The High Cost of Free Parking

By
Donald C. Shoup

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CHAPTER

6

The Cost of Required Parking Spaces

Discovery commences with the awareness of anomaly.

—THOMAS KUHN

The cost of meeting a parking requirement depends on the cost of the required parking spaces. Because most parking is free in the U.S., it may seem reasonable to assume that most parking spaces don't cost much, but in this chapter I will show that each space in a parking structure costs at least $125 a month. The estimate requires extended calculations, however, so readers like Kingsley Amis's *Lucky Jim*, "whose policy it was to read as little as possible of any given book," may wish to skim or skip the chapter if they accept that parking spaces cost this much.[1] In the next chapter I will use this estimate to show that the cost of all parking spaces in the U.S. exceeds the value of all cars and may even exceed the value of all roads. These findings point to an anomaly that requires an explanation: *if parking costs so much, why is it usually free?*

HOW MUCH DOES A PARKING SPACE COST?

There is no way to estimate the cost of surface parking without knowing the price of land, which varies by location. Depending on the price of land, a surface parking space can cost almost nothing or more than $100,000.[2] For structured parking, however, we can estimate a lower bound on the cost per space *without* knowing the price of land. Because a parking structure occupies land that could be used for surface parking,

we can estimate the cost of the parking spaces *added* by the structure, and the relevant question thus becomes: *What is the cost per parking space added?*

Consider a 750-space parking structure built at UCLA on a site that had provided 200 surface spaces.[3] Although it contains 750 spaces, it adds only 550 spaces to the parking supply. The construction cost was $12.8 million, or $23,200 *per space added* ($12,777,000 ÷ 550 spaces).

We cannot credit the structure with providing the 200 parking spaces that would have been on the site if the structure had not been built, and calculating the cost for the 550 spaces *added* by the structure thus takes into account the opportunity cost of the land used for its footprint. We can therefore calculate the cost per parking space added by a parking structure without the need to estimate land values. Note, however, that by valuing the opportunity cost of land as a surface parking lot, this method neglects other alternative uses that might be more valuable. Because a parking structure is usually built only when land is too valuable to use for surface parking, the cost per space added by a structure is therefore a lower-bound estimate of the total cost (including land cost) of structured parking spaces.

Cost per Space Added by 15 Parking Structures

Using this method, I have estimated the cost of the parking spaces added by 15 parking structures built on the UCLA campus between 1961 and 2002. Table 6-1 shows the results.[4]

Column 1 shows when each structure was built, column 2 its name, and column 3 the number of spaces in it. Column 4 shows the number of potential surface spaces lost as a result of building the structure (no surface spaces are lost for the four that are underground).[5] Subtracting the lost surface spaces from the spaces in the structure gives the net number of spaces added (column 5). In total, the 15 structures contain 19,686 spaces and occupy sites that would have provided 3,110 surface spaces. They therefore added 16,576 spaces.

Column 6 shows the original cost of each structure in the year of construction, and column 7 converts this cost into 2002 dollars by adjusting for construction cost inflation. Column 7 thus shows how much each structure would have cost if it had been built in 2002.[6] Column 8 shows the original cost per space added, and column 9 converts this to 2002 dollars. For the structures built between 1961 and 2002, the average cost in 2002 dollars was $22,500 per parking space added.

The cost per space in a parking structure depends on two factors: the structure's cost per square foot and the number of square feet per parking space. First, the structure's cost per square foot depends on the quality of the design and materials and whether it is aboveground or underground.

Table 6-1. Cost per Parking Space Added by 15 Parking Structures

Year built	Structure name	Spaces in structure	Surface spaces lost	Spaces added by structure	Structure cost		Cost per space added	
					Year built	2002	Year built	2002
(1)	(2)	(3)	(4)	(5)=(3)-(4)	(6)	(7)	(8)=(6)/(5)	(9)=(7)/(5)
1961	5	765	219	546	$1,091,000	$8,421,000	$2,000	$15,400
1963	14	1,428	355	1,073	$1,745,000	$12,662,000	$1,600	$11,600
1964	3	1,168	213	955	$1,859,000	$12,985,000	$1,900	$13,300
1966	9	1,800	298	1,502	$3,490,000	$22,392,000	$2,300	$14,800
1967	8	2,839	666	2,173	$6,061,000	$36,896,000	$2,800	$17,000
1969	2	2,253	323	1,930	$5,610,000	$28,903,000	$2,900	$14,900
1977	CHS	921	319	602	$7,084,000	$17,980,000	$11,800	$29,900
1980	6	750	200	550	$6,326,000	$12,777,000	$11,500	$23,200
1983	4	448	0	448	$8,849,000	$14,229,000	$19,800	$31,800
1990	1	2,851	346	2,505	$52,243,000	$72,182,000	$20,900	$28,900
1990	RC	144	53	91	$2,040,000	$2,819,000	$22,300	$30,800
1991	SV	716	0	716	$14,945,000	$20,209,000	$20,900	$28,300
1995	3 Addition	840	118	722	$9,900,000	$11,831,000	$13,700	$16,400
1998	4 Addition	1,263	0	1,263	$33,217,000	$36,685,000	$26,300	$29,000
2002	7	1,500	0	1,500	$47,300,000	$47,300,000	$31,500	$31,500
Total		19,686	3,110	16,576	$201,760,000	$358,271,000	—	—
Average	1961-1969	1,709	346	1,363	$3,300,000	$20,400,000	$2,300	$14,500
Average	1977-2002	1,048	115	933	$20,200,000	$26,200,000	$19,900	$27,800
Average	1961-2002	1,312	207	1,105	$13,500,000	$23,900,000	$12,800	$22,500

