International Transport Forum

Parking Prices and Availability, Mode Choice and Urban Form

Discussion Paper

181 Roundtable

Sofia F. Franco

Nova University of Lisbon

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Introduction

Parking policies have significant environmental and economic implications, including effects on climate change, air pollution, energy consumption, traffic congestion, housing affordability and economic development. Parking – on-street and off-street – is also responsible for the consumption of vast amounts of land, and it accounts for a substantial share of the social costs of car ownership and use.

Like food and housing, parking is necessary. Most car users expect to find free parking at home, at work and at various destinations such as stores, churches, restaurants, schools and parks. A possible explanation is that parking is typically not supplied as a response to the market, but required by mandate. It tends to be bundled with most land uses, covering large areas with asphalt and parking structures. In addition, the infrastructure required for parking is expensive. Providing for it drives up construction and rental prices and often forces developers to build in more distant, cheaper locations with poor access to amenities such as public transport, in essence shifting parking costs into higher product prices and lower wages.

Parking subsidies also encourage private car use because they collectivise the cost of parking. In the absence of such subsidies, and disregarding the external costs of parking, the individualised parking cost that drivers would incur would be very high, particularly in urban cores. Yet, employer-paid parking, on-street parking subsidies, and free parking at shopping malls partially shield automobile users from a substantial share of the private cost of car use. As a result, parking is free or heavily subsidised because everything else is more expensive.

Availability of parking spaces affects commuters' mode choice. All car trips start and end in a parking space. When parking is scarce or hard to find at either or both ends of a trip, the relative advantage of public transport exceeds that of car use. However, people will often drive walkable or bikeable distances if parking is easily available. Therefore, policies that contribute to an abundant parking supply, especially in areas well served by public transport, work at cross-purposes with the goals of reducing solo driving and increasing the use of sustainable travel modes.

Despite current expectations in many cities, parking does not need to be free. To achieve a shift from private cars to more sustainable methods of transport it is important to understand the many ways that the price and availability of parking at both ends of a trip influence automobile use, land use and urban form. This will allow for the development of appropriate land-use planning, parking reforms and infrastructure provision and increase the use of sustainable transport modes, such as walking, biking or public transport, to services and places of employment.

This paper provides insights on how the price and availability of parking influence mode choices and urban form and, how parking reforms may achieve important policy goals. It discusses how minimum off-street parking requirements, employer-provided parking and parking cash-outs affect land consumption and car ownership and use. Most of the evidence it provides is based on the cases of Los Angeles (LA) County and the City of Los Angeles, California in the United States, though a few examples from other cities in the United States and elsewhere are also included.

The next section starts by providing estimates of construction and land costs for different types of parking spaces in different locations of LA County. This is important as planners cannot know how much parking mandates increase the cost of development and its other cost implications if they do not know the cost of required parking spaces. In fact, most parking costs are borne indirectly, through mortgages and rents (for most off-street parking provided as part of building developments), or general taxes (for on-street parking on local roads). The paper illustrates how parking minimums may impact the development cost of residential and non-residential buildings in the City of Los Angeles. Since the total cost of providing parking varies by location, the shadow cost of blunt mandated parking is also spatially variant, influencing the location and type of parking supplied and ultimately urban form. Next, the paper discusses in detail the effects of parking mandates on parking supply and on urban form. It then turns to the importance of accurately assessing how much parking exists in cities. Parking inventories are important to planners, property developers, investors and lenders as they can uncover an opportunity to build more efficient cities. Because the availability of parking at both ends of a trip and the price of parking can affect commute mode choices, the paper then provides evidence on how both parking price and availability influence automobile use. The section further discusses how employer-paid parking and parking cash-outs influence suburbanisation levels and travel mode choices. Finally, the paper's conclusion gives special attention to the practical implications of parking reforms.

How much does it cost to supply a parking space?

For cities to reform parking policies, they need to understand two things: 1) how developers make decisions about parking and 2) how costly the provision of mandated parking is. For instance, while market-rate developers build parking either to satisfy perceived demand or in response to pressure from financial investors, parking minimums typically act as a determinant for the amount of parking built (Cutter and Franco, 2012; Stangl, 2019). Therefore, it is important to know how much different parking structures cost and their impact on the overall the cost of development.

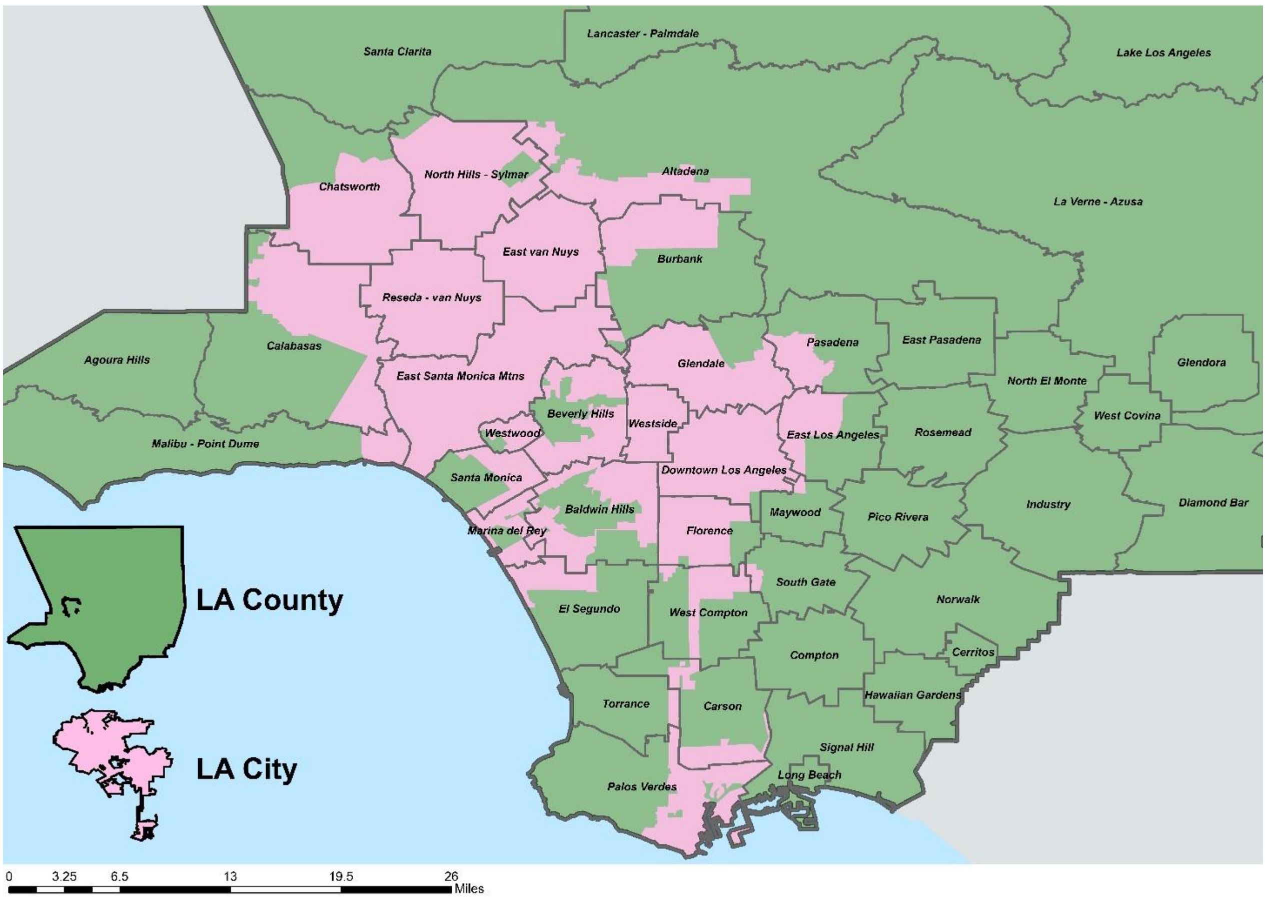
On average, a typical car is driven only 5% of the time (Shoup, 2005). This means that cars spend 95% of their time parked on the street or in a parking facility. In LA County, the parking spaces required by cities to store unused cars covers at least 200 mi^2 of land. This is equivalent to 14% of the County's incorporated land area (Chester et al., 2015; Shoup, 2018). Supplying so many parking spaces is expensive. In fact, the cost of building a single parking space can amount to far more than the net worth of many American households (Shoup, 2016).

Los Angeles County and the City of Los Angeles

Figure 1 shows Los Angeles County and the City of Los Angeles[1]. Los Angeles County is the most populous county in the United States, with around ten million inhabitants as of 2018, according to the U.S. Census Bureau. It has 88 incorporated cities and many unincorporated areas in its 4 083 mi^2. Its county seat is the City of Los Angeles. As of 2018, about four million residents lived in the approximately 469 mi^2 that fall within the limits of the City of Los Angeles. It is the most populous city in California and the second-most populous city in the United States, after New York City.

Los Angeles County is also widely recognised for its automobile dependence and issues associated with traffic congestion, which may be due to the decentralised nature of the county's density along freeway corridors. The County currently has more lane-miles of arterials, highways, and interstates per square mile than any other US metro area (FHWA, 2013). However, the area occupied by roads is only a fraction of the land devoted to automobiles, since the total land area dedicated to on- and off-street parking is 40% larger than the 140 mi² dedicated to the roadway system (Chester et al., 2015). In addition, LA County offers more abundant and free parking than many other metro areas in the United States (Manville and Shoup, 2005). This infrastructure is scattered throughout the metropolitan area in on-street parking spaces and off-street parking lots and structures, as detailed later in the paper.

Figure 1. Los Angeles County and the City of Los Angeles



Cost of a typical parking space

The total cost to build a parking space embeds land, construction, and operating and maintenance costs. Its exact cost is determined by the type of parking to be built (surface, structured, semi-underground or underground)[2].

