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Cruising for parking

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Abstract

Suppose curb parking is free but all the spaces are occupied, and off-street parking is expensive but immediately available. In this case, you can cruise to find a curb space being vacated by a departing motorist, or pay for off-street parking right away. This paper presents a model of how drivers choose whether to cruise or to pay, and it predicts several results: you are more likely to cruise if curb parking is cheap, off-street parking is expensive, fuel is cheap, you want to park for a long time, you are alone in the car, and you place a low value on saving time. The model also predicts that charging the market price for curb parking—at least equal to the price of adjacent off-street parking—will eliminate cruising. Because the government sets curb parking prices, planners and elected officials strongly influence drivers' decisions to cruise. The failure to charge market rates for curb parking congests traffic, pollutes the air, wastes fuel, and causes accidents. Between 1927 and 2001, studies of cruising in congested downtowns have found that it took between 3.5 and 14 min to find a curb space, and that between 8 and 74 percent of the traffic was cruising for parking.

Keywords: Parking; Pricing; Congestion

1. Introduction

> My father didn't pay for parking, my mother, my brother, nobody. It's like going to a prostitute. Why should I pay when, if I apply myself, maybe I can get it for free.
> George Costanza

When a resource is communally owned, the right of "first possession" means that anyone who captures the resource has the right to use it. Free curb parking is an example of communal ownership, because drivers occupy it on a first-come, first-served basis. If all the curb spaces are occupied, drivers must cruise to find a space vacated by a departing car. Cruising for parking probably began soon after the wheel was invented.

2. Cruising in the 20th century

Cruising creates a mobile queue of cars that are waiting for curb vacancies, but no one can see how many cars are in the queue because the cruisers are mixed in with other cars that are actually going somewhere. Perhaps because cruising is invisible, most transport economists and planners have neglected it as a source of congestion. Nevertheless, a few researchers have attempted to estimate the volume of cruising and the time it takes to find a curb space. They have analyzed videotapes of traffic flows, interviewed drivers who park at the curb, and have themselves cruised. Table 1 shows the results of every study of cruising I have been able to find. Between 8 and 74 percent of the traffic was cruising for parking, and the average time to find a curb space ranged between 3.5 and 14 min. The wide variance in the estimates of cruising surely reflects reality. On most streets most of the time, none of the traffic is cruising, but on some streets some of the time, most of the traffic may be cruising.

Are these studies dating back to 1927 only of historical interest? The data were probably not very accurate when they were collected, and the results depend on the time and place where they were collected. The data are selective because researchers study cruising only where they expect to find it. Conditions have also changed since many of the observations were made. Nevertheless, cruising itself has not changed, and the studies at least show that searching for curb parking has wasted time and fuel for many

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Table 1
Twentieth century cruising

Year	City	Share of traffic cruising (percent)	Average search time (min)
1927	Detroit (1)	19%	
1927	Detroit (2)	34%	
1933	Washington		8.0
1960	New Haven	17%	
1965	London (1)		6.1
1965	London (2)		3.5
1965	London (3)		3.6
1977	Freiburg	74%	6.0
1984	Jerusalem		9.0
1985	Cambridge	30%	11.5
1993	Cape Town		12.2
1993	New York (1)	8%	7.9
1993	New York (2)		10.2
1993	New York (3)		13.9
1997	San Francisco		6.5
2001	Sydney		6.5
Average		30	8.1

Note: The numbers after Detroit, London, and New York refer to different locations within the same city.
Sources: Simpson (1927), Hogentogler et al. (1934), Huber (1962), Inwood (1966), Bus + Bahn (1977), Salomon (1984), O'Malley (1985), Clark (1993a, b), Falcocchio et al. (1995), Saltzman (1994), and Hensher (2001).

decades. Because curb parking is underpriced and overcrowded in the busiest parts of most of the world's big cities, the sun never sets on cruising.

Even a small search time per car can create a surprising amount of traffic. Consider, for example, a congested downtown where it takes three minutes to find a curb space and the parking turnover is 10 cars per space per day. Each curb space generates 30 min of cruising time per day. If the average cruising speed is 10 miles an hour, each curb space generates five vehicle miles traveled (VMT) per day. Over a year, this cruising amounts to 1825 VMT, greater than halfway across the United States, for each curb space. Because this cruising adds to traffic that is already congested, it makes a bad situation even worse.