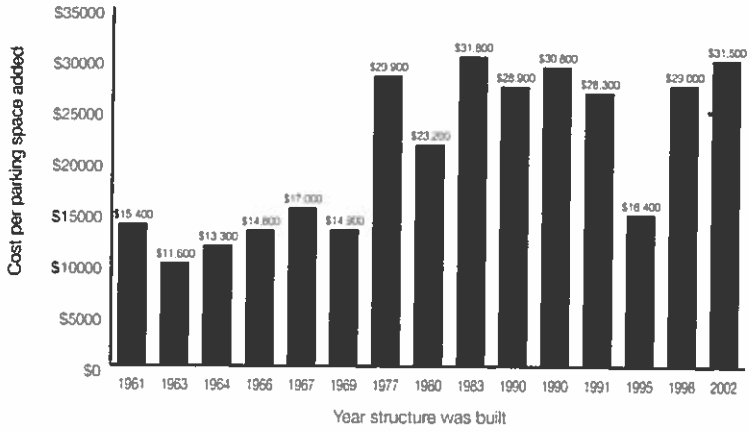
Note: The *ENR* Construction Cost Index is used to convert the original construction cost to 2002 dollars.

A structure with superior architectural design or built underground will cost more per square foot. Second, the number of square feet per parking space refers to the efficiency of the structure's layout: more square feet per parking space means lower efficiency and a higher cost per space. For example, if the construction cost is $50 per square foot, an efficient structure with 300 square feet per space will cost $15,000 per space (300 x $50), while a less efficient structure with 400 square feet per space will cost $20,000 per space (400 x $50).[7]

Urban Density Influences the Type of Structure

Figure 6-1 shows the cost per space added by each structure (from column 9 in Table 6-1), and it reveals a striking pattern: the average cost is $14,500 per space added by the structures built in the 1960s and $27,800 per space added by the ones built since 1977. After adjusting for inflation, the spaces added since 1977 have cost 92 percent more than the spaces added in the 1960s. Although the newer spaces are more expensive, the type of parking structure rather than the year of its construction explains most of the variation in cost.

Figure 6-1. Cost Per Parking Space Added (2002$)



The newer spaces are more expensive for two reasons. First, seven of the nine structures built since 1977 have some or all spaces underground, while no underground spaces were built in the 1960s. Underground parking requires expensive excavation, shoring, waterproofing, fireproofing, ventilation, and lighting. Second, the structures built since 1977 are smaller, averaging 39 percent fewer spaces than the ones built in the 1960s. Small structures are less efficient because the fixed costs of ramps, elevators, and stairwells are spread among fewer spaces. The aboveground Recreation Center (RC) structure is unusually small (only 144 spaces) and expensive ($30,800 per space added).[8]

The price of land does not enter these calculations, so it does not *directly* explain the high cost of parking spaces added since 1977. Nevertheless, it *indirectly* explains the high cost of new structures because the increasing scarcity of vacant land on campus has led to more expensive methods of construction that conserve land, such as building underground or on small sites.[9]

The UCLA parking structures built in the 1960s resemble those typically built in suburban areas where land is inexpensive and large undeveloped sites are available. In his study of suburban office developments in Southern California, Richard Willson found that the average land-and-construction cost for structured parking was $12,300 per space in 1995 ($14,700 per space when adjusted for construction cost inflation to 2002), which is almost identical to the average inflation-adjusted cost of $14,500 per space added by the suburban-style aboveground structures built at UCLA in the 1960s.[10] The lower cost of parking structures built at UCLA

in the 1960s thus reflects the lower cost of building parking structures in suburban areas.

Structure Type Determines the Cost per Space

We can examine two parking structures built as additions to existing structures to explore why the cost per space increased after 1977. The two new additions are similar to the older original structures. The aboveground Structure 3 addition built in 1995 resembles the original aboveground Structure 3 built in 1964, and the underground Structure 4 addition built in 1998 resembles the original underground Structure 4 built in 1983 (Table 6-2). When we look at the cost per space in 1998 dollars, each addition cost almost the same as the original structure.[11] This close match shows that the cost per space added depends not on the year it was built but rather on the structure type—aboveground or underground.[12]

Table 6-2 also shows the cost of an underground garage constructed beneath Pershing Square in downtown Los Angeles in 1952.[13] The original cost of $2,500 per space is equivalent to $25,800 in 1998—close to the cost per space for the two underground garages built at UCLA in 1983 and 1998. In real terms, the cost of building underground parking changed little in half a century.

We can also compare the average cost of UCLA's aboveground parking structures with the national average. In *Building Construction Cost Data*, R. S. Means publishes cost estimates for various types of construction in

Table 6-2. Cost of Aboveground and Underground Parking Structures (Cost per space added by five parking structures in Los Angeles)

	Aboveground (Structure 3)		Underground (Structure 4)		Underground (Pershing Square)
	1964 Original	1995 Addition	1983 Original	1998 Addition	1952 Structure
Current $	$1,900	$13,700	$19,800	$26,300	$2,500
1998 $	$12,200	$14,700	$28,600	$26,300	$25,800

The original portion of UCLA's Structure 3 (built in 1964) contains 1,168 spaces in five aboveground levels; the addition built in 1995 contains 840 spaces in seven aboveground levels.

The original portion of UCLA's Structure 4 (built in 1983) contains 448 spaces in two underground levels; the addition built in 1998 contains 1,263 spaces in two underground levels.

The Pershing Square Garage (built in downtown Los Angeles in 1952) contains 2,150 spaces in three underground levels.

The ENR Construction Cost Index is used to convert original construction costs to 1998 values.

the U.S., and parking garages are one category. In 2001, the median construction cost for aboveground parking garages was $12,000 per space, and the 75th percentile cost was $15,600 per space (25 percent of garages cost more than $15,600 per space).[14] Because construction costs in Los Angeles were 8.5 percent above the national average, the median cost for Los Angeles was $13,000 per space, and the 75th percentile cost was $16,900.[15] UCLA's cost of $14,500 *per space added* by aboveground structures was thus between the median and 75th percentile *cost per space* for Los Angeles. When the lost surface spaces are not subtracted from the number of spaces in each structure, the inflation-adjusted construction cost per space in UCLA's aboveground structures built in the 1960s was only $11,900 per space, which is below the national average cost for aboveground parking structures.