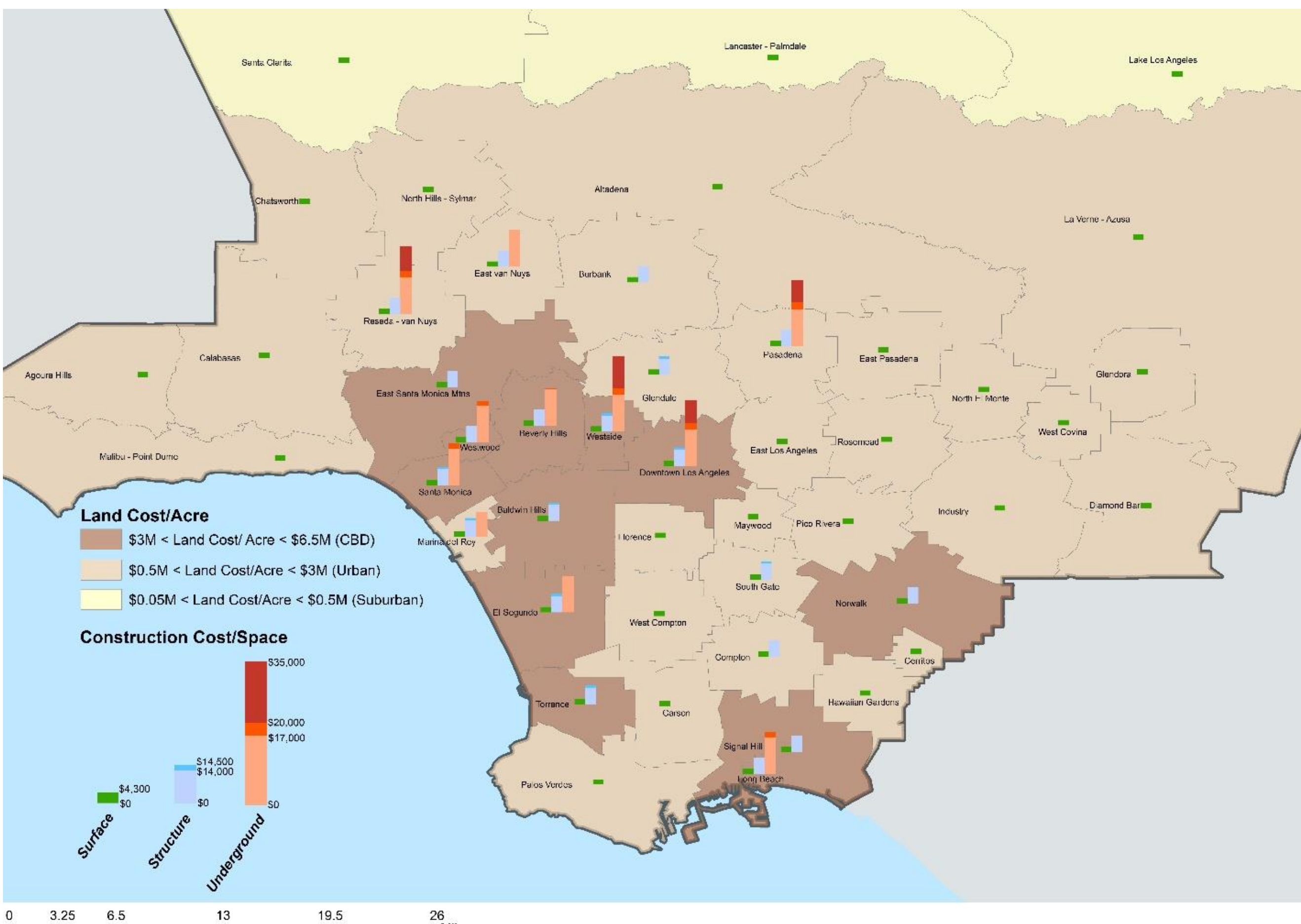
Surface parking tends to be a popular parking option among developers because of its affordability in comparison to other parking structures. They are also the easiest and quickest to build. On the other hand, above-ground parking garages offer a vertical solution, allowing for more parking spaces per acre of land than surface lots, but at a higher cost. Structured parking also requires more capital investment and construction time than surface lots. Underground parking is the third and most expensive option for parking, primarily because it requires excavation. It is also more challenging from engineering and geological standpoints.

Figure 2 illustrates Franco's (2016) estimates of the average construction cost per space for various types of parking in 46 areas of LA County (suburbs, urban and the central business district), and Zhang and Arnott's[3] estimates of the land costs per acre throughout the County[4]. Both costs are measured in 2000 United States Dollars (USD). The average construction cost estimates assume a 350 ft^2 efficiency per space[5]. The classification of each of the 46 areas shown on the map as suburban, urban, or central business district (CBD) is also based on the square foot land values by Zhang and Arnott.

Because operation, maintenance (e.g. cleaning crews, gate operators and security), indirect and environmental costs, and underground land values are absent, the costs in Figure 2 underestimate the cost of a typical parking space[6]. Yet, the price tag shown provides a sense of how expensive it can be to build a parking space, particularly in CBDs and coastal urban areas.

Based on Figure 2, surface parking lots typically cost around USD 4 282 per space. In contrast, it is estimated that the average construction cost of an underground parking space ranges from USD 11 637 to USD 34 956, while the construction cost of an above-ground structured parking space can range between USD 13 924 and USD 14 522 per space.

Figure 2. Los Angeles County: land cost per acre and average construction cost per space



Note: Costs are in 2000 USD; CBD = central business district.

When taking into account land costs, there is a large component for surface parking wherever land prices are high. For instance, the land cost of a 350 ft^2 surface parking space can vary from USD 664 (in suburban Lake Los Angeles) to USD 11 000 (Urban East Los Angeles), USD 34 000 (Santa Monica), USD 36 000 (Downtown Los Angeles), or USD 54 000 (Baldwin Hills).

Therefore, when land costs are included it turns out that surface parking can be the most expensive kind of parking in dense cities and CBDs of the County. Moreover, high densities in downtown areas, expensive real estate and scarce public space imply that the opportunity cost of an above-ground parking space can also be very high.

It is important to note that even though on-street parking uses less land per space than off-street parking, because it requires no driveway, the land it uses often has high opportunity costs if road space needed for traffic lanes, bicycle lanes, sidewalks or greenspace is used as a curb space.

Mandated parking in the City of Los Angeles

Most cities in the United States require parking for every land use in proportion to the size of a building or based on its use. Reasons put forward to justify such mandates include preventing parking spillovers from new development into surrounding areas, reducing illegal parking, and preventing congestion from cruising for vacant on-street parking spaces. While well-intended, these mandates are highly criticised because of the way they are set, which has substantial negative effects on urban form and travel mode choices.

Cities typically set off-street parking minimums based on parking generation rates from the Institute of Transportation Engineers, which report average peak parking occupancy at a few suburban sites with ample free parking and no public transport, or rely on what other cities require.

Table 1. Default parking minimums in the City of Los Angeles

Use of building (or portions of)	Minimum parking requirements
Residential use	
Single-family dwelling	two spaces/unit
Two-family dwelling or apartment (units < three habitable rooms)	one space/unit
Two-family dwelling or apartment (units > three habitable rooms)	two spaces/unit
Commercial use	
Commercial or business office	one space/500 ft^2
Small restaurant, café, or coffee shop (1 000 ft^2 or less)	one space/200 ft^2

Source: City of Los Angeles (2020), Section 12.21.

As a result of being set with no connection to the market or to the locational features of a project site, minimum parking requirements (MPRs) likely overestimate the amount of parking required in an urban context or in areas with good public transport. By definition, MPRs set a binding floor on the amount of parking that must be built. Table 1 provides examples of the default parking minimums currently set by the City of Los Angeles.

For the most part, these minimums are considered to be too high, but developers cannot provide less parking without receiving some form of variance from the city. However, the process to request a parking reduction can be lengthy, expensive and uncertain (Manville et al., 2013). The mandates shown in Table 1 can also be higher or lower in different areas of the city depending on their specific area plans and whether a development project is granted a variance under one of the city's ordinances that provide parking minimum reductions.

In the late 1990s, the city adopted an Adaptive Reuse Ordinance, which eliminated parking requirements for development that preserves existing historic downtown buildings. Under this ordinance, old commercial and industrial buildings, if converted to residential use, are only required to maintain the existing parking supply but are not required to provide more (Manville et al., 2013). In 2012, the city approved the Cornfield Arroyo Seco Plan, which eliminated parking requirements in the north end of the downtown area. Under these two downtown regulatory measures, developers can thus decide to include as much or as little parking as makes sense for new developments.

The City of Los Angeles has also enacted several other ordinances that grant developments a by-right reduction to the parking minimum, if the development meets certain conditions. Examples include the Density Bonus Ordinance (City of Los Angeles (2020), Section 12.22-A.25), the Bicycle Parking Ordinance (City of Los Angeles (2020), Section 12.21-A) and the Transit Oriented Communities (TOC) (City of Los Angeles (2020), Section 12.22-A.31). While the Density Bonus Ordinance and TOC are not intended to reduce parking, a parking minimum reduction is one of the incentives granted to increase the city's affordable housing stock.

Cost of mandated parking

Laws that require a minimum amount of parking when parking is already difficult to provide can stifle an entire neighbourhood's growth. Though developers will provide some parking in the absence of parking mandates, back-of-the envelop calculations illustrate how the cost of complying with default parking requirements may increase the total cost of constructing, for example, a 500-square-foot office building with an underground garage.

Complying with the default parking minimum increases the cost of an office building by an average of 48%[7] in the City of Los Angeles. It is interesting to note, however, that a city average can mask spatial variation in the cost of mandated parking as parking construction costs tend to vary within the city. Table 2 illustrates how the cost of satisfying the default city parking requirement shown in Table 1 increases the total cost of constructing an office building with underground parking in different areas of the City of Los Angeles.

Similar calculations can be done for apartment buildings. The City of Los Angeles requires that two parking spaces be provided for every two-bedroom apartment. Franco (2016) estimates that the average cost of building an underground parking space is around USD 50 779 (in 2013 USD) in Downtown and USD 27 776 in El Segundo. This suggests that the parking requirement for a multi-storey apartment building would require a developer to spend USD 101 558 and USD 55 552 per dwelling unit in Downtown and in El Segundo, respectively, to comply with the city's default residential parking mandate.

It would be unsurprising, then, that developers limit the density of developments and the number of projects so to avoid the high costs incurred by the parking structure (Manville and Shoup, 2005). Such high construction costs also create an incentive for developers to build in low-density areas of the city where land is cheaper and parking requirements can be met with surface parking lots.

Often, land parcels in downtown areas are small and irregular and buildings frequently cover the entire parcel. In addition, many buildings in downtown areas are architecturally and historically significant and predate widespread car ownership. They do not have parking nor the space to add it. In these situations, providing on-site underground parking can be very expensive or even physically impossible.

Table 2. Cost of minimum parking requirements for underground parking structures in office buildings in the City of Los Angeles

City of Los Angeles area	Default mandated parking	Building area (ft^2)	Parking area (ft^2)	Construction cost (USD/ ft^2) parking	Construction cost (USD/ ft^2) building	Cost increase
Downtown Los Angeles central business district (CBD) area	1	500	350	145	158	64%
Westside CBD area	1	500	350	166	158	74%
Beverly Hills* CBD area	1	500	350	83	158	37%
El Segundo* CBD area	1	500	350	79	158	35%
Santa Monica* CBD area	1	500	350	92	158	41%
Marina del Rey* Urban area	1	500	350	55	158	25%
Westwood CBD area	1	500	350	90	158	40%
Reseda-van Nuys Urban area	1	500	350	149	158	66%
East van Nuys Urban area	1	500	350	81	158	36%
Pasadena* Urban area	1	500	350	145	158	64%

* See Figure 1 for the location of these areas.

Notes: The reader should note that the names in Table 2 refer to areas in the City of Los Angeles. For example, the areas designated as Pasadena, Beverley Hills, El Segundo and Santa Monica in Table 2 do not refer to the cities of Pasadena, Beverley Hills, El Segundo and Santa Monica. They represent the areas in the City of Los Angeles around those cities which are also part of the same name zones that compose the County as illustrated in Figure 1.
Building construction costs for a Grade A office building (an office building that has been constructed or renovated within the last five years) are measured in 2012 USD.
Parking construction costs are in 2013 USD.

Sources: Shoup (2018), Franco (2016).

Parking mandates, parking supply and urban form

Brueckner and Franco (2017) developed a two-zone spatial model of residential parking. It provides insights on the location of different parking regimes (surface, structural and underground) and how generous parking minimums may result in lower development densities and over-allocation of land to parking space.