Where on-street parking is cheaper than off-street parking, cruising is individually rational. Collectively, however, it congests traffic, causes accidents, wastes fuel, pollutes the air, and degrades the pedestrian environment. Cities create all these problems when they underprice curb parking. Underpricing of anything creates a shortage, and curb parking is no exception. Underpriced curb parking is gross mismanagement of scarce urban land, with widespread ramifications for transportation, cities, the economy, and the environment.

3. Choosing to cruise

When we cruise for parking on crowded streets, we rarely seem to think about how we end up in this mobile purgatory. How *do* you choose whether to cruise or to pay? A simple model of the benefits and costs of cruising can help answer this question. The model predicts several results: you are more likely to cruise if curb parking is cheap, off-street parking is expensive, fuel is cheap, you want to park for a long time, you are alone in the car, and you place a low value on saving time.

To set the scene for the model, suppose curb parking is free but so crowded that you have to spend time hunting for a space. You can park off-street without waiting, but you have to pay for it. Given the tradeoff between spending time to find curb parking or spending money to pay for off-street parking, should you cruise or pay?

Drivers do not explicitly calculate whether to cruise or to pay, but several factors influence the decision. To help understand the choice, consider the following variables (and their dimensions).[1]

p	price of curb parking ($/h)
m	price of off-street parking ($/h)
t	parking duration (h)
c	time spent searching for parking at the curb (h)
f	fuel cost of cruising ($/h)
n	number of people in the car (persons)
v	value of time spent cruising ($/h/person)

We can use these seven variables to compare the time and fuel cost of cruising with the money cost of parking off-street. I will, for the moment, assume that the walking time from the parked car to the final destination is the same for both curb and off-street parking.

First, consider how much you save on parking if you can find a curb space. The price of parking at the curb is p dollars per hour, and the price of parking off-street is m dollars per hour, so parking at the curb rather than off-street saves $m-p$ dollars per hour. The amount you save by parking at the curb is the duration (t) multiplied by the difference between the prices of off-street and curb parking, or $t(m-p)$. For example, if curb parking is free, off-street parking costs $1 an hour, and you park for two hours, you save $2 by parking at the curb.[2]

Second, cruising has a fuel cost. If your car consumes fuel at a rate of f dollars per hour of cruising for parking, and you cruise for c hours, the total cost of fuel spent

[1]For the model, I assume that drivers are indifferent between curb and off-street parking if the price and the time required to find a space are the same in both cases. There are no time limits, and drivers pay in a linear proportion to the number of minutes parked in both cases. In reality, curb parking is often more convenient if a space is available right in front of the final destination because the walking distance from the car to the destination is shorter. Curb parking is also often available in smaller increments (such as 6 or 10 min) while off-street parking is available only in larger increments (such as 20 or 30 min), and the price per minute declines for longer stays.

[2]I assume that you know in advance how long you want to park, and that you pay only for the exact time that you park. The parking charge is a linear function of the number of minutes you park, with no advance commitment to how long you park. Shoup (2003) describes parking meters that allow you to pay for the exact time that you park, determined *ex post*.

for cruising is fc.[3] For example, if the fuel cost is $1 per hour and you cruise for 6 min (0.1 h), the fuel cost is 10¢. (If drivers ignore the cost of fuel for cruising, $f = 0$.)

Third, cruising has a time cost. The value you place on saving time depends on your income and on many factors that are unique to each trip: whether you are in a hurry, the weather, the scenery, safety, your health, and so on. The value of time will, of course, vary from person to person, but even the same person will place a higher or lower value on time depending on the circumstances. Each person's time cost of cruising is the value of time (v) multiplied by the time spent cruising (c), or vc. Because every person in the car must spend the same time cruising, the total time cost for everyone in the car is the number of people in the car (n) multiplied by each person's time cost (vc), or nvc.[4] So if you are alone in the car, value time savings at $9 an hour, and cruise for 6 min before parking, your cost of time spent cruising is 90¢. Adding one passenger in the car doubles the time cost to $1.80. A second passenger makes it $2.70, and so on.

The money saved by parking at the curb and the cost of cruising for a curb space are,

$t(m-p)$,	(1)	money saved by parking at the curb
fc,	(2)	money cost of cruising for curb parking
nvc,	(3)	monetized cost of time spent cruising for curb parking
$fc + nvc = c(f + nv)$,	(4)	money and (monetized) time cost of cruising for curb parking

At what point does cruising for curb parking become more expensive than paying to park off street right away? Let c^* denote the time that equates the time-and-fuel cost of cruising with money cost of off-street parking. There is no cost difference between cruising and paying if you expect to spend exactly c^* minutes to find a curb space, so you are indifferent between the two choices.[5] This equilibrium occurs when the money saved from parking at the curb, $t(m-p)$, equals the money and time cost of cruising, $c^*(f+nv)$. So if you expect that it will take longer than c^* to find a curb space, you should pay to park off-street. But if you expect that it will take less than c^*, then you should cruise.