Cost of Other Parking Structures

The estimate of $22,500 a space added refers to all parking structures at UCLA, but comparable garages elsewhere cost as much or more. One good comparison is a 380-space municipal parking garage built in 1998 in Westwood Village, one block from UCLA. Its footprint previously provided 101 surface spaces, so the structure added 279 parking spaces. The construction cost was $8,622,000, or $30,000 per parking space added—37 percent higher than at UCLA.[16]

Parking spaces are also expensive in other cities. As Chapter 9 explains, some cities allow developers to pay a fee in lieu of providing the required parking spaces; the cities then use the revenue to provide public parking. To justify their in-lieu fees, some cities have carefully documented the cost of constructing public parking spaces. These costs are $18,000 per space in Lake Forest, Illinois; $32,400 per space in Walnut Creek, California; $37,000 per space in Beverly Hills, California; and $51,000 per space in Palo Alto, California.[17] Newspaper articles occasionally report the cost of public parking structures, such as a 750-space aboveground public parking garage in San Jose, California, built in 2002 at a cost $57,000 a space (including land cost).[18] The City of Seattle paid $61,000 per space for a 1,200-space garage beneath the Pacific Place shopping center.[19] The International Parking Institute makes annual awards for excellence in parking structure design, and the construction cost was $40,117 a space (excluding land cost) for a 511-space structure that was given the highest award in 2003.[20] Parking spaces can also cost much more. The Multilevel Parking Industry Association of Japan reported that underground garages built in Kawasaki, Nagasaki, Tokyo, and Yokohama have cost between $280,000 and $414,000 per space![21]

The average cost of $22,500 per space added by parking structures built at UCLA is thus not unusually high. If parking spaces cost this much, parking requirements intended to satisfy the peak demand for free parking grossly inflate the cost of urban development and greatly reduce the drivers' cost of using cars.

MONTHLY COST OF A PARKING SPACE

How much do parking spaces have to earn to repay their cost? To answer this question, we need to know the *monthly* cost of a parking space. We can convert the construction cost per parking space added into a monthly cost by assuming an interest rate and an amortization period. The original capital cost of each structure has already been converted into 2002 dollars (see Table 6-1). If future costs and revenues are also measured in 2002 dollars, we can convert the capital cost into a monthly cost by using the real interest rate (the interest rate after accounting for inflation), which is commonly assumed to be around 4 percent a year. A longer amortization period produces a lower monthly cost, so to be conservative we can assume 40 years.[22] At 4 percent interest, a $22,500 capital cost amortized over 40 years will require payments of $94 a month.[23] Therefore, the capital cost of a new parking space is equivalent to paying $94 a month for 40 years.

In addition to the initial capital cost, parking spaces have operation and maintenance costs. Parking structures take a beating from heavy vehicles driving through them every day, and they are prone to weather damage. The UCLA Parking Service spends $33 a month per space for administration, cleaning, insurance, lighting, maintenance, revenue collection, and security (see Table 6-3). The total cost per space added by the 15 parking structures built since 1961 therefore amounts to $127 a month ($94 + $33).

Table 6-3. Monthly Cost of a Parking Space (2002$)

Assumptions	
Capital cost per space	$22,500
Amortization period	40 years
Interest rate	4 percent
Cost per space per month	
Capital cost	$94
Operating and maintenance cost	$33
Cost per space per month	**$127**

This estimate of $127 a month per space is low because it is based on the following conservative assumptions.

1. Land is valued at its opportunity cost for surface parking, but a parking structure is built only when land is too valuable to use for surface parking, so the land value may be much higher.
2. The opportunity cost of land is measured only for the structure's footprint, but a parking structure requires additional land for access roads and landscaped setback.
3. No land cost is calculated for underground parking structures, although they occupy space that could be used for other purposes, such as storage and mechanical equipment.
4. The operation and maintenance cost per space for parking structures is calculated for the entire parking system (including surface lots). But structures have higher costs for elevators, lighting, ventilation, security, and maintenance than do surface lots.
5. Property taxes are excluded because UCLA is a tax-exempt institution.
6. Structures are optimistically assumed to have a useful life of 40 years.
7. The interest rate is only 4 percent a year.[24]

Given these conservative assumptions, the 15 parking structures built at UCLA since 1961 cost *at least* $22,500 per space or *at least* $127 a month per space.

This figure of $127 a month per space is also low compared with the debt service for UCLA's newest parking structure, built in 2002 at a cost of $31,500 per space. At an annual interest rate of 6.125 percent for 27 years, the debt service is $201 a month per space (see Table 6-4). This may seem expensive, but consider the financial situation of anyone who borrows the money necessary to buy land and build a parking garage. Revenue of more than $127 a month per space would probably be necessary to cover the debt service, operating costs, property taxes, and insurance for the structure. The cost estimate of $127 a month per space is also low when compared to the price of parking in many commercial spaces. A survey of 59,000 parking spaces in downtown Seattle in 2002, for example, found the average price of commercial parking was $200 a month.[25] A similar survey of 32,000 parking spaces in downtown Bellevue, Washington, in 2002 found the average price of commercial parking was $138 a month.[26] And a nationwide survey of the prices charged for structured parking in 43 Central Business Districts (CBDs) in the U.S. in 2003 found the average price for unreserved parking was $141 a month.[27] (Despite these high prices, employer-paid and validated parking reduces the cost of parking for most drivers to zero. Therefore, the posted prices for parking in down-

Table 6-4. Debt Service for Parking Structure 7

1. Total cost of structure	$47,282,000	
2. Number of parking spaces in structure	1,500	
3. Cost per parking space	$31,500	per space
4. Interest rate	6.125%	per year
5. Term	27	years
6. Annual debt service per debt-financed space	$2,414	per year
7. Monthly debt service per debt-financed space	$201	per month

Source: Memo from the UC Office of the President to the UC Regents, November 7, 2001.

town spaces are evidence more of the high cost of providing parking than of what drivers pay for it.) Finally, University of Michigan economics professor Richard Porter estimated that the cost of the 4,500 public parking spaces in structures and lots in Ann Arbor was $160 a month per space.[28] Therefore, the estimated cost of $127 a month per space for parking structures at UCLA is low when compared to the cost of both private and public parking elsewhere in the U.S.