In the model, all households own a car and value residential parking space regardless of the parking regime generating the parking area. The model assumes that households have no preference over the type of building (high-rise or low-rise) that contains their dwelling floor space. Off-street parking provides utility to households by offering more convenience and safety than on-street parking. The household has a shorter and possibly safer walk to the car, and off-street parking eliminates the search costs that may be incurred finding an on-street parking space. These benefits are assumed to increase proportionately as the amount of parking space associated with the dwelling increases. In the model, on-street parking is not priced or regulated.

All households work in a single central business district (CBD), commute to work only by car, incur commuting travel costs and earn a homogeneous income. Parking is freely available at the workplace and assumed to be provided on-site and underground for simplicity. While road congestion is omitted for simplicity, it is assumed the household experiences parking-related congestion in the neighbourhood of residence, which generates an additional neighbourhood-level travel cost. This cost is due to the congestion caused by other residents searching for an on-street space, preventing movement in and out of the neighbourhood as commuters access the road heading to the CBD. Assuming that the provision of off-street parking reduces this congestion, the extra travel cost falls as the average off-street-parking area per dwelling in the neighbourhood increases. This represents a cost-side benefit that accompanies the utility gain from a dwelling's off-street parking area.

The rental price a household is willing to pay for a dwelling includes payments for both the dwelling space and the parking area, which are bundled by the residential developer, following actual real-world practice in residential markets. Thus, the household does not face separate prices for these dwelling attributes, as would be the case if dwelling floor space and parking area were provided by separate producers.

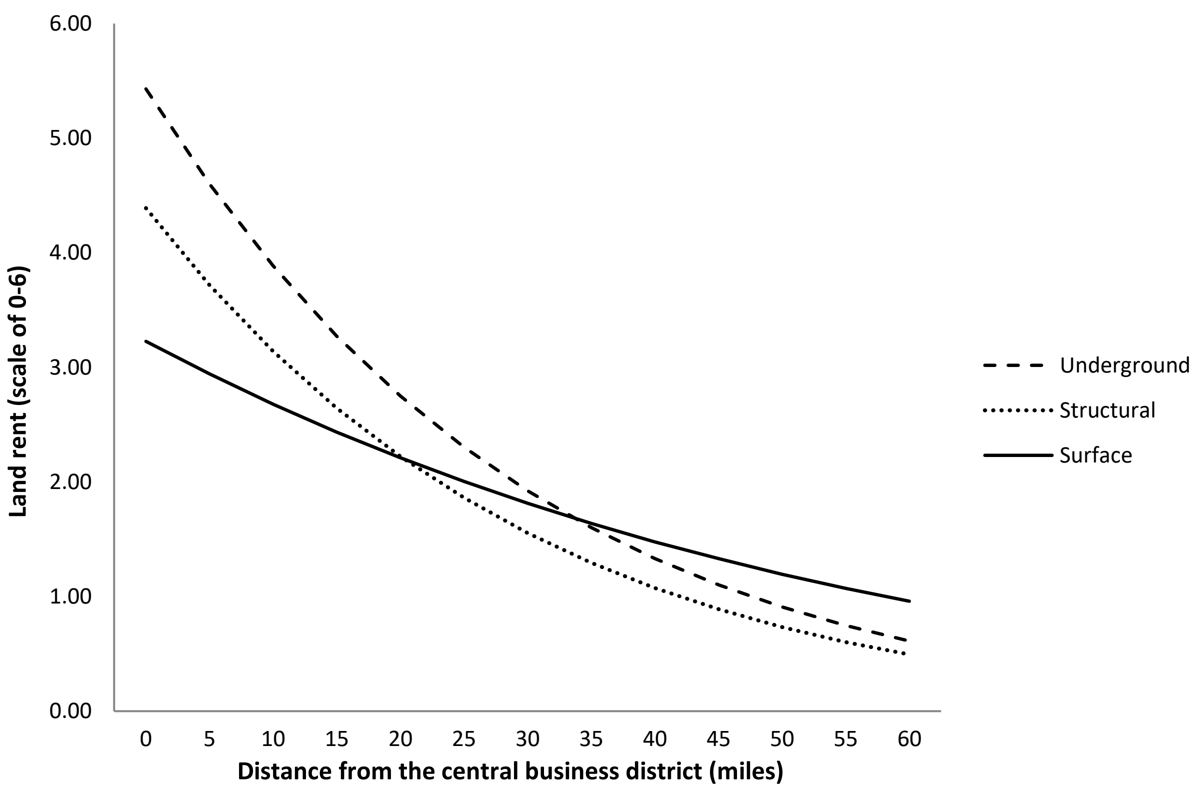
Residential developers use capital to produce floor space, which is divided into dwelling units. They also provide parking area associated with the dwelling[8]. Under any of the three parking regimes (surface, structural and underground), the developer maximises profit by choosing the dwelling size, parking area per dwelling, residential structural density (capital per unit of residential land, an indicator of building height) and parking inputs, taking into account the maximum rental price households are willing to pay for a dwelling in each location[9]. However, atomistic developers who ignore the collective beneficial effects of their off-street parking choices per dwelling create congestion in the neighbourhood, where on-street parking is unable to meet the demand created by inadequate residential off-street parking.

The following analysis of urban form first addresses the spatial behaviour of the developer's choice variables. It questions whether dwelling size and parking area per dwelling increase or decrease with distance from the CBD while exploring the spatial behaviour of both residential and parking structure density. It then explores the effect of an MPR, which specifies a spatially invariant minimum level of parking area per dwelling – thus failing to incorporate the spatial variation that an omniscient urban planner would dictate, on urban form.

Location of different parking regimes

Figure 3 illustrates the location of different parking regimes in a city based on Brueckner and Franco's (2017) numerical simulations. For simplicity, they assume a linear city with a unique CBD located at point zero. Parcels close to the CBD command higher rents than suburban areas. At each location from the CBD, land is allocated competitively to one of three residential uses, which differ by the type of parking provided with a dwelling. Land is allocated to the best and most valuable use in a specific location. As a result, a particular parking regime will be present in a given location if developers using that regime bid more for land than developers using the other regimes. Therefore, the relative locations of the parking regimes can be inferred by considering the heights and the slopes of the land-rent curves in Figure 3.

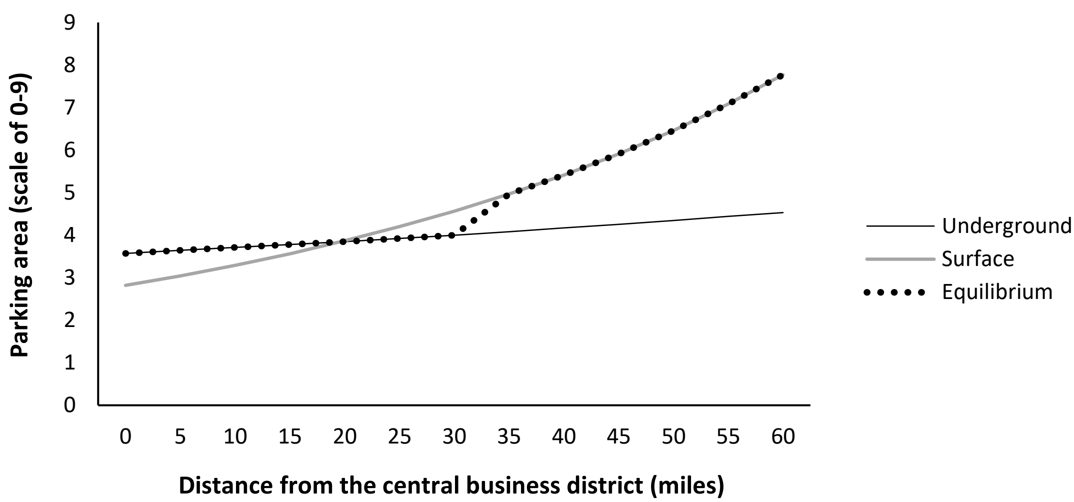
Figure 3. Land rent under different parking regimes



As expected, Figure 3 shows the use of surface parking in the city's suburban area, where land is cheaper, and one of the other parking regimes (structural or underground) in the higher-priced city centre. However, because land rent with structured parking in the numerical example is always dominated at each location by the land rent with either underground or surface parking, the only two parking regimes that will exist in equilibrium are underground and surface parking.

While Figure 3 helps understand which land use and, therefore, parking regime will be chosen at different locations in the city, Figure 4 provides the equilibrium spatial profile of the amount of parking area supplied per dwelling.

Figure 4. Equilibrium parking area per dwelling



It is interesting to note that regardless of the parking regime, the amount of parking area increases with distance from the CBD, being much higher in the suburbs than towards the central core. This is consistent with anecdotal evidence and is related to the fact that parking area is more costly to supply in central city areas than in fringe areas where room for expansion and cheaper land allow for more parking at a reasonable cost. The spatial behaviour of parking land in equilibrium is thus illustrated by the envelope (dotted line) of the two lines that reflect the spatial behaviour of parking area under each parking regime.

Urban form with and without minimum parking requirements

Figures 5 and 6 illustrate the impacts of generous parking requirements on parking area and dwelling size based on Brueckner and Franco's (2017) numerical example. The first interesting feature to note from these figures is that the market equilibrium resulting from the developers' choices is not efficient: dwelling sizes are too big and parking area per dwelling is too low when compared to the optimal solution (when the externality is internalised in developers' decisions).

In the unregulated scenario (without MPRs), developers do not account for the collective positive effect of on-site parking choices per dwelling on the parking-related congestion in the neighbourhood (due to e.g. cruising for off-site parking). Thus market equilibrium, in terms of dwelling size and parking area per dwelling, is not efficient.

Figure 5. Market (equilibrium) and optimal parking areas in the presence and absence of minimum parking requirements