[3]The fuel cost per hour of cruising is the cost of fuel per gallon divided by the miles cruised per gallon and then multiplied by the cruising speed. For example, if gasoline costs $1 per gallon, and your car gets 20 miles per gallon, cruising costs 5¢ per mile. If you cruise at 20 miles per hour, the fuel cost of cruising is $1 per hour.

[4]The cost of time spent cruising, v, may differ among persons in the car. If everyone's value of time is weighted equally, we can interpret v as the average value of time.

[5]The time spent walking from the car to the final destination is neglected here.

The break-even point occurs where the cost of cruising equals the savings from parking at the curb.

$$c^*(f + nv) = t(m - p) \tag{5}$$

The search time at which you are indifferent between cruising and paying is,

$$c^* = \frac{t(m-p)}{f + nv} \tag{6}$$

At time c^*, you realize no *net* savings by parking at the curb instead of off-street. The money the city loses from underpriced curb parking does not accrue to you or to anyone else, but is instead dissipated in time and fuel spent cruising. And because each driver in congested traffic imposes time delays on all other drivers, cruising makes all drivers worse off, including those who are not trying to park.

4. Equilibrium search time: an example

We can use an example to illustrate the equilibrium search time. Suppose you want to park for one hour ($t = 1$), off-street parking costs $1 an hour ($m = 1$), and curb parking is free ($p = 0$). You thus save $1 by parking at the curb rather than off-street. If you drive 10 miles an hour and your car gets 20 miles per gallon of gasoline, the cruising consumes half a gallon of gasoline an hour. If gasoline costs $2 a gallon, the fuel cost is $1 an hour ($f = 1$). You are alone in the car ($n = 1$) and your time is worth $9 per hour saved ($v = 9$). The equilibrium search time, c^*, is

$$c^* = \frac{t(m-p)}{f + nv} = \frac{1(1-0)}{1 + 1 \times 9} = 0.1\,\text{h} = 6\,\text{min}$$

In this case it is worth spending up to 6 min to find a curb space. If fuel costs $1 an hour, and you cruise for 6 min (0.1 h), you spend 10¢ for fuel ($1 × 0.1). You save $1 on parking for an hour, so your net saving from parking at the curb is 90¢ ($1 saving on parking minus 10¢ spent for fuel). In a sense, you "earn" $9 an hour for the time spent cruising (90¢ saved for 0.1 h of cruising). If you value time savings at $9 an hour, 6 min is the search time that leaves you indifferent between searching for curb parking and paying to park off-street immediately. You are no better off parking free at the curb after searching for 6 min than if you had paid $1 to park off-street immediately.[6]

[6]If it takes less than 6 min to find a curb space, you earn more than $9 an hour by cruising, so cruising for free curb parking is cheaper than paying to park off-street immediately. If it takes more than 6 min to find a curb space, you earn less than $9 an hour by cruising, so paying to park off-street immediately is cheaper than cruising for free curb parking. This appears to suggest that cruising should allocate curb parking to drivers who place a lower value on saving time spent driving. Nevertheless, a driver who has a higher value of time and wants to park for a longer duration may be willing to cruise longer than a driver who has a lower value of time who wants to park for a shorter duration because $c^* = t(m-p)/(f + nv)$, with parking duration in the numerator and value of time in the denominator.

This example suggests two results. First, "free" curb parking is not really free. Although cruising's costs are not directly out-of-pocket (like money put in a parking meter), they are incurred in the form of time and fuel used to find a curb space. "Free" curb parking leaves the driver no better off, but everyone else is worse off because cruising congests traffic and pollutes the air; the city also loses the money it would have received if it had charged the market price for curb parking. Second, since the time spent cruising is the price of curb parking, this price depends on each person's opportunity cost of time.[7] In this example, solo drivers who value time savings at more than $9 an hour should pay to park right away, and those with a lower value of time should cruise. Free curb parking thus attracts solo drivers who place a low value on saving time. Areas where curb parking is free, many cars are solo driven, and drivers place a low value on saving time will therefore have long search times.