The cost of $127 a month per space for structured parking is low by national standards. In her book *Parking Structures*, Mary Smith shows that both surface parking and aboveground structured parking cost about $12,000 per space if the price of land is $30 per square foot. Structured parking is cheaper than surface parking only at land prices above $30 per square foot ($330 per square meter or $1.3 million per acre).[29] At a land price of $30 per square foot, the capital-plus-operating cost for an unattended aboveground garage is about $150 a month per space.[30] Because structured parking costs even more than $150 a month per space at higher land prices, a parking structure must earn at least $150 a month per space to pay its way.

We should also distinguish between the cost per space of a parking structure and the cost per *occupied* space. In his case studies of office developments in Southern California, Richard Willson explains that the cost per space in the structure usually underestimates the cost per occupied space because some spaces always remain empty. He argues that the cost of these empty spaces must be allocated among the occupied spaces if parking fees are to cover the total cost:

> The costs of providing unused spaces would have to be spread over those who use the facility. Since many of the parking facilities are half empty, this fee is much higher than the fee for a single occupied space. For the surface-lot case studies, the utilization-adjusted break-even fee averages $92 per month. Each all-day parker would have to be charged that amount if the total parking

revenue were to equal the cost of providing the parking facility. For the parking-structure studies, the utilization-adjusted break-even fee averages $161 per month.[31]

These calculations suggest that $127 a month per space is a *conservative estimate* of the cost for a structured parking space. There are also, however, the external costs to consider.

EXTERNAL COSTS OF A PARKING SPACE

Beyond the capital and operating costs of providing parking spaces, we can estimate how additional parking spaces increase other costs in the transportation system. After all, planners require developers to provide parking spaces because they expect drivers to use them. We should therefore ask: do the required parking spaces increase vehicle travel? If so, how will this added vehicle travel increase the external costs of traffic congestion and air pollution?

Induced Travel

Parking spaces do not *create* travel demand, of course, but a larger supply of parking reduces its market price and therefore reduces the price of vehicle travel. In the short run, the lower prices induce those who were already driving to drive even more. Some who would have stayed home begin driving. And some who would otherwise walk, cycle, or ride public transit shift to driving. In the long run, the lower price of parking leads to increased vehicle ownership and thus further increases vehicle travel.[32] Parking spaces do not create vehicle travel, but they do enable it.

The phenomenon of vehicle travel induced by new parking spaces (added vehicle-*storing* capacity) is similar to the phenomenon of vehicle travel induced by new roads (added vehicle-*carrying* capacity). As Don Pickrell explains, road construction increases vehicle travel by increasing its speed and reducing its time price.[33] Similarly, parking requirements increase the supply and reduce the money price of parking. Because cars spend most of their time parked, the price of parking (if motorists pay for it) can be a large part of the cost of vehicle travel. But many transportation analysts neglect the price of parking in estimating the demand for vehicle travel, probably because parking is usually free to drivers almost everywhere. But where drivers do pay for parking, it strongly influences travel behavior: the higher the price of parking, the more travelers ride public transit, carpool, bike, or walk to their destinations.

Using information from the environmental impact report (EIR) for UCLA's newest parking structure, I will provide an example of how new parking spaces increase vehicle travel and how the increased vehicle

travel increases traffic congestion and air pollution. These estimates are specific to one case, but they show that new parking spaces can create substantial external costs.

Environmental Impacts

The EIR was conducted for UCLA's 1,500-space Parking Structure 7, which was built in 2001–2003.[34] The EIR provides full documentation for nearly every aspect of the structure, including the predicted number of vehicle trips and vehicle miles travelled (VMT) it will generate, and the

Table 6-5. External Costs of a Parking Space ($/Month)

Panel 1. VMT per parking space

Trips per space (trips/month)	Trip length (VMT/trip)	VMT per space (VMT/month)
(1)	(2)	(3)=(1)x(2)
82.6	8.8	**727**

Panel 2. Congestion cost per parking space

VMT per space (VMT/month)	Congestion price ($/VMT)	Congestion cost ($/month)
(4)=(3)	(5)	(6)=(4)x(5)
727	$0.10	**$72.70**

Panel 3. Emissions cost per parking space

	Emissions per space (lbs/month)	Emissions price ($/lb)	Emissions cost ($/month)
	(7)	(8)	(9)=(7)x(8)
ROG	1.32	$3.84	$5.07
CO	13.79	$2.22	$30.61
NO_x	1.37	$5.88	$8.06
PM_{10}	0.03	$4.87	$0.15
SO_x	0.07	$3.96	$0.28
			$44.16

Panel 4. Total external costs per parking space

Congestion ($/month)	Emissions ($/month)	Total ($/month)
(10)=(6)	(11)=(9)	(12)=(10)+(11)
$72.70	$44.16	**$116.86**

Source: Intramural Field Parking Structure Environmental Impact Report, State Clearinghouse Number 1999091001, University of California, Los Angeles, May 2001.

vehicle emissions from the cars traveling to and from it. Table 6-5 shows the data on vehicle trips and vehicle emissions estimated in the EIR.