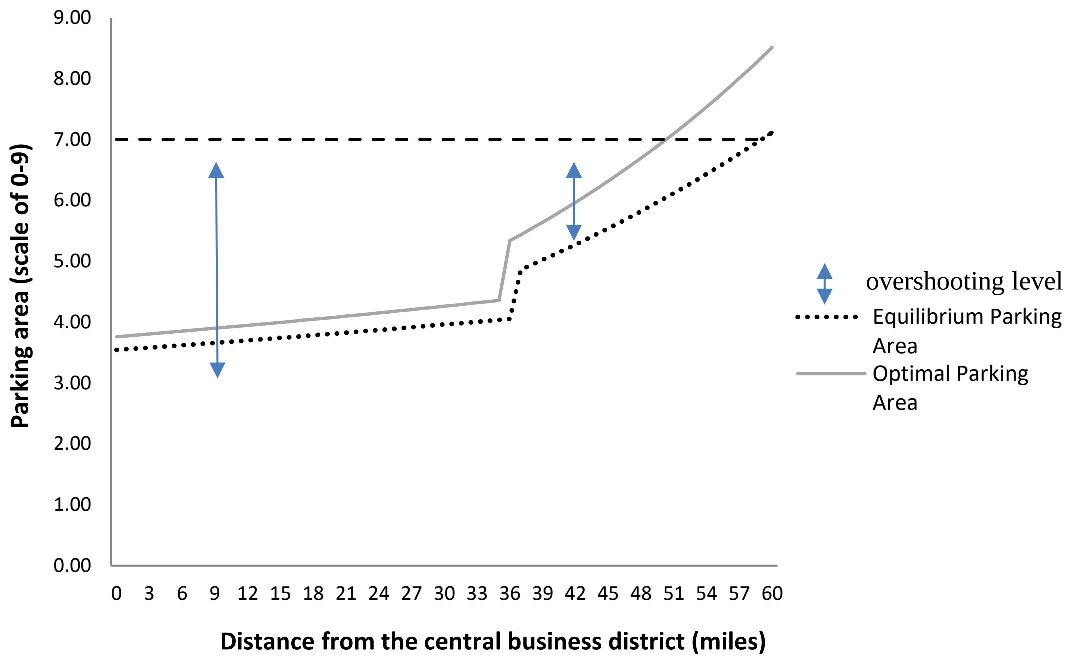
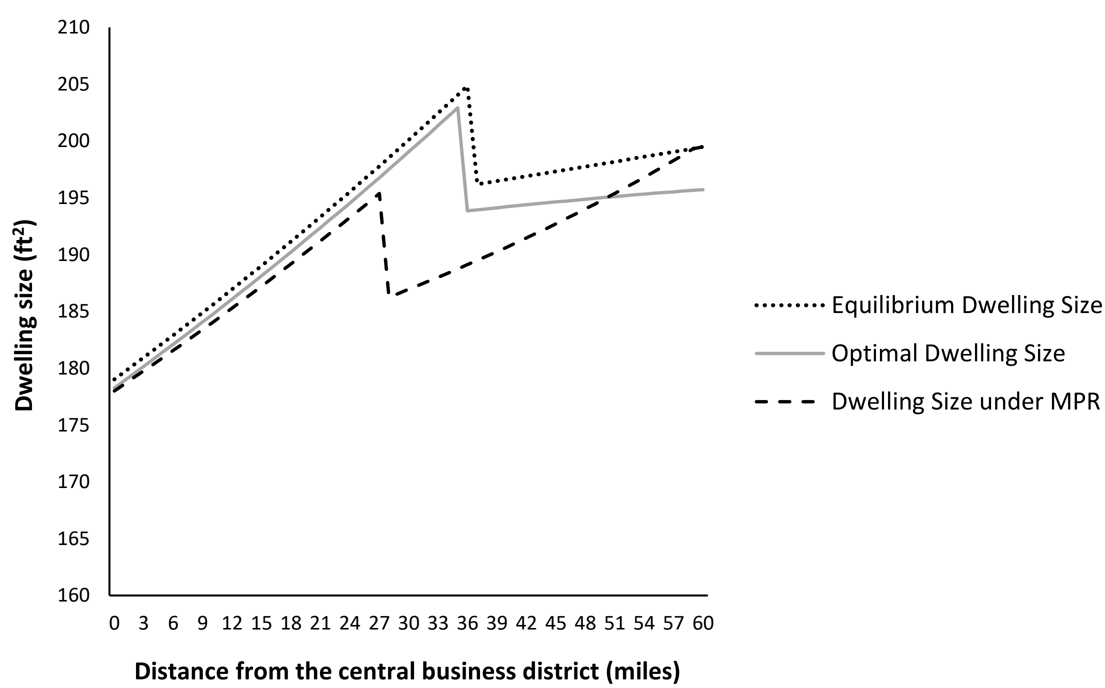


Figure 6. Market (equilibrium) and optimal dwelling sizes in the presence and absence of minimum parking requirements



Cities often take the crude approach of imposing a uniform minimum parking requirement throughout the city, as seen earlier in Table 1, whereas the optimal solution would be to raise parking area per dwelling above the private equilibrium value at each location in the city. Under such a blunt policy, when the minimum parking area required per dwelling far overshoots the optimal value, the underground regime is much more constrained compared to the surface parking regime because surface parking area per dwelling tends to be higher both in the equilibrium and optimal cases. As a result, land rent falls more drastically for the underground regime than for the surface regime in the boundary between the parking regimes, leading to the expansion of the surface parking area (that is, more parcels will be developed for residential use with surface rather than underground parking). This over-allocation of land to surface parking creates sprawling areas that are inhospitable to non-automotive forms of transport and losses of open space and biodiversity. Figure 5 also shows that the amount of over-supply of parking area due to generous parking minimums is larger near the central core than towards the suburbs. Finally, Figure 6 shows that a uniform MPR reduces dwelling sizes everywhere in the city, which, in turn, has implications for population density levels.

Are parking mandates binding constraints?

The MPR is binding almost everywhere in the numerical example provided in Brueckner and Franco (2017). However, Cutter and Franco (2012) provide empirical results designed to test whether MPRs in LA County represent binding constraints on developers. To do so, they use two approaches relying on a non-residential property database. The first approach, called denoted direct tests, compares a building's available parking area to the area mandated by the MPR. Where evidence shows that the two areas tend to be close, one might assume that the MPR constraint is typically binding. Table 3 presents the results of such a test for 249 office properties built in Los Angeles County between 1973 and 2006.

In Table 3, the difference between the average parking supplied and the estimated parking required is very close to zero. This suggests that MPRs are well enforced and binding for the office properties in the sample.

The second approach in Cutter and Franco (2012) estimates the value of additional parking using a hedonic price model, and then compares this value to the cost of providing additional parking. The results show that value is less than cost. This suggests that MPRs lead developers to provide more parking than they would voluntary, making the constraints binding.

Stangl (2019) conducted a direct test similar to that in Cutter and Franco (2012), which focused on a sample of 300 approved residential and mixed-use developments located in the City of LA between 2013 and 2018. Her results show that parking minimums did have a binding effect on the amount of residential parking built, although developers in certain areas built more parking than required. In particular, 58% of developments in her sample built at or just above their default binding minimum and 42% of developments built at least 10% above the binding minimum. The study also shows that as developments received larger parking minimum reductions, they built less parking relative to what they would otherwise have been required to build.

Table 3. Comparison of average parking supply and parking mandates for office properties in Los Angeles County

Cities in Los Angeles County	Building area (ft^2)	Parking supplied	Required parking	Difference
Alhambra	1 000	2.98	3.88	-0.90
Baldwin Park	1 000	4.90	3.75	1.14
Burbank	1 000	2.61	2.93	-0.32
Downey	1 000	2.79	2.77	0.02
El Monte	1 000	3.92	3.64	0.28
Glendale	1 000	2.18	2.60	-0.42
Long Beach	1 000	3.69	3.74	-0.04
Los Angeles	1 000	2.10	1.92	0.18
Pomona	1 000	3.63	3.98	-0.35
Inglewood	1 000	8.63	3.92	4.71
Santa Monica	1 000	1.81	3.26	-1.45
Torrance	1 000	3.20	3.29	-0.09
West Covina	1 000	3.13	3.29	-0.17
Whittier	1 000	4.21	3.26	0.95

Source: Cutter and Franco (2012).

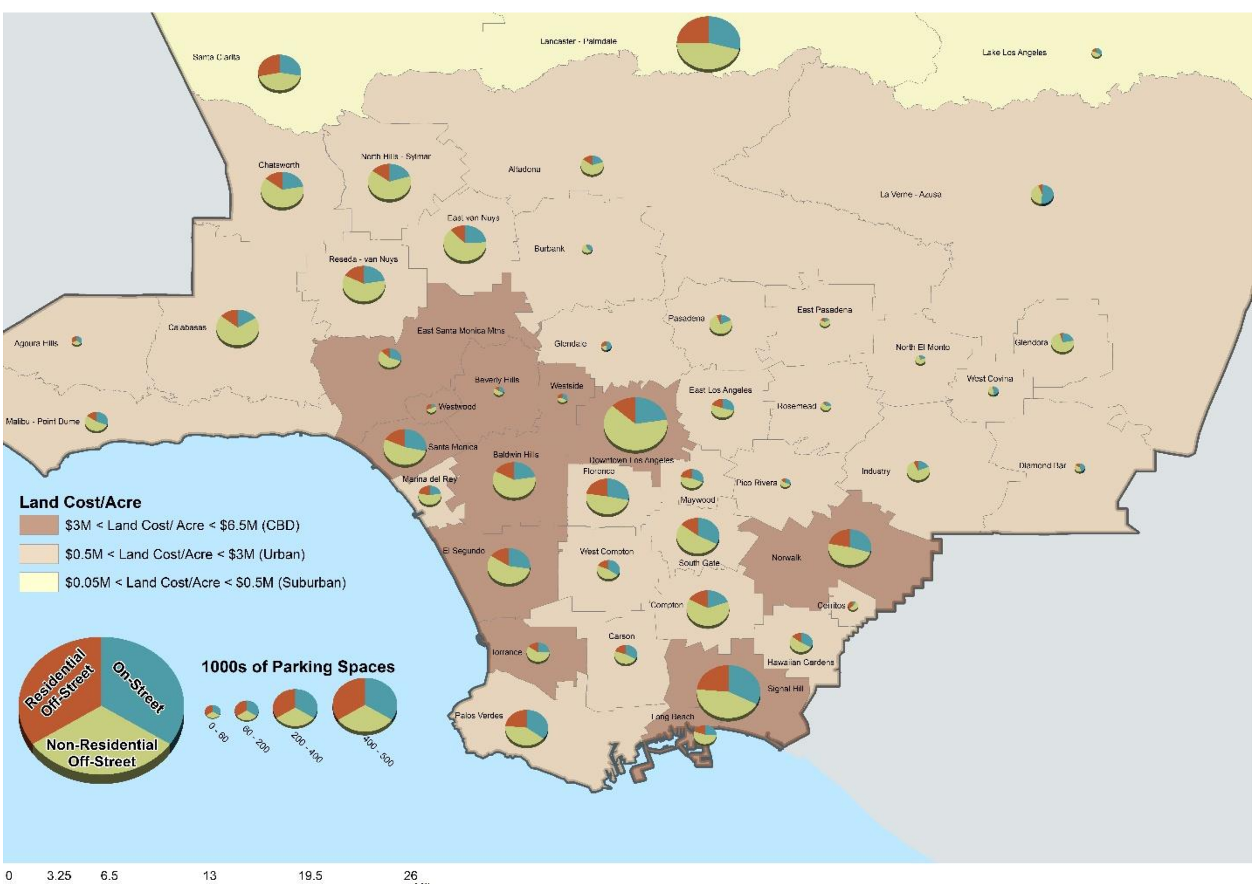
Cutter, Franco and Lewis (2019) use a hedonic approach with a sample of 2 616 office property sales across Los Angeles County to examine how the shadow cost of MPRs, calculated as the wedge between parking cost and value, differs across density and land value gradients. The analysis uses a geographically weighted regression approach that estimates how the local value of parking varies across the geography of LA County. It also estimates location-specific construction costs for both surface and structured parking spaces. Combining these two estimates allows for the calculation of the spatially varying private property specific net cost of MPRs. The analysis shows that an office property at the 90th percentile of density and value is predicted to face an additional parking net cost of USD 37 per square foot of main building area compared to one at the 10th percentile of each measure (for a parking space/350 ft^2). The likely smaller property sizes in central areas of the County would add to this differential. This is a substantial percentage of the marginal building cost. This comparison, then, suggests that parking requirements impose enough of a cost differential between dense, valuable areas and lower-value peripheral areas that building activity is incentivised to move towards the cheaper areas.

Do cities have too much parking?