This equilibrium-search-time example also suggests that raising the price of curb parking reduces the parkers' time-and-fuel cost of cruising by as much as it increases their money payments for parking. The *net* burden on parkers is zero, and the price rise converts private waste into public revenue.

5. The wages of cruising

Cities create the incentive to cruise when they charge less for curb parking than the price of adjacent off-street parking. To examine this incentive, I collected data on the price of curb and off-street parking for an hour at noon at the same location—City Hall—in 20 cities throughout the US.[8] Table 2 shows the results. The average price is $1.17 an hour for curb parking, and $5.88 an hour off-street. Cruising saves drivers the most money in New York, where the price of off-street parking is $14.38 for the first hour, but curb parking is only $1.50. Cruising saves money in all cities except Palo Alto and San Francisco. In the 20 cities, the average price of curb parking is only 20 percent of the price of off-street parking, and the highest price of curb parking is only $2 an hour.

The supply of parking affects its price. Boston's high price of off-street parking ($11) stems in part from a cap the city has placed on the number of off-street parking spaces available downtown. The parking inventory is frozen at its 1975 level—35,500 spaces. Developers who want to build new parking spaces must buy licenses owned by existing parking facilities that close.[9] This supply cap drives up the market price of off-street parking and produces an ironic outcome: combined with the low price of curb parking, the higher price of off-street parking increases the incentive to cruise. Boston limits the private off-street parking supply, but fails to price its own public curb parking properly. A survey in 2003 found that the average price for off-street parking in the Boston CBD was $390 a month, and $30 a day.[10] In contrast, Boston charges the same price ($1 an hour) for all

Table 2
The wages of cruising for parking at city hall (curb parking one hour at noon)

City	State	Price of parking for one hour		Savings for finding a curb space
		Curb	Off-street	
(1)	(2)	(3) $/h	(4) $/h	(5) = (4)–(3) $
Baltimore	MD	$2.00	$6.00	$4.00
Berkeley	CA	$0.75	$1.00	$0.25
Boston	MA	$1.00	$11.00	$10.00
Buffalo	NY	$1.00	$3.00	$2.00
Cambridge	MA	$0.50	$4.00	$3.50
Chicago	IL	$1.00	$13.25	$12.25
Houston	TX	$0.25	$1.50	$1.25
Long Beach	CA	$2.00	$2.50	$0.50
Los Angeles	CA	$1.50	$3.30	$1.80
New Orleans	LA	$1.25	$3.00	$1.75
New York City	NY	$1.50	$14.38	$12.88
Palo Alto	CA	$0.00	$0.00	$0.00
Pasadena	CA	$1.00	$6.00	$5.00
Philadelphia	PA	$1.00	$3.00	$2.00
Portland	OR	$1.00	$1.50	$0.50
San Diego	CA	$1.00	$6.00	$5.00
San Francisco	CA	$2.00	$2.00	$0.00
Santa Barbara	CA	$0.00	$5.00	$5.00
Santa Monica	CA	$0.50	$4.20	$3.70
Seattle	WA	$1.00	$8.00	$7.00
Average		$1.17	$5.88	$4.71

Assumptions: A solo driver parks for one hour at noon on a weekday.

[7]Smolensky, Tideman, and Nichols (1972, 95) say, "Queues can be viewed as prices assessed in time, and time prices, like money prices, ration according to the tastes, income and opportunity costs of buyers."

[8]The cities are an opportunistic sample of places where my research assistants and I visited and were able to gather the data. Nevertheless, the sample shows that curb parking is probably much cheaper than off-street parking in many big and small cities. City Hall was chosen because it is a standard reference point that everyone can recognize. The data were collected in 2001–2003.

[9]Boston Transportation Department (2001). The Boston Air Pollution Control Commission administers the "parking freeze" in Boston Proper (the downtown). The number of spaces available to the general public is frozen at the 1975 level, but the Boston Air Pollution Control Commission may grant exemptions to private off-street parking that is available exclusively to employees, guests, or customers in a building. Residential parking isn't capped. The total off-street parking supply increased by only 9 percent between 1977 and 1997, and in 1997 the 35,500 public parking spaces represented 60 percent of the total 59,100 off-street spaces in Boston Proper. Additional freezes apply in East Boston, South Boston, and at Logan Airport. Portland, Oregon, had a similar limit on the number of parking spaces—known as the parking lid—in the CBD. It was replaced in 1995 by limit on 0.7 spaces per 1000 square feet of net leasable area, in part because historic buildings without any parking were losing nearby surface parking lots and were increasingly difficult to lease (Portland TriMet, 2002, 3–9).