Congestion cost: $73 a month per space. The full cost of an automobile trip includes not only the cost borne by the driver but also the external costs of congestion the driver imposes on other travelers. When a car enters a road that is already near its carrying capacity, it slows down all the other vehicles already on the road. Slowing these other vehicles increases everyone else's travel time and fuel consumption. Nothing alerts individuals to these external costs of their driving, and most drivers are unaware of or indifferent to the external costs their own driving creates.[35]

Using trip generation rates estimated specifically for UCLA parking structures, the EIR reports that 1,500 new parking spaces will generate 5,630 one-way vehicle trips per weekday, or 3.8 trips a day per space, implying a parking turnover rate in the structure of 1.9 vehicles a day per space.[36] If we assume that the structure is used only 22 weekdays a month (i.e., no trips are calculated for the weekends), each space will generate 82.6 vehicle trips a month.[37] The EIR reports that the average distance for vehicle trips to campus is 8.8 miles, so each space will generate 727 VMT a month per space (82.6 x 8.8). We can use this estimate to calculate how adding a parking space increases the cost of traffic congestion in Los Angeles.

Several transportation analysts have estimated the cost of traffic congestion in Los Angeles, and their results suggest the value of reducing peak-hour vehicle travel is at least 10¢ per VMT. In 1991, Michael Cameron estimated that the external cost of vehicle travel in Los Angeles ranged from 10¢ to 37¢ per VMT.[38] He also estimated that a peak-period congestion toll of 15¢ per VMT would be needed to reduce congestion enough to raise average freeway speeds to 35-40 miles an hour. At this speed, the external cost of congestion produced by drivers would be 15¢ per VMT. After an extensive literature survey in 1992, Kenneth Small also concluded that a peak-period charge of 15¢ per VMT (in 1990 dollars) would be appropriate on congested freeways in Los Angeles.[39] Using a large-scale transportation model with data for 1991, Elizabeth Deakin and Greig Harvey estimated that if the appropriate congestion charges were imposed on Southern California's highway network, they would average 10¢ a mile.[40] Finally, in 1991 Patrick DeCorla-Souza and Anthony Kane estimated that the cost of reducing congestion by adding new highway capacity to serve peak users in Los Angeles would be 20¢ per peak-hour VMT.[41]

If we value the congestion cost of 727 VMT a month at the low end of these values for Los Angeles—10¢ per VMT—the external cost of congestion amounts to $73 a month per new parking space.

Emissions cost: $44 a month per space. Vehicle emissions are another major external cost of driving. Los Angeles has the worst air pollution in the nation, and motor vehicles produce most of it.[42] As Kenneth Small and Camilla Kazimi report, transportation accounts for 75 percent of total reactive organic gas (ROG) emissions in Los Angeles, 98 percent of carbon monoxide (CO), 83 percent of oxides of nitrogen (NO_x), and 68 percent of oxides of sulfur (SO_x).[43]

Using the vehicle emission factors estimated by the South Coast Air Quality Management District (SCAQMD), the EIR calculated the total emissions per weekday for vehicles traveling to and from the new structure. Column 7 of Panel 3 of Table 6-5 shows the vehicle emissions per space per month created by these vehicles.

Putting a dollar value on the cost of pollution is not easy, but one reasonable method is to use the SCAQMD's threshold values for the cost-effectiveness of emissions-reduction measures (see column 8).[44] I have used these official values as an estimate of the cost of the pollution emissions created by additional vehicle travel. The external cost of vehicle emissions induced by a new parking structure thus amounts to $44 a month per space. This estimated cost of $44 for 727 VMT implies an emissions cost of 6¢ a mile.

With an emissions cost of 6¢ a mile and a congestion cost of 10¢ a mile, the total external cost of vehicle travel is 16¢ a mile. For the average trip length of 8.8 miles, the total external cost per trip to or from Parking Structure 7 is thus $1.41. In another attempt to calculate the external costs of vehicle travel, in 2001 Kaan Ozbay, Bekir Bartin, and Joseph Berechman estimated that the marginal external cost for a 10- to 15-mile highway trip in New Jersey was $1.25, or 8¢ to 13¢ a mile.[45] The estimate for Los Angeles may be slightly higher because Los Angeles has worse traffic congestion and air pollution.[46]

Total external costs: $117 a month per space. The fourth panel shows that the total induced external costs of a new parking space amount to $117 a month: $73 for added congestion and $44 for added pollution. Although this may sound high, the estimate is based on uniformly conservative assumptions.

1. The VMT and the vehicle emissions are estimated only for weekday trips.
2. The congestion cost per VMT is taken from the bottom of the range of estimates for Los Angeles.
3. The average one-way trip distance is only 8.8 miles, while the average one-way automobile commute to work in Southern California is 15 miles.[47]

4. Greenhouse gas (CO_2) emissions from 1.1 million VMT per month are ignored.
5. The congestion and pollution costs associated with building the structure are ignored. In addition to the estimated impacts of *using* the parking structure, *constructing* it required excavating the 10-acre site to a depth of 31 feet. Removing 222,000 cubic yards of earth required 26,000 truck trips (with a peak of 63 truck trips an hour) through campus and Westwood Village, along Wilshire Boulevard to the San Diego Freeway, and eventual disposal.

Despite these conservative assumptions, the external cost of $117 a month for a new parking space still seems surprisingly high, but this may be only because no one has bothered to estimate it before.

These external costs are calculated for Los Angeles, and they would be lower in cities that have less traffic and cleaner air. (But that raises an important point: new parking spaces create even higher external costs in cities that are already polluted and congested.) In any case, one can easily vary the four assumptions in the calculation—the trip generation rate, the average trip distance, the vehicle emission rates, and the costs of pollution and congestion—to see how they affect the external costs of increased driving induced by new parking spaces in other places. The pollution costs of new parking spaces may be especially high in developing countries where the vehicle emissions and population densities are higher. For example, Mutasem El-Fadel and Hayassam Sbayti at the American University of Beirut studied the environmental impacts of a proposed 2,000-space parking garage in the center of Beirut. They estimated that it would increase the ambient levels of CO by 29 percent and of NO_2 by 38 percent in the already polluted air. These increases in pollution would occur because most Lebanese cars are old and poorly maintained; the average age of the fleet was 14 years.[48] With dirtier cars and higher population densities, the external cost of new parking spaces in developing countries may be far higher than in the U.S.