One must know how much parking exists in cities to properly answer this question. Yet, comprehensive parking inventories have never existed for U.S. cities. Even though parking is required for new construction, cities typically do not collect data on their parking supply[10]. As a result, many parking-related questions, including those related to parking reforms, have never been answered, or even investigated, properly.

Parking inventories are important data to planners, property developers, investors and lenders. They can identify parking shortages and surpluses. These inventories can also support developers who cannot afford to build extra parking at the expense of the other parts of their projects, or policy makers who are ready to relax MPRs for new construction or are concerned about spending public works money on free parking. In addition, current trends in transport modes make access to this type of data valuable. New forms of transport such as ridesharing (e.g. Lyft and Uber) are emerging in urban areas. Without basic knowledge of how much parking is available, planners do not have a reliable basis on which to make decisions about future supply policy, current management policy or even how their transport systems are working.

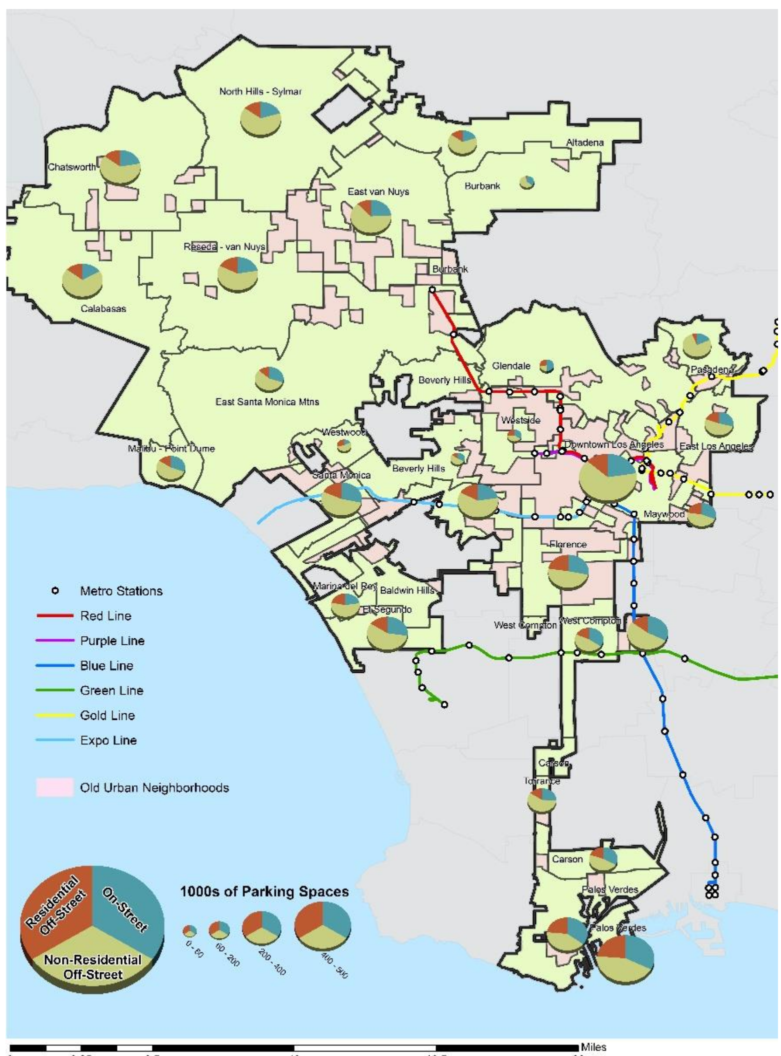
Figure 7. Los Angeles County: Off-street and on-street parking supply in 2010



Source: based on data from Chester et al. (2015).

Chester et al. (2015) provide the first comprehensive spatial inventory of where parking infrastructure exists in Los Angeles County and how it has evolved over time. Inspection of their data reveals that the amount of parking varies widely within cities and between cities. Between 1950 and 2010, LA County gained about 12 million parking spaces. Though the growth of parking varied across the county since the 1950s, with much occurring in outlying urban low-density residential and commercial areas, the highest density of parking spaces is still within the urban core, most of which is associated with non-residential development. As of 2010, LA County had 18.6 million parking spaces, including 5.5 million residential off-street, 9.6 million non-residential off-street, and 3.6 million on-street spaces.

Figure 8. City of Los Angeles: Off-street and on-street parking supply in 2010



Source: based on data from Chester et al. (2015).

Figure 7 illustrates the amount and location of different types of parking in different areas of LA County in 2010, based on the parking data made available by Chester et al. (2015). Figure 7 shows, for instance, that non-residential parking lots and parking structures (non-residential off-street parking) in downtown Los

Angeles represent the majority (74.5%) of the total spaces (1.19 million) estimated for this zone of the County. Downtown Los Angeles is served by public transport and has dense mixed uses (see Figure 8). However, the abundance of non-residential parking in this part of LA likely discourages the use of more sustainable travel modes such as public transport or active commuting (cycling and walking).

The indiscriminate application of uniform parking requirements has actually led to a large oversupply of parking in many areas, though perceived parking shortages are often used to justify MPRs and some areas of the City of Los Angeles do struggle with an imbalance between parking supply and demand. However, there are also situations in which developers are willing to build more parking than required. These situations deserve more investigation, as they may provide further insights into how developers decide how much parking to build.

Take the case of the so-called "old urban" neighbourhoods of the City of Los Angeles, mapped in Figure 8[11]. The old urban neighbourhoods, mostly concentrated in central Los Angeles, cover 17% of the city's land and are characterised by high densities, older housing stock, good access to public transport and a high percentage of residents more likely to take non-motorised trips than residents in other neighbourhoods (Stangl, 2019).

Yet, the residential developments approved for construction in these neighbourhoods between 2013 and 2018 tend to include parking above their default and binding minimums, suggesting that parking minimum reductions do not seem to impact developers' decisions in these areas of the city (Stangl, 2019).

Stangl (2019) reports that a developer would build 34% more of its binding minimum and 6% more of its default minimum on a project located in an old urban neighbourhood than on one located in another type of neighbourhood[12]. The author hypothesised that this might be related to the scarcity of parking in this type of neighbourhood. Developers might build more parking to capitalise on its scarcity, allowing them to charge higher prices to potential residents. In other neighbourhoods with abundant parking, developers do not seem to see any advantage in building extra parking[13].

A possible strategy to align the City of Los Angeles and the developers' incentives with the goal of supporting sustainable forms of transportation in LA could be to establish parking maximums instead of granting minimum reductions in the old urban neighbourhoods.

Parking maximums establish an upper limit on parking supply, either at the site level or across an area, and may prevent developers from building excessively large lots. However, a parking maximum can pose implementation issues just like a parking minimum. To properly establish a maximum, it is necessary to determine the appropriate number of spaces and to allocate them to specific development projects. Furthermore, a restricted parking supply can present problems with spillover effects if not implemented carefully. Another potential problem is that restricting the parking supply of an area may put that area at a competitive disadvantage which may, in the long-run, translate into lower marketability of its land parcels. Thus, parking maximums make sense in places where the benefits with rapid transit service, attractive pedestrian environments, or concentrations of businesses, outweigh any inconvenience from reduced parking.

Some U.S. cities have already implemented parking maximums. For instance, San Francisco limits downtown parking to 7% of the building's floor area. Seattle allows a maximum of one parking space/1 000 ft^2 of office space downtown. Internationally, cities like London in 2004 and Mexico City in 2017 have also moved from parking minimums to parking maximums.

Parking supply, parking prices and commute mode choice

Impacts of parking supply on car ownership and use

Studies have examined how parking space availability in workplace and residential settings affect commute mode choice. Parking space availability at employment sites has attracted considerable research efforts for decades (Inci, 2015). Parking space availability at home sites, though, has only recently become subject to increasing research interest (Christiansen et al., 2017; Guo, 2013a and b; Marsden, 2006; Weinberger, 2012; Franco and Khordagui, 2019)[14].

There is evidence that guaranteed off-street parking at home results in a larger share of car owners choosing to drive to work, even in areas that are well served by public transport (Weinberger, 2012)[15]. Since all car trips start and end in a parking space, provision of off-site parking at home yields an available space without uncertainty and little time sacrifice when returning home. In addition, parking ease (the ability to manoeuver the vehicle in and out of the off-street parking space) and the certainty of having a designated private parking space (spaces can be guaranteed but not reserved) have also been shown to lead people to drive more often (Guo, 2013a and b).

Franco and Khordagui (2019) also find that parking space availability at home, both off-street and on-street, correlates significantly with the probability of driving to work in Los Angeles County. On-street residential parking availability, however, seemed to matter more than off-street residential parking, since a 10% increase in on-street parking is associated with a 1.3% increase in the probability of driving, whereas a similar increase in off-street parking is associated with a 0.6% increase in the probability of driving. A possible explanation is that even though many households in residential areas have a driveway or a garage (and zoning requires on-site parking for any new construction) they choose to park in the street, presumably so they can use their garage for other purposes (e.g. storage). Such behaviour may be further incentivised by the fact that on-street parking is hardly regulated by price and time limits in many residential areas[16]. This is in contrast to commercial areas and CBDs.

Another interesting finding from Franco and Khordagui's (2019) study is that off-street parking availability at the work location is also positively associated with driving to work, though the effect is statistically insignificant. Their finding may be due to the composition of the sample. Most of the commuters who drive to work (74%) in the sample park onsite at their workplace, potentially resulting in a lack of concern about the overall availability of non-residential off-street parking (e.g. parking lots and parking structures) at their work location.

Zoning regulations that require residential buildings to include off-street parking, such as MPRs together with under-priced on-street parking, seem therefore to contribute to increases in driving to work. This is particularly disconcerting at a time when cities seek to reduce congestion and increase the use of public transport, biking and walking. Moreover, parking availability can influence destination choice, trip timing, and car occupancy (Feeney, 1989; Inci, 2015), as well as car ownership (Guo, 2013a and b).

Parking prices are a key consideration for many commuters (Litman and Doherty, 2009; Franco and Khordagui, 2019), though parking availability, ease of access and certainty of off-street parking all influence vehicle ownership, overall mode share and the propensity to drive.

Impacts of parking prices on car use

Some evidence suggests that parking costs affect car ownership rates (Ostermeijer, Koster and van Ommeren, 2019) and that inexpensive or free parking is also an incentive for solo driving (Willson and Shoup, 1990; Willson, 1992; Hess, 2001; Shoup, 2005; Khordagui, 2019; Franco and Khordagui, 2019). When commuters are shielded from the cost of parking, they drive alone more often. This implies that parking subsidies such as employer-paid parking, a popular transport fringe benefit in the United States and other countries, incentivises workers to drive to work alone over walking, biking or taking public transport[17]. In California, for example, approximately 95% of auto commuters receive free parking (Shoup, 2005). Employer-paid parking is common even in CBDs, where the cost to employers of offering free parking is much higher. One survey of the LA CBD found that 53% of auto commuters received employer-paid parking (Shoup, 2005).

Employers have incentives to provide parking subsidies because they are a qualified fringe benefit that is not subject to tax. This allows firms to pay lower wages and save on payroll taxes without penalising employees[18]. Moreover, it is a way to retain employees. The excess supply of parking space due to MPRs also reduces employees’ willingness to pay for it.

