hourly Revenue from Curb Parking space on Santa Monica Blvd with Current and Market-rate Pricing

Vehicle Type	(1) Vehicles in Parking Zone (study period)	(2) Hourly per space (1)/(24*20)	(3) Average Duration (minutes)	(4) Revenue per space per hour, $1.50 rate (2)*(3)*(1.5/60)	(5) Revenue per space per hour, $3.00 rate (2)*(3)*(3/60)	(6) Revenue per space per hour, $3.75 rate (2)*(3)*(3.75/60)
Black car	4	0.01	0.3	$0.00	$0.00	$0.00
Commercial	7	0.01	61	$0.02	$0.04	$0.06
Motorcycle	3	0.01	7	$0.00	$0.00	$0.00
Other	1	0	4	$0.00	$0.00	$0.00
Private car	495	1	48	$1.23	$2.46	$3.07
Ride-sourcing	97	0.2	2	$0.01	$0.02	$0.03
Taxi	2	0.004	11	$0.00	$0.00	$0.00
Truck	1	0.002	62	$0.00	$0.01	$0.01
Unknown	2	0	1	$0.00	$0.00	$0.00
Total	***612***	***1.3***		***$1.27***	***$2.53***	***$3.16***

Table 29. Hourly Revenue from Curb Parking on Santa Monica, with Current Parking Spaces and Following Conversion of Parking spaces to Passenger Loading.

(1) Rate	(2) Hourly Revenue per Space	(3) No. of Spaces Current	(4) Hourly Revenue Current (2)*(3)	(5) No. of Spaces with conversion	(6) Hourly Revenue with conversion (2)*(5)
$1.50	$1.27	20	$25.32	8	$10.13
$3.00	$2.53	20	$50.64	8	$20.26
$3.75	$3.16	20	$63.30	8	$25.32

Charging a market rate for curb parking would have the additional benefit of incentivizing higher turnover in the curb parking zone. Drivers parking for two hours currently save more money by parking at the curb than drivers parking for only one hour (see **Table 30**). As I discussed in my literature review, Shoup (2005) hypothesizes that savings on curb parking incentivize drivers to cruise circuitously until a vacancy opens up. The amount of time drivers will tolerate “cruising” in such fashion varies in proportion to the amount they save on curb parking.[49] Shoup and Pierce (2013) find that parkers are particularly price-sensitive at leisure destinations (such as Santa Monica), likely producing an even stronger incentive to cruise. Hence, the low-price of curb parking on corridors like Santa Monica encourages lengthy stays and high levels of occupancy, as cars parking for the longest durations are most likely to wait for spaces until they open up. Indeed, the author repeatedly observed cars on the corridor maneuver into parking spots within 10 to 20 seconds of a car driving away.

Table 30. Savings from Parking at the Curb on Santa Monica

(1) Hourly rate: Curb Parking	(2) Hourly rate: Public Parking	(3) Hours Parked	(4) Price in Lot (2)*(3)	(5) Price at Curb (1)*(3)	(6) Savings (4)-(5)
$1.50	$3.00	1	$3.00	$1.50	$1.50
$1.50	$3.00	2	$6.00	$3.00	$3.00

Closing or inverting the price differential between curb and off-street parking in such a scenario would remove the incentive for long-term parkers to cruise, freeing up occupancy for more short-term vehicle usage. Shoup's study of cruising for curb parking in Westwood Village (Shoup 2005) estimated that implementing a market-rate parking price would double turnover and halve occupancy. If market-priced curb parking on Santa Monica Blvd likewise doubles hourly turnover, then the curb parking zone on Santa Monica would serve 80 percent of the vehicles it currently handles, in an average hour, with just eight spaces (see **Table 30**). The vehicles would park for an average duration of 24 minutes, rather than 48 minutes. Assuming that each vehicle carries an average of five passengers (as suggested by **Table 16**), market pricing would nearly double each parking space's passenger throughput from seven to thirteen passengers per hour (**Table 28**).

While the number of passengers served by the curb parking zone declines in aggregate in this scenario due to the conversion of spaces, the increase in passengers served by loading spaces will more than offset the reduction. Long-term parkers that previously used the curb parking zone may instead choose to park in off-street parking facility, trading the time cost of walking for monetary savings on parking (Pierce and Shoup 2013), or to use an alternative mode of transportation, freeing up space for the short-term parkers who may have previously (mis-)used the loading zone or no stopping zone.

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[49] The full equation for the amount of time at which one will be indifferent to cruising for parking is given as $t * \frac{m-p}{f-nv}$ where t is the time parked, m= price of off-street parking, p= price of curb parking, f= cost of fuel, n= number of persons and v= value of time.

Tables 31 and **31.** Vehicles and Passengers served by a Curb Parking Space and the Curb Parking Zone ("Total Vehicles") per Hour on Santa Monica Blvd with Under-priced and Market-rate Parking Fees

(1) Vehicles per space per hour (current)	(2) Vehicles per space per hour (market-rate)	(3) Total Vehicles per hour (current)	(4) Total Vehicles per hour (market-rate) (2)*8	(5) Average Duration
1.3	2.6	25.5	21	24

(5) Passengers per space per hour (1)*5	(6) Passengers per space per hour (market-rate) (5)*(2)	(7) Total Passengers per hour (current) (5)*8	(8) Total Passengers per hour (market-rate) (6)*8
7	13	130	104

However, even if the average occupancy of a curb parking space decreases, ineffectual enforcement of loading spaces (refer back to **Tables 11** and **12**), can continue to incentivize short-term parkers to hoard loading space. Such behavior will limit the effectiveness of any loading space conversion policy.