New parking spaces also induce increases in other external costs associated with vehicle travel: noise, greenhouse gas emissions, and accident costs not paid for by the drivers who cause the accidents. Consider also the ecology of parking lots. They increase the impervious surface area in a city, reduce the area for water to percolate into the soil, and increase stormwater runoff. Parking lots also accumulate oil drippings that contain toxic metals, such as chromium, and the runoff then pollutes water supplies. After heavy rain, the runoff enters storm sewers at an accelerated rate, contributing to the risk of flooding. The faster runoff also erodes the banks of streams and rivers, and adds more sediment to the water.[49] Finally, poorly designed parking lots and structures often degrade the

townscape. When these other costs above and beyond traffic congestion and air pollution are considered, the estimate of $117 a month for the external cost of a new parking space becomes even more conservative.

This brings us to the great imbalance between what parking costs and what drivers pay for it. UCLA spends $201 a month per debt-financed space in the parking structure we have been using in this example (see Table 6-4). When the external cost of $117 a month is added, the total social (internal plus external) cost associated with a new parking space is $318 a month. In 2002, the price for a permit to park on campus was $54 a month—only 16 percent of the total social cost per parking space. Drivers pay far less than the marginal social cost of driving to UCLA, but this is merely one example of the much larger problem: almost all parking is grossly underpriced.

Drivers who pay $54 a month for a permit to park in Structure 7 surely do not realize that their parking spaces cost more than $200 a month or that the congestion and pollution added by their vehicle trips cost more than $100 a month. Drivers base their travel decisions only on the prices they personally face. On the day Structure 7 opened, UCLA's *Daily Bruin* interviewed drivers who park there. Consider this response from a third-year psychology student: "I didn't have a permit before so I had to vanpool. For me, having a permit is awesome."[50] Awesome indeed. Paying only $54 a month to park in a space that cost $31,500 to build *is* awesome. That's quite a subsidy, and there is probably no better bargain on campus. The large subsidy for parking drew this student from a vanpool to solo driving, and thus increased traffic congestion and air pollution. Each individual driver enjoys a parking subsidy, but the whole society suffers.

Economists and planners often propose parking policies as possible ways to *reduce* the external costs of traffic congestion and air pollution. For example, Dutch transportation economist Erik Verhoef says, "Since virtually every car has to be parked at the end of the trip, parking policies may offer a potentially strong instrument for influencing traffic flows."[51] But by increasing the supply and reducing the price of parking spaces, off-street parking requirements make parking itself yet another external cost of vehicle travel and thus *increase* traffic congestion and air pollution. Although parking spaces themselves do not directly increase traffic, the lower price of parking does. We own more cars and drive them more often than we would if we paid market-rate prices for parking. The costs of congestion and pollution are hard to measure and to attribute to individual drivers, which is why they remain external costs. In contrast, charging for parking is easy, so there is no reason why it should be an external cost. By increasing vehicle travel, off-street parking requirements increase the total external costs of driving and make an already bad situation far worse.

CONCLUSION: THE HIGH COST OF REQUIRED PARKING SPACES

Cities require a precise number of parking spaces for every land use, and one would therefore expect to find many studies of how much these spaces cost. Where are they? Perhaps planners have not studied the cost of parking simply because they rarely think about it when they set parking requirements. This neglect sounds unwise, and it is. Two unstated assumptions—that parking is free, and that its cost is irrelevant—lie behind parking requirements in zoning ordinances. Cities therefore require developers to supply enough parking spaces to meet the peak demand for free parking, regardless of the cost.

Parking structures at UCLA have cost *at least* $22,500 per space added, or $127 a month per space. These estimates were made with conservative assumptions, including a low interest rate, a long amortization period, a low opportunity cost of land, and no taxes. In addition, the external cost of congestion and pollution associated with driving to and from a parking space amounts to *at least* $117 a month. When both the internal and external costs are calculated, the total social cost of a new parking space comes to *at least* $244 a month. But the cost of parking at UCLA is not the important point. The important point is that parking is expensive for everyone except drivers.

CHAPTER 6 NOTES

1. Amis (1958, 18). Jim Dixon, a university lecturer, is the protagonist of *Lucky Jim*.

2. Because a typical parking lot has about 330 square feet per space (for both the parking spaces and for circulation of cars to access the spaces), a parking space will have a land cost of $100,000 where land is worth $300 a square foot.

3. The example is UCLA's Parking Structure 6, which was built in 1980 and is described in Table 6-1.

4. The UCLA Parking Service is one of the largest single-site parking systems in the nation, with 21,000 parking spaces in structures and surface lots. One atypical structure is excluded from the list of structures. This "demountable" structure was prefabricated and was intended for removal (and reassembly elsewhere) at a later date. It was placed on a portion of Lot 32, remote from the main campus, and its appearance would be unacceptable on the main campus. In regard to its location, Bob Hope said, "It takes four years to get through UCLA, or five if you park in Lot 32." The construction contracts for all the structures were competitively bid, so the cost records are accurate and detailed, and they include the costs of planning and design.

5. Surface parking lots at UCLA occupy 851,725 square feet of land and contain 2,591 parking spaces, for an average of 329 square feet per surface space (including access lanes). Therefore, each structure's footprint was divided by 329 square feet to estimate the number of surface spaces lost. No surface parking spaces are assumed to be lost for underground parking structures.