By directly or indirectly subsidising parking at work, employers reduce the cost of the commute trip by car while requiring the employee to pay only the driving cost. This, in turn, encourages employees to drive to work more often. Moreover, when such a subsidy is common practice everywhere, the cost of travel within cities is low, potentially encouraging their spatial expansion. Thus, parking subsidies at the workplace can further work at cross-purposes with policies designed to reduce traffic congestion, energy consumption and air pollution as well as policies that promote more compact forms of urban development.

Brueckner and Franco (2018) provide insights on the effects of a switch from employee-paid parking to employer-paid parking on mode choice and level of suburbanisation[19]. Under such a switch, the burden of parking costs moves from auto commuters to employers, thus reducing the wage for all workers. Figures 9 and 10 are based on the authors’ numerical simulations. The figures illustrate how the mode choices and suburbanisation (measured by the level of population in the suburbs) vary as a function of the employee’s parking cost share. The “foot” choice in Figure 9 indicates a central residence, which entails the mode choice of walking to work.

A switch from employee-paid parking to employer-paid parking increases road use as it reduces the city core’s residential land area, resulting in greater suburbanisation of the population and an overall increase in the suburban commute flow to the CBD. Such changes come at the cost of overall wellbeing. Thus, firms’ provision of free or low-cost parking spaces causes serious economy-wide inefficiencies.

One possible solution to reducing such distortions and improving overall economic efficiency is to charge for workplace parking (Brueckner and Franco, 2018). Workers would have to pay for parking at market rates, which are usually high in large cities and in CBDs. Employers would raise employee wages accordingly to offset the cost. In fact, there is already some anecdotal evidence in the city of Seattle that charging for parking by the day instead of by month is a powerful instrument of dissuasion that reduces the number of employees driving alone to work (Gutman, 2017). Khordagui (2019) also finds a negative statistically significant association of daily parking prices and the decision to drive to work in California. However, entirely eliminating such a popular transport subsidy as employer-paid parking, which benefits so many workers, is likely to raise considerable political objection. Parking cash-out programmes have been advocated as an alternative.

Figure 9. Travel mode choice with different workplace parking subsidies

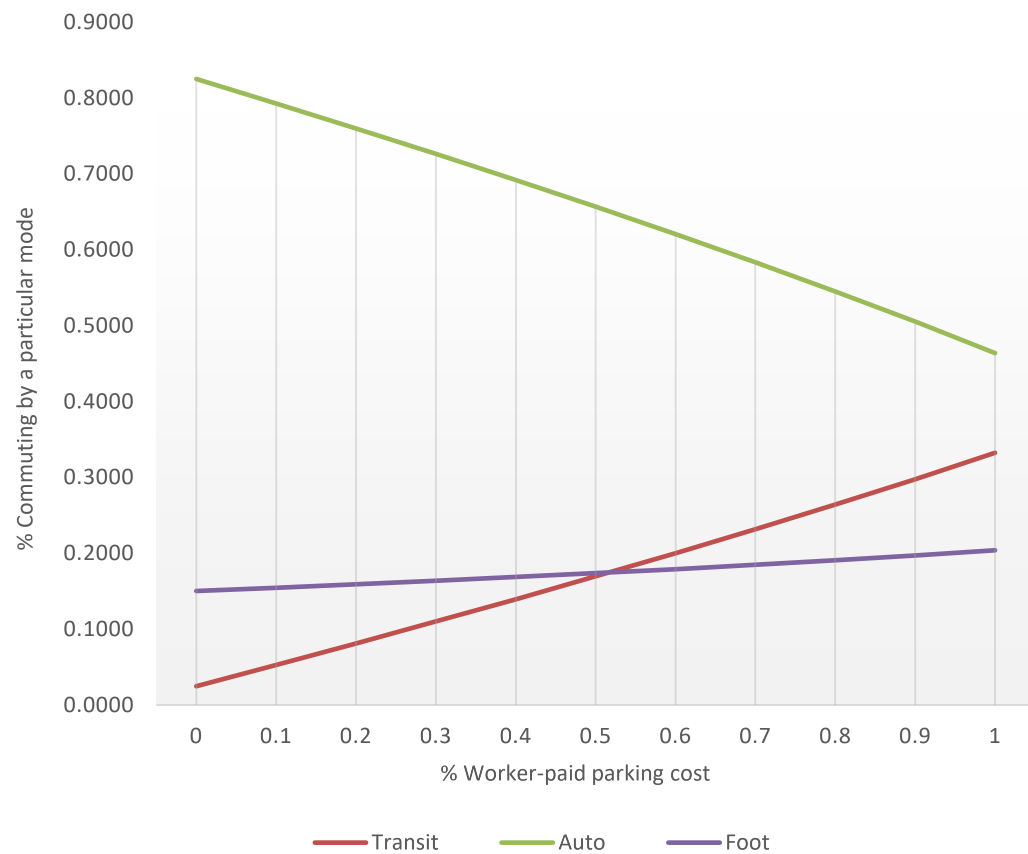
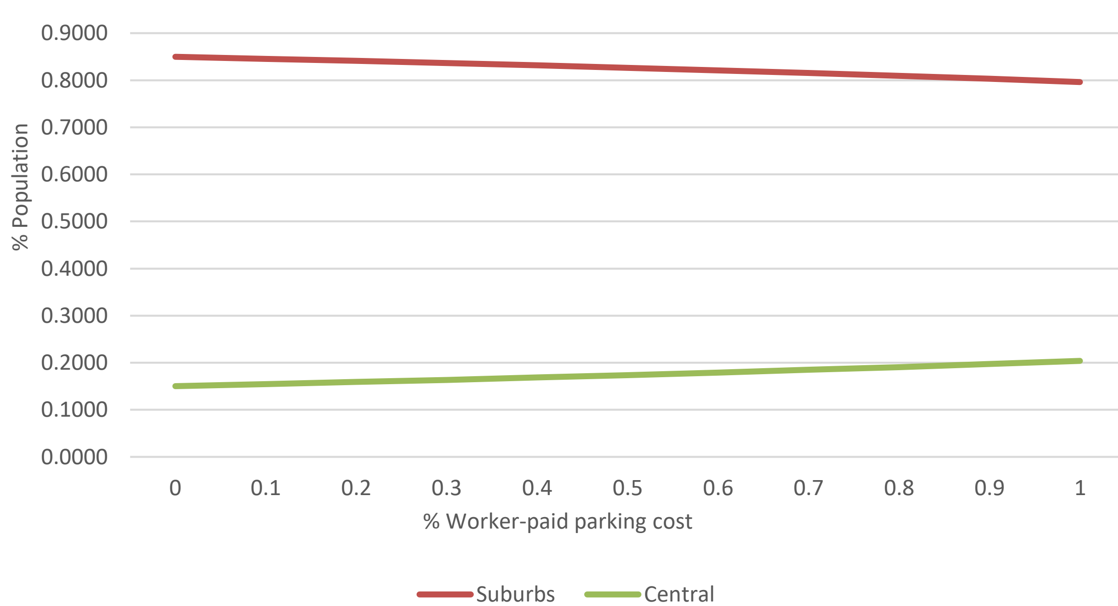


Figure 10. Impact of workplace parking subsidy on suburbanisation



Parking cash-out

Under a cash-out programme, employers who lease or partially subsidise parking on behalf of their employees must offer their employees the choice of keeping their allotted parking spot or trading it for an equivalent cash payment. This cash payment must equal the parking subsidy, that is, the cost to the employer of renting or leasing a parking space on behalf of the employee. Providing this choice to employees shows them that "free" parking is not free after all. Commuters who forgo the cash payment are effectively making the choice to spend it on parking and paying a price to park at work. Employees who accept the cash pay income taxes on it, but can use the money as they choose. The employer also pays payroll taxes associated with the cash that is provided to employees in lieu of parking.

Parking cash-out programmes have existed in California since 1992[20]. Firms in different CBDs in LA County that offered employees the cash option were surveyed in the years directly following the implementation of this law. The survey revealed the potential mode share benefits of such a programme. It found that the number of people who drove to work alone fell by 17% after cashing out, while carpooling, transport and active commuting increased by 64%, 50% and 33%, respectively (Shoup, 2005).

Table 4. The value of parking subsidies

Los Angeles County areas	Exclusion amount (USD/month)	Market parking price (USD/day)	Value of parking subsidy (USD/month)
Downtown Los Angeles (223)	245	10	205
Westside (55)	245	10	205
Beverly Hills (63)	245	12	247
El Segundo (23)	245	12.5	250
Santa Monica (53)	245	13	263
Marina del Rey (23)	245	8	153
Westwood (33)	245	14	284
Reseda-van Nuys (18)	245	10	196
Pasadena (56)	245	7	143
Burbank (20)	245	3	67
Long Beach (47)	245	10	205
Glendale (29)	245	8	153

Notes: Parking prices are in 2013 USD. The monthly value of the parking subsidy is calculated as an FMV and assumes that employees work five days a week. In parenthesis is the number of off-street commercial parking garages used to calculate the average daily market price in each area of the County. For each location see Figure 1.

Source: Franco (2016).

Brueckner and Franco (2018) also examined the effects of a cash-out policy[21]. Under such a policy, all workers (both drivers and non-drivers) were given a wage supplement equal to the parking cost. Their simulations show that in the absence of income taxation this policy restores efficiency to the first best solution[22]. The level of effectiveness of cash-out programmes is, however, dependent on urban density, alternative travel mode accessibility and size of the cash subsidy.

Table 4 shows estimates of the daily market parking price workers would have to pay in different locations of LA County if workplace parking subsidies would be removed. The table also provides estimates of what would be the cash-equivalent per month that employers would need to offer their employees if the cash offered equals the parking subsidy, and the parking subsidy is valued at the fair market value (FMV)[23]. While the FMV of employer-parking is often less than the exclusion amount, monthly market parking costs in major cities or in primary CBDs may also exceed the exclusion amount[24]. All values presented in Table 4 are in 2013 USD.

Franco and Khordagui (2019) provide empirical evidence on the effects of pricing workplace parking via cash-out on the short-term work commute mode choice in LA County25. Their sample includes 927 individual home-based commute trips from the 2012 California Household Travel Survey. Drivers, both driving alone and carpooling, comprise 79.6% of their sample (with 78.3% being solo drivers). Transport riders comprise 11.4% of the full sample, whereas the non-motorised commuters represent 6.5%. Two other interesting features are that only 5.18% of those workers who drove to work reported paying for parking, and 80% of those who drove yet did not report paying for parking parked on-site as opposed to parking on-street or off-street at a commercial lot or garage. This is not surprising given the existence of MPRs and that a large number of LA employers provide free parking as a fringe benefit to their employees (Shoup, 2005).

It may seem that a commuter who parks for free at work will not care about the prevailing market parking price. However, under California's cash-out programme, each parking spot has an opportunity cost equivalent to the cash foregone. Therefore, Franco and Khordagui (2019) assume that all commuters in their sample parking for free were in fact offered a cash equivalent to replace their parking subsidy at work, and had foregone that cash. Under this assumption, parking can no longer be viewed as free and must be assigned a price equal to the cash-equivalent foregone, which was proxied to the prevailing capacity-weighted market parking price near an employment site[26].