Cities can dis-incentivize the *de facto* use of loading space for parking, after converting parking spaces to loading spaces, by retaining parking meters at the spaces (or installing mobile payment mechanisms) and charging drivers to use these spaces for more than five minutes, with an ultimate cap of 20 or 30 minutes. Cities could set a higher rate for short-term parking in these spaces than for curb parking (e.g. $1.00 rather than $.50 per ten minutes on Santa Monica Blvd.) in order to prioritize use for loading. Such tiered loading fees would privilege the brief, pre-arranged quick pick-ups and drop offs conducted by ride-sourcing vehicles, over the lengthy and indeterminate waits characteristic of private cars and taxis—without prohibiting the latter. Short-term loading spaces will likely not induce cruising activity, (of the kind that constrains parking occupancy) even if they charge a lower price than curb parking, since the limited duration permitted for use of the spaces would result in limited cost savings.

Ramped-up enforcement of loading zone time limits can complement the loading fees. License plate recognition technology, that uses cameras (mounted on parking enforcement vehicles) or handheld readers to digitally record and store data on the licenses of violating cars can prove both more efficient and cost-effective than traditional manual enforcement (Wood 2014). For example, Calgary, Canada's Park Plus system uses a combination of mobile payment (in which parking drivers pay through mobile accounts), camera-based enforcement and administrative ticketing (i.e. a peace officer inspects tickets but does not have to directly issue them) to swiftly track down and punish offenders. Cities can adopt such a model to better identify and (cite) violators.

3. Use Ride-sourcing and Shared Mobility as Tools for Managing Curb Parking Demand and Utilization

Finally, since ride-sourcing and transit vehicles appear to make far more efficient use of curb space than private vehicles, policy-makers and planners should encourage use of these and other forms of shared mobility on commercial corridors with a high level of activity in order to increase curb space productivity. Even on Melrose, where ride-sourcing vehicles transported only 12 percent of persons arriving or departing, these vehicles occupied the curb for a fraction of the time occupied by private cars for each passenger they delivered (refer back to **Table 19**).

Planners have long used Transportation Demand Management (TDM) measures as tools to mitigate the traffic impacts of commercial and residential development. My study suggests that planners should consider Curb Parking Demand Management ("CPDM") measures on commercial corridors, to streamline the curb utilization associated with high volumes of (desirable) visitor traffic.

First, planners can exempt new commercial developments from requirements to provide off-street parking (often instituted as a response to curb parking shortages) in return for implementing loading space for ride-sourcing and other shared-mobility vehicles. Planners can simultaneously incentivize use of shared modes by requiring these developers to provide transit passes to employees and to offer discounts or promotions to customers who use ride-sourcing or transit. Uber's "Local Offers" program, which offers Visa Credit Card holders in select markets ride rebates for shopping at particular businesses, could provide a model for the customer promotions (Constine 2016).

More importantly, planners can work with businesses on corridors identified as having curb parking problems—through liaising with neighborhood business associations or Business Improvement Districts (BIDs)--to implement the aforementioned ride-sourcing and transit promotion programs, in tandem with converting a few of the existing curb parking spaces on the corridor to short-term loading spaces. Through continually evaluating the performance of such measures and successively adjusting measures to improve their efficacy (e.g. raising the price of curb parking to reach a desired turnover rate), cities may be able to improve curb space's transport capacity, reduce net levels of driving and counter double-parking activity.

On a final note, assessing the performance of curb space requires that cities have comprehensive information on their curb space in commercial districts. My evaluation of curb space allocation for my project, required that I view curb markings in Google Earth, as both the cities of Los Angeles and West Hollywood lacked complete, uniform data on the location of curb zones. While the Los Angeles Department of Transportation (LADOT) has a shapefile of parking meter locations in the city, and the city of West Hollywood provided me with data on loading zone locations, neither city had data available on the location of red curb zones or non-metered parking. Furthermore, the city of West Hollywood could not provide information on the criteria for determining red curb and loading zones. Sadly, studies such as De Cerreño et. al. (2004), which found that a majority of cities belonging to the National Association of City Transportation Officials (NACTO) lacked data on their curb zones, suggest that these shortcomings are far too common. In a new era of on-demand shared mobility, city governments must not only better allocate curb space but manage it, as a valuable resource.

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Appendix

Table 32. Business License Categories included in Retail- and Entertainment-related Business License density metric (**Figure 3**).

City	Business Category
Los Angeles (Primary NAICs Description)	Art Dealers
	Beer/Wine
	Book Stores
	Clothing Accessories
	Drinking Places
	Full-service restaurants
	Gifts/novelties
	Men's Clothing
	Museums
	Other Clothing
	Shoe Stores
	Traveler Accommodation
	Women's Clothing
Santa Monica (Business Type)	Art Gallery, Dealer
	Artist, Artisan
	Bar
	Bar / Entertainment
	Book
	Clothing / Accessories
	Coffee
	Coffee House
	coffee store
	Delicatessen
	General Merchandise
	Gifts, Handicrafts
	Restaurant
	Shoes
	Used and New Books
West Hollywood	Dance
	Entertainment
	Public Eating
	Public Eating with Alcohol