6. To estimate the increase in the cost of construction since each parking structure was built, the 20-city average of the *ENR* Construction Cost Index for 2002 was divided by the *ENR* Construction Cost Index for the year in which the parking structure was built. This ratio was multiplied by the original construction cost to show the construction cost expressed in dollars of 2002 purchasing power. The *ENR* Construction Cost Index, a widely accepted measure of cost inflation in the construction industry, is published in the magazine *ENR* (formerly *Engineering News Record*) and is available online at www.enr.com. The index rose from 847 in 1961 to 6,538 in 2002.

7. Mary Smith (1999, 532) explains how cost per square foot of floor area and efficiency together determine the cost per space. Retail customer parking with high turnover requires larger spaces than office employee parking and is thus less inefficient (more square feet per space), and angle parking is less efficient than perpendicular parking.

8. The high cost is due to the small footprint and the resulting inefficient layout of the structure (more square feet of structure per parking space). The structure has parking spaces only on one side of the aisles (it is "single loaded") while larger structures are "double loaded" with parking spaces on both sides of the aisles.

9. The high cost of construction in Los Angeles can explain only a small part of the high cost of adding recent parking spaces at UCLA because the *ENR* Construction Cost Index for Los Angeles in 1998 was only 14 percent above the median Construction Cost Index for all the 20 cities that *ENR* monitors.

10. Willson (1995, 39). The construction cost is adjusted by the *ENR* Construction Cost Index.

11. The *ENR* Construction Cost Index is used to convert the original construction costs to 1998 dollars. The original aboveground structure contains 39 percent more parking spaces than the aboveground addition, and its footprint is twice as large as that of the addition. Economies of scale help explain the original structure's slightly lower cost per space. The underground addition is almost three times the size of the original underground structure, and economies of scale may help explain the newer structure's slightly lower cost per space.

12. The cost per parking space added by a parking structure should vary less among different locations and over time than does the cost of most other real estate. For example, measuring a standard unit of housing is difficult because houses vary greatly in size and quality. Housing values also vary greatly among locations and over time because of differences in land values. A parking space may be the most uniform unit of real estate on earth.

13. Klose (1965, 190) gives the original cost of constructing the Pershing Square garage. Because the *ENR* Construction Cost Index rose faster than the Consumer Price Index between 1952 and 1998, the cost of constructing parking spaces rose relative to other prices.

14. R. S. Means (2001, 483).

15. R. S. Means (2001, 618). In another publication, *Square Foot Costs*, R. S. Means (2002, 130) reports that the construction costs for a five-level aboveground garages ranged from $20.25 to $84.05 per square foot. With an average area of 330 square feet per parking space, the construction cost ranges from $6,700 to $27,700 per parking space.

16. Letter from Vitaly Troyan of the Los Angeles Bureau of Engineering, October 12, 1999. The parking structure—on Broxton Avenue in Westwood Village—has two levels underground and four levels aboveground. Like the RC structure on the UCLA campus, the Broxton Avenue Structure has a small footprint and an inefficient layout, with single-loaded aisles.

17. In Lake Forest the cost of $18,000 per space is the land-and-construction cost of surface parking lots. In Walnut Creek the cost is $32,400 per space added by a municipal parking structure (as calculated by the method shown in Table 6-1). In Beverly Hills the cost of $37,000 per space refers to the average estimated land-and-construction cost of municipal parking spaces for projects that applied to pay the in-lieu fees between 1978 and 1992; the highest cost was $53,000 per parking space. In Palo Alto, the cost of $50,994 is the cost per space added by two municipal parking structures (calculated by the method shown in Table 6-1).

18. Kate Folmar, "Bold Downtown Project Cost $58 Million, to Include Restaurants, Shops, Banquet Hall," *San Jose Mercury News*, January 5, 2003.

19. Washington State Department of Transportation (1999, 6).

20. *The Parking Professional*, August 2003, p. 18 and 35. The six-level structure (two underground and four aboveground) was built at the Texas Medical Center in Houston, Texas. Giant 90-foot-long x 60-foot-tall water walls were used to mask the structure, and a computer program creates a series of animated sequences of falling water at various rates and densities to create a continuous show. Jackson & Ryan were the architects.

21. Land cost does not explain the high cost per space because all spaces are underground. The 120-space Heiwa Kouen garage in Nagasaki cost $280,000 per space; the 500-space Yokohama-eki Higashi-guchi garage in Yokohama cost $304,000 per space; and the 380-space Kawasaki-eki Higashi-guchi Chika garage in Kawasaki cost $414,000 per space. These values are calculated with an exchange rate of $1=110 Yen. Several factors contribute to these high costs. Underground parking garages are often built in front of an existing railway station, and they must be built in stages without closing off surface traffic. The Shinkawa garage in Tokyo was built under a river. Regulations for earthquake-resistant construction are also more strict in Japan than in the U.S. Even if these garages were fully occupied all day every day, they wouldn't pay for themselves. See Multilevel Parking Industry Association of Japan (1997).

22. UCLA's first parking structure, built in 1961, required extensive reconstruction 30 years later. The structure built in 1963 was demolished 36 years later to redevelop the site. The structure built in 1964 required extensive repairs 35 years later. The other structures built in the 1960s do not meet current design or earthquake safety standards. The structure built in 1977 needs extensive repairs and may be demolished. Forty years is thus a long period over

which to amortize the capital cost of a parking structure. One would normally not want to amortize a loan over a period longer than the expected economic life of the structure financed by the loan. Since the payment of $94 a month is calculated in dollars on 2002 purchasing power, it would have to increase over time at the rate of inflation to maintain its real value.

23. Varying the assumptions about a parking structure's lifespan and the interest rate will affect the equivalent monthly capital cost per parking space. For example, with a 4 percent interest rate, a 30-year life raises the monthly cost per space to $113, while a 100-year life reduces it to $80. With a 50-year life, a 3 percent interest rate reduces the monthly cost per space to $76, while a 5 percent interest rate increases it to $107.