Franco and Khordagui's (2019) results show that the price for taking the "free" parking space at work (the forgone cash equivalent) is a factor highly correlated with employee automobile use in the short-run in LA County. A 10% increase in such a "price" is associated with a 1.1% decrease in the probability of driving to work. Their multinomial logit results further suggest that higher prices have the potential to shift people away from solo driving to using public transport and non-motorised modes. A 1% increase in daily parking prices at work is associated with a 0.09% reduction on the probability of driving to work, while it is associated with increases in the probability of using public transport and active commuting modes in the order of 0.37% and 0.3%, respectively. These results then suggest that parking cash-out programmes may affect a commuter's travel choices by revealing the opportunity cost of a "free" parking space at work.

One concern with parking cash-out programmes is that they might lead to significant increases in costs to employers. But in car-dependent cities such as those in Los Angeles County the share of employees driving alone to work is high. Therefore, it is not expected that the programme costs to the employer be substantial. Also, the effect of such a programme on workers' mode choice is contingent on urban form and the price, accessibility and quality of alternative modes to the work sites. Since downtowns, in general, tend to be walkable and have good public transport access, there is a high likelihood that employees will take the cash-out option. This is, nevertheless, conditioned that their points of origin (residences) also have good access to public transport.

Conclusions

This paper provides a discussion of the effects of parking prices and parking availability on commute mode choices and urban form with most of its evidence based on Los Angeles County. The paper also discusses existing parking policies such as minimum and maximum parking requirements, employer-paid parking and parking cash-out programmes and their implications for the existing levels of parking supply and solo driving in Los Angeles County.

The paper draws on lessons learned from experiences with these policies in Los Angeles County and suggests a set of parking reforms aligned with those Professor Donald Shoup advocates. Providing parking policy recommendations for specific cities is beyond the scope of this paper. Urban form, accessibility to and quality of public transport tend to vary across cities and are determinants of the efficiency and distributional effects of parking policies. As such, reforms should be tailored to the specificities of each city, but the suggestions outlined throughout the paper and below can help achieve more sustainable and efficient outcomes.

The studies reviewed here show that policies determining parking supply and pricing influence developers' decisions on how much land to provide for parking, and individual choices of how many cars to own and which travel mode to take to cover daily travel needs. Those choices have key implications for land use, urban form, congestion and air pollution. Therefore, parking policies can be key to achieve more environmentally sustainable urban mobility and development patterns.

Progressive land-use reforms are already taking root in the City of Los Angeles and in other American cities. Cities like Lancaster, Santa Monica, San Diego, San Francisco in California, as well as Houston, Texas and Cincinnati, Ohio have already eliminated parking requirements – either citywide or for central districts. Since 2014, the Los Angeles City Planning Department has been working on a city community plan update called DTLA 2040, which, if approved, would eliminate minimum parking requirements (MPR) for all of downtown Los Angeles. The city's goal is to strengthen LA's core to accommodate the city's long-term priorities for development, in particular, the additional estimated 125 000 people, 70 000 housing units and 55 000 jobs expected for the downtown area in the next two decades (DTLA 2040, 29 August 2019). By removing off-street parking requirements for new residential and office buildings, cities allow developers and businesses to decide how many parking spaces to provide. (LACP, n.d.)

Despite the damages sometimes caused by workplace parking subsidies, removing employer-paid parking is a challenge. Instead, cash-out programmes offer a more viable option to deal with the distortionary effects of these subsidies. Parking cash-out programmes potentially affect a commuter's travel choices by revealing the opportunity cost of a "free" parking space at work. In addition to increasing wellbeing, they are likely to be accepted by both employees and employers and to increase tax revenues; as cash-outs are not exempt from income and payroll taxation.

Charging market prices for curb parking also makes economic sense. Under-priced curb parking creates an incentive to cruise in already-congested traffic areas, as on-street prices tend to be much lower than commercial garage prices. It also distorts data on local residents' use of on-site garages, as well as on car use in residential areas. If cities charge the right prices for curb parking to leave one or two open spaces on each block, then there will be no parking shortages (Shoup, 2018; Hampshire and Shoup, 2018). With no shortage of on-street parking and controlled spillover, MPRs become redundant. But from a political economy perspective, increasing on-street parking prices can be a very challenging task, likely to encounter strong opposition from local communities. Therefore, if cities use parking revenues to improve public services on metered streets, such a revenue-recycling policy may help them gain political support to implement demand-based prices for on-street parking. The SFpark and LA Express Park experiences show that cities can actually make huge improvements even without frequently adjusting prices in response to demand (Shoup, 2018).

Ultimately, complimentary parking reforms make cities better places to live and do business and allow them to meet their environmental sustainability goals.

Notes

1 The 46 zones of Los Angeles County represented in Figure 1 and remaining maps in this paper were created under the RELU-TRAN (Regional Economy Land Use and Transportation)–Los Angeles Project. More information on how those zones were created can be found at https://vcpa.ucr.edu/.

2 Surface parking refers to parking lots directly on land. Structured parking is above-ground parking garages that contain one or more above-ground floors and no below-ground floors. Underground parking refers to underground garages that contain one or more below-ground floors and no above-ground floors. Semi-underground structures, or “mixed” parking, refers to parking structures that contain both above-ground and below-ground floors.

3 The author thanks Huiling Zhang and Richard Arnott for providing her with their unpublished 2011 Multicampus Research Programs and Initiatives technical report entitled “Computing Value Per Square Foot of Vacant Parcels and Aggregating to Model Zone Level [Version 1]”, which informed this paragraph.

4 Even though the cost of constructing a parking space may vary within the same city due to soil conditions, size and site shape, the average estimates found by Franco (2016) are aligned with other average construction cost estimates for typical above-ground and below-ground parking facilities in the United States (Litman and Doherty, 2009; Shoup, 2018). Her calculations use published estimates of local construction costs provided by the RS Means Quick Cost Estimates and a sample of 737 commercial off-street parking facilities assembled in 2013. In her sample, Downtown Los Angeles houses 30% of the commercial parking facilities. Out of those facilities, 61% are surface parking lots with a total of 13 906 parking spaces and 30% are above-ground parking garages with a total of 26 945 off-street parking spaces. The underground facilities in downtown LA add an extra 4 934 off-street parking spaces to the sample.

5 Off-street parking requires driveways and access lanes, and so typically requires 300-400 square feet per space, allowing 100-150 spaces per acre (Litman and Doherty, 2009).

6 The underground land value refers to the opportunity cost that underground garage space occupies, as this space could be used for other purposes such as storage and mechanical equipment.

7 Some cities in California (e.g. Palo Alto, Carmel, Claremont, Glendale, Los Angeles, Beverly Hills and Santa Monica) also allow developers to pay a fee in lieu of providing the off-street parking spaces required by zoning ordinances in a way that is similar to charging an impact fee to finance public infrastructure. The cities then use the revenue to provide public parking spaces to replace the private parking spaces the developers would have provided (Shoup, 2005). This in-lieu parking fee can also be used to reveal the cost of complying with MPRs. In fact, Shoup (2005) shows that in-lieu parking fees reveal that the cost of complying with MPRs is more than four times the cost of the impact fees that cities levy for all other public purposes combined. The willingness to pay these in-lieu fees rather than supplying parking spaces suggests that a developer wants to supply less parking. In-lieu parking fees also exist in other US cities (e.g. Orlando, Florida and Chapel Hill, North Carolina) and outside the United States (e.g. Waltham Forest, United Kingdom; Port Elizabeth, South Africa; Calgary, Alberta; Vancouver, British Columbia; Hamburg, Germany).

8 Under the surface parking regime, parking area is provided via a parking lot, which requires minimal capital, assumed to be zero for simplicity. Under the structural parking regime, however, a parking structure built adjacent to the residential structure provides parking area. While capital cost is much higher than under surface parking, structural parking saves on land through use of a multi-storey structure. Underground parking, by contrast, requires no additional land beyond that used for the residential building. Parking area is provided within an underground structure directly below the building, which involves higher capital cost than above-ground structural parking.

9 The parking inputs are land in the case of surface parking, land and capital in the case of structural parking, and capital alone in the case of underground parking (the land input is already available). Under the latter two regimes, parking structural density (capital per unit of parking land) is one of the developer’s choice variables, indicating the height of the above-ground parking structure or the depth of the underground structure.

10 In 2010, San Francisco (SF) became the first city in the United States to conduct an inventory of its parking supply. The SF census of parking spaces was based on a random sample of 30% of city streets. However, none of the counts included private parking spaces in residential garages.

11 The location of the “old urban” neighbourhoods in Figure 8 is based on mapped information provided in Stangl (2019).

12 The default minimum was the amount of parking the development would have been required to build without a parking minimum reduction. The binding minimum was the amount of parking the development was actually required to build after receiving a parking minimum reduction. A development that did not receive a parking minimum reduction would have the same default and binding minimums.

13 Guo and Ren (2013) also found that, after the switch from parking minimums to parking maximums in 2004, developments located in areas with the highest residential densities and best transport service in London provided more parking than immediately adjacent areas. The authors hypothesised that this behaviour could be due to the high concentration of high-income residents in those areas who might be willing to pay high premiums for parking, thus justifying its construction and opportunity costs.

14 McCahill et al. (2016) also provide evidence that parking increases are a likely driver of automobile use in nine U.S. cities dating to 1960. The authors used the Bradford Hill criteria, adopted from the field of epidemiology, to explore the question and found that an increase in parking provision from 0.1 to 0.5 parking space per person was associated with an increase in automobile mode share of roughly 30 percentage points.

15 A feature of residential areas is that the required parking space is related to car ownership. This contrasts with non-residential areas where parking space is provided for all cars used by workers, shoppers and visitors to reach them. As a result, the availability of public transport in any residential area has little impact on parking needs. Households may take public transport to work, but still own a car for other purposes. Moreover, residential parking is aimed at satisfying the long-term parking demands of car owners, not the short-term demands of visitors and commercial vehicles. Visitors to residential areas are expected to find space along the curb or pay for space in a garage or parking lot.

16 Most of the newer residential areas are developed at a sufficiently low density to provide the needed space along the street. This contrasts with non-residential areas (and with some older residential areas, especially in the city centre) where the intensity of development is so high that curb space is clearly inadequate and off-street parking is a necessity.

17 Employer-paid parking is a tax-exempt fringe benefit that employees qualify for only by driving to work. This parking subsidy entails either free parking or parking at very low rates. To provide such benefit, employers have to either rent spaces or buy or lease the land on which their workers park; if they rent parking spaces in nearby garages, they pay the rental price to the operator. Also, if they lease it, they pay rent on each space, and if they own it, they still pay construction, maintenance, and security fees.

18 This incentive also exists with employer-paid charging of electric vehicles (Fetene et al., 2016) and the provision of fuel cards and company cars (De Borger and Wuyts, 2011; Gutiérrez-i-Puigarnau and van Ommeren, 2011).

19 The model divides the urban space into two zones, centre and suburbs, which are connected by a congested road and a public-transport line. Commuting cost within both zones is zero, with residents of the central zone walking to work. Commuters do not have an innate preference for driving or transport use and, therefore, commuters in a decentralised setting choose the cheapest mode. Workers walking to work or commuting by public transport are assumed not to own a car. Each road commuter requires an allotment of CBD land for parking, and because the central zone's area is fixed, parking land reduces the amount available for central residences and CBD production. In addition, each road user requires a fixed amount of parking land at their suburban residence. The model characterises optimal resource allocation from the perspective of a social planner. The decentralised planning solution, which requires employee- rather than employer-paid parking, congestion tolls, and a tax (subsidy) to offset the road capacity deficit (surplus) and the fixed cost of the transport system, is also explored in the paper.