24. The revenue bonds issued to finance parking structures at UCLA bear interest rates of 6.1 percent, 8.25 percent, and 7.74 percent, and one revenue bond has a variable rate that can float between 4 percent and 9 percent. These are all tax-exempt interest rates, and taxable bonds issued to finance commercial parking structures will bear higher interest rates. The revenue bonds include a risk premium to compensate for the risk involved in the lender's investment, but the bonds are secured by the revenues of the entire parking system (including surface spaces), not by the revenues of the particular parking structure financed by a bond. The revenue bonds can be a safe investment for the lender even if the investment in a new parking structure is risky for UCLA. The appropriate risk premium for investment in a single structure is therefore higher than implied by the interest rates on existing UCLA Parking Service bonds.

25. Puget Sound Regional Council (2003, 10).

26. Puget Sound Regional Council (2003, 27).

27. Colliers International (2003, 28).

28. Porter (1999, 162-63) estimated that the cost of Ann Arbor's 4,500 public parking spaces was $8.8 million a year.

29. Similarly, University of Pennsylvania professor of urban design Jonathan Barnett (2003, 52) says, "Land costs need to be well over $1 million an acre before land-cost, by itself, makes it advisable to build a garage instead of at-grade parking."

30. Smith (2001, 24 and 27). Smith says a common rule of thumb is that the first level of an underground parking structure costs 1.5 times the above-grade costs, with the multiplier doubling for each additional underground level.

31. Willson (1995, 35). After seeing Willson's estimate, the Chicago Regional Transportation Authority (1998) commissioned similar case studies at office developments in 10 Chicago suburbs. These studies found that the peak parking demand was only 68 percent of capacity. The utilization-adjusted break-even fee for these parking spaces ranged from $96 to $103 per month.

32. In the long run, the reduced price of parking will increase both the total person-miles of travel by all modes and vehicle travel's share of this total. The number of person-miles of travel by walking, cycling, and public transit will decline.

33. Pickrell (2001).

34. Intramural Field Parking Structure Final Environmental Impact Report, State Clearinghouse Number 1999091001, University of California, Los Angeles, May 2001. Because UCLA commissioned the EIR, the structure's environmental impacts are unlikely to be overestimated.

35. External effects are not deliberate creations but are the unintended or incidental by-products of an activity. Even if drivers are aware of these external effects, they are unlikely to feel guilty about them because, after all, everyone else is doing the same thing.

36. 5,630 trips ÷ 1,500 spaces = 3.753 one-way trips or 1.9 round-trips a day per space.

37. 3.753 x 22 = 82.6 one-way trips a month. This calculation assumes that the parking spaces are used on 22 weekdays a month and not on weekends. This neglect of weekend traffic produces a conservative estimate of vehicle trips and VMT per month.

38. Cameron (1991). Because traffic congestion is even worse without a toll, the congestion-related external costs of vehicle use are presumably higher than 15¢ per VMT where there are no tolls.

39. Small (1992).

40. Deakin and Harvey (1996, 7-8). Deakin and Harvey's estimate included tolls on the arterials and collector streets as necessary.

41. DeCorla-Souza and Kane (1992).

42. U.S. Environmental Protection Agency (1995). Los Angeles is the only region in the EPA's most-polluted category of "extreme nonattainment" of national air quality standards. The four other categories of nonattainment are, in decreasing seriousness: severe, serious, moderate, and marginal.

43. Small and Kazimi (1995).

44. South Coast Air Quality Management District (2000, 29). If the cost per ton of emissions reduced by a proposed control measure is less than the SCAQMD's threshold value, the measure is considered cost effective and is required. Because the SCAQMD presumably does not require emission controls that cost more than the value of the emissions reduced, we can interpret these threshold cost-effectiveness measures as the SCAQMD's estimate of the value to society of reducing emissions. These values refer to the cost of emissions in 2000.

45. Ozbay, Bartin, and Berechman (2001, 100). They defined the marginal external costs as "the costs auto users are not held accountable for, including those every user imposes on the rest of traffic, such as the costs of congestion, accidents, air pollution, and noise" (Ozbay, Bartin, and Berechman 2001, 82).

46. The Texas Transportation Institute (TTI) annually surveys traffic data in 75 American cities and calculates the Roadway Congestion Index to rank them by the severity of their traffic congestion. Los Angeles has ranked highest on the TTI Roadway Congestion Index in every year since 1983 (Texas Transportation Institute 2003, Exhibit A-18). The TTI estimated that Los Angeles drivers experienced 739 million person-hours of delay in congested traffic in 1997 and that the time wasted and excess fuel consumed in this congested traffic was worth $12.4 billion a year. To put this estimated cost in perspective, the construction cost of the magnificent Getty Center that opened in Los Angeles in 1997 was approximately $1 billion. Therefore, the TTI's estimated cost of traffic congestion in Los Angeles equals the cost of constructing a dozen Getty Centers every year.

47. Annual surveys conducted between 1989 and 1996 found that average one-way vehicle commute distances ranged from 14.8 to 16.9 miles (Southern California Association of Governments 1996). In calculating the VMT reductions associated with reducing a vehicle trip to work, the SCAQMD assumes an average one-way distance for each avoided vehicle commute trip of 15 miles.

48. El-Fadel and Sbayti (2001, 19).

49. Albanese and Matlack (1998) found that the parking lots at eight shopping centers in Hattiesburg, Mississippi, were occupied well below capacity even at the periods of peak demand. The runoff from these parking lots increased the sediment in nearby streams and reduced the number and diversity of fish in the streams.

50. *UCLA Daily Bruin*, April 9, 2003.

51. Verhoef (1996, 96). He shows that under certain circumstances (each car driver uses an equal amount of road space per trip, congestion is equally spread over the road network, and all drivers have the same parking duration), the optimal parking fee can substitute for the optimal road toll. Downs (1992) also discusses parking policies to reduce traffic.