20 The California parking cash-out law requires employers with more than 50 employees who provide either free or subsidised parking to their employees to offer commuters the option of taking an equivalent cash payment in lieu of the tax-exempt parking. The requirement applies only to parking spaces firms rent rather than own., There is no net cost to the employer when an employee forgoes the parking and takes the cash because the employer's unused parking subsidy directly funds the employee's cash allowance.

21 Using simulations, De Borger and Wuyts (2009) show that a parking cash-out policy may even outperform a congestion tax in terms of the effects on welfare and modal shift.

22 With income taxation, the wage supplement is taxable, but the tax disappears if the supplement is exchanged for parking. As a result, the additional tax can be viewed as a cost of not using the auto mode. Since this cost will distort mode choice, leading to road use beyond the first-best level, the cash-out does not have the same efficiency benefit as in a world without income taxes. To restore efficiency, the fringe benefit of employer-paid parking would need to be taxable, in which case there would be no adverse tax effect from not choosing the auto mode.

23 The FMV of parking provided by an employer is based on the cost an individual would have to pay for parking at the same time and site in an arm's length transaction or, if the employer cannot ascertain this information, in the same or a comparable lot in the general location under the same or similar conditions.

24 Employees are allowed up to a certain limit in tax-free parking or subsidised up to that amount, denoted as an exclusion amount. Any amount over the taxable amount should be included in gross income.

25 Hess (2001) has estimated the effects of free parking on mode choices in Portland, Oregon's CBD and found that with free parking, 62% of commuters will drive alone, 16% will commute in carpools and 22% will take public transport. With a daily parking charge of USD 6, 46% will drive alone, 4% will carpool and 50% will choose public transport.

26 Khordagui (2019) also provides evidence of the effects of parking prices on the decision to drive to work. In contrast to Franco and Khordagui (2019), her study focuses on the state of California and on a binary choice model. Moreover, the study uses the average of the reported parking price by all those who drive to the destination zip code to proxy for the opportunity cost of a free parking space at work in that destination zip code. It does not fully control for the effects that urban form may have on travel mode choices nor does it explore the role of parking availability on commute mode choices.

References

Brueckner, J. and S. Franco (2018), "Employer-paid parking, mode choice, and suburbanization", *Journal of Urban Economics*, Vol. 104, pp. 35-46, https://doi.org/10.1016/j.jue.2017.12.002.

Brueckner, J. and S. Franco (2017), "Parking and urban form", *Journal of Economic Geography*, Vol. 17/1, pp. 95-127, https://doi.org/10.1093/jeg/lbv048.

Chester, M., et al. (2015), "Parking Infrastructure: A Constraint on or Opportunity for Urban Redevelopment? A Study of Los Angeles County Parking Supply and Growth", *Journal of the American Planning Association*, Vol. 81/4, pp. 268-286, https://doi.org/10.1080/01944363.2015.1092879.

Christiansen, P., et al. (2017), "Parking facilities and the built environment: Impacts on travel behaviour", *Transportation Research Part A: Policy and Practice*, Vol. 95, pp. 198-206, https://doi.org/10.1016/j.tra.2016.10.025.

City of Los Angeles (2020), "Chapter I: General Provisions and Zoning", in *Official City of Los Angeles Municipal Code*, City of Los Angeles, https://codelibrary.amlegal.com/codes/los_angeles/latest/lapz/0-0-0-1.

Cutter, W. and S. Franco (2012), "Do parking requirements significantly increase the area dedicated to parking? A test of the effect of parking requirements values in Los Angeles County", *Transportation Research Part A: Policy and Practice*, Vol. 46/6, pp. 901-925, https://doi.org/10.1016/j.tra.2012.02.012.

Cutter, W., S. Franco and S. Lewis (2019), "The Shadow Cost of Parking Minimums: Evidence from Los Angeles County", UCI Working Paper, University of California Los Angeles, https://www.anderson.ucla.edu/documents/areas/ctr/ziman/Cutter_Franco_Lewis_2016_resub_FINAL.pdf.

De Borger, B. and B. Wuyts (2009), "Commuting, transport tax reform and the labour market: Employer-paid parking and the relative efficiency of revenue recycling instruments", *Urban Studies*, Vol. 46/1, pp. 213-233, https://doi.org/10.1177/0042098008098643.

De Borger, B., B. Wuyts (2011), "The tax treatment of company cars, commuting and optimal congestion taxes", *Transportation Research Part B: Methodological*, Vol. 45/10, pp. 1527-1544, https://doi.org/10.1016/j.trb.2011.06.002.

Feeney, B. (1989), "A review of the impact of parking policy measures on travel demand", *Transportation Planning and Technology*, Vol. 13/4, pp. 229-244, https://doi.org/10.1080/03081068908717403.

Fetene, G. (2016), "The economics of workplace charging", *Transportation Research Part B: Methodological*, Vol. 88, pp. 93-118, https://doi.org/10.1016/j.trb.2016.03.004.

FHWA (2013), "Household Travel and Freight Movement", Federal Highway Administration, U.S. Department of Transportation, https://www.fhwa.dot.gov/policy/2013cpr/chap1.cfm.

Franco, S. and N. Khordagui (2019), "Commute mode choices and the role of parking prices, parking availability and urban form: Evidence from Los Angeles County", UCI Working Paper, University of California, Irving.

Franco, S. (2016), "Parking costs in Los Angeles County", Technical Report 2016-2-June, MRPI program of the University of California, Application of the RELU-TRAN model to the Greater Los Angeles Region, retrieved from https://vcpa.ucr.edu/ (accessed on 19 April 2020).

Guo, Z. and Ren, S. (2013), "From minimum to maximum: Impact of the London parking reform on residential parking supply from 2004 to 2010?", *Urban Studies*, Vol. 50/6, pp. 1183-1200, https://doi.org/10.1177/0042098012460735.

Guo, Z. (2013a), "Does residential parking supply affect household car ownership? The case of New York City", *Journal of Transportation Geography*, Vol. 26, pp. 18-28, https://doi.org/10.1016/j.jtrangeo.2012.08.006.

Guo, Z. (2013b), "Home parking convenience, household car usage, and implications to residential parking policies", *Transportation Policy*, Vol. 29, pp. 97-106, https://doi.org/10.1016/j.tranpol.2013.04.005.

Gutiérrez-i-Puigarnau, E. and J. Van Ommeren (2011), "Welfare effects of distortionary fringe benefits taxation: The case of employer-provided cars", *International Economic Review*, Vol. 52/4, pp. 1105-1122, https://doi.org/10.1111/j.1468-2354.2011.00661.x.

Gutman, D. (2017), "The not-so-secret trick to cutting solo car commutes: Charge for parking by the day", *Seattle Times*, https://www.seattletimes.com/seattle-news/transportation/the-not-so-secret-trick-to-cutting-solo-car-commutes-charge-for-parking-by-the-day/ (accessed on 20 April 2020).

Hampshire, R. and Shoup,D. (2018), "What Share of Traffic is Cruising for Parking," *Journal of Transport Economics and Policy*, Vol. 52/3, pp. 184-201, https://www.researchgate.net/publication/325247222_What_Share_of_Traffic_is_Cruising_for_Parking.

Hess, D. (2001), "Effect of free parking on commuter mode choice: Evidence from travel diary data", *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 1753/1, pp. 35-42, https://doi.org/10.3141/1753-05.

Inci, E. (2015), "A review of the economics of parking", *Economics of Transportation*, Vol. 4, pp. 50-63, https://doi.org/10.1016/j.ecotra.2014.11.001.

Khordagui, N. (2019), "Parking prices and the decision to drive to work: Evidence from California", *Transportation Research Part A: Policy and Practice*, Vol. 130, pp. 479-495, https://doi.org/10.1016/j.tra.2019.09.064.

LACP (n.b.), DTLA 2040, Los Angeles City Planning, https://planning.lacity.org/plans-policies/community-plan-update/downtown-los-angeles-community-plan-update#about (accessed on 19 April 2020).

Litman, T. and E. Doherty (2009), "Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications", Second edition, Victoria Transport Policy Institute, https://www.vtpi.org/tca/tca01.pdf.

McCahill, C. et al. (2016), "Effects of parking provision on automobile use in cities: Inferring causality", *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2543/1, pp. 159-165, https://doi.org/10.3141/2543-19.

Manville, M. et al. (2013), "Parking requirements and housing development: Regulation and reform in Los Angeles", *Journal of the American Planning Association*, Vol. 79/1, pp. 49-66, https://doi.org/10.1080/01944363.2013.785346.

Manville, M. and D. Shoup (2005), "Parking, people, and cities", *Journal of Urban Planning and Development*, Vol. 131/4, pp. 233-245, http://shoup.bol.ucla.edu/People,Parking,CitiesJUPD.pdf.

Marsden, G. (2006), "The evidence base for parking policies—a review", *Transport Policy*, Vol. 13/6, pp. 447-457, https://doi.org/10.1016/j.tranpol.2006.05.009.

Mukhija V. and D. Shoup (2006), "Quantity versus quality in off-street parking requirements", *Journal of the American Planning Association*, Vol. 72, pp. 296-308, https://doi.org/10.1080/01944360608976752.

Ostermeijer,F., H. Koster and J. van Ommeren (2019), "Residential parking costs and car ownership: Implications for parking policy and automated vehicles", *Regional Science and Urban Economics*, Vol. 77, pp. 276-288, https://doi.org/10.1016/j.regsciurbeco.2019.05.005.

Shoup, D. (2005), *The High Cost of Free Parking*, Planners Press, Chicago.

Shoup, D. (2016), "Cutting the cost of parking requirements", ACCESS Magazine, Vol. 48, pp. 26-33, www.accessmagazine.org/articles/spring-2016/cutting-the-cost-of-parking-requirements.

Shoup, D. (2018), *Parking and the City*, Planners Press, Chicago.

Stangl, K. (2019), "Parking? Lots! Parking Over the Minimum in Los Angeles", UCLA Institute of Transport Studies, https://doi.org/doi:10.17610/T65P41.

Weinberger, R. (2012), "Death by a thousand curb-cuts: Evidence on the effect of minimum parking requirements on the choice to drive", *Transport Policy*, Vol. 20, pp. 93-102, https://doi.org/10.1016/j.tranpol.2011.08.002.

Willson, R. (1992), "Estimating the travel and parking demand effects of employer-paid parking", *Regional Science and Urban Economics,* Vol. 22/1, pp. 133-145, https://doi.org/10.1016/0166-0462(92)90029-Z.

Willson, R. and D. Shoup (1990), "The effects of employer-paid parking in downtown Los Angeles: A study of office workers and their employers", Working paper, Graduate School of Architecture and Urban Planning, University of California Los Angeles.

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This paper provides evidence how parking reforms can help reduce car dependency and achieve a more efficient use of city space. It looks at how the price and availability of parking influence transport choices and urban form. It also investigates the effect of minimum parking requirements and regulations on developer decisions and land use. The paper draws primarily on evidence from Los Angeles County and the City of Los Angeles, California, in the United States.

All resources from the Roundtable on Zero Car Growth? Managing Urban Traffic are available at: www.itf-oecd.org/zero-car-growth-managing-urban-traffic-roundtable.

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