[10]Colliers International (2003, pp. 28–29). The highest price for unreserved parking in Boston's CBD was $600 a month, and the lowest was $285 a month.

meters in the city. Far from using prices to manage the demand for curb parking, Boston underprices curb parking and thus encourages drivers to cruise for it.

Boston's off-street parking cap makes sense as a way to reduce congestion on routes *to* the city, but its failure to follow through with market prices for curb parking increases congestion *in* the city. Everyone would criticize off-street parking operators if long lines of cars regularly spilled into the streets and congested traffic because the lots and garages were always full. Nevertheless, cities create the same result with curb parking by underpricing it, and nobody notices because the cars hunting for curb parking are hidden in the general traffic flow.

6. Two pricing strategies

Cities can use two pricing strategies to discourage cruising. The first is to charge the market price for curb parking. When the prices of curb and off-street parking are equal ($p = m$), the equilibrium cruising time (c^*) is zero.

$$c^* = \frac{t(m-p)}{f+nv} = \frac{t(0)}{f+nv} = 0$$

If curb parking costs the same as off-street parking, why drive around hunting for a curb space? Since curb parking (after you spend time and money to find it) costs the same as off-street parking, you don't save any money by cruising. If all curb spaces are occupied and there is no economic incentive to cruise, you should park off-street without wasting time and fuel.[11]

If curb parking remains free, however, a second strategy to discourage cruising is to reduce the price of off-street parking to zero. The logic is the same: if off-street parking is free, why drive around looking for a curb space? Since the prices of curb and off-street parking are again equal ($m = p = 0$), the equilibrium time is again zero.

$$c^* = \frac{t(m-p)}{f+nv} = \frac{t(0)}{f+nv} = 0$$

Cities can therefore eliminate cruising either by charging market prices for curb parking or by requiring enough off-street spaces to reduce the price of off-street parking to zero. The price of curb parking is one of the few policy variables that cities control directly, but almost all American cities have chosen the wrong policy: require plentiful off-street parking rather than charge fair market prices for scarce curb parking.

7. Elasticities

Table 3 shows how each of the variables in the model affect the decision whether to cruise or to pay. The second column shows the partial derivatives of c^* (the maximum time a driver is willing to cruise) with respect to the variables in the first column. Six factors affect the decision to cruise: (1) the price of curb parking, (2) the price of off-street parking, (3) parking duration, (4) the price of fuel, (5) the number of persons in the car, and (6) the value of time.

Table 3
Equilibrium search time

Variable	Partial derivative of c^*	Elasticity of c^*
p (curb parking price)	$\frac{\partial c^*}{\partial p} = -\frac{t}{f+nv} < 0$	$\eta_p = -\frac{p}{m-p} < 0$
m (off-street parking price)	$\frac{\partial c^*}{\partial m} = +\frac{t}{f+nv} > 0$	$\eta_m = +\frac{m}{m-p} > 0$
t (parking duration)	$\frac{\partial c^*}{\partial t} = +\frac{m-p}{f+nv} > 0$	$\eta_t = +1$
f (fuel cost of cruising)	$\frac{\partial c^*}{\partial f} = -\frac{t(m-p)}{(f+nv)^2} < 0$	$\eta_f = -\frac{f}{f+nv} < 0$
n (number of persons)	$\frac{\partial c^*}{\partial n} = -\frac{tv(m-p)}{(f+nv)^2} < 0$	$\eta_n = -\frac{nv}{f+nv} < 0$
v (value of time)	$\frac{\partial c^*}{\partial v} = -\frac{nt(m-p)}{(f+nv)^2} < 0$	$\eta_v = -\frac{nv}{f+nv} < 0$

Notes: The length of time (c^*) a motorist is willing to search for curb parking is: $c^* = \frac{t(m-p)}{f+nv}$. The elasticity ($\eta_i$) of c^* with respect to variable i is: $\eta_i = \frac{\partial c^*/\partial i}{c^*/i}$.

The third column shows the elasticity of c^* with respect to each variable. The coefficient of elasticity is denoted by η (the Greek letter *eta*). These elasticities show how a small change in each variable increases or decreases the time a driver is willing to cruise. Five results stand out.

First, η_p (the elasticity of search time with respect to the price of curb parking) depends only on the prices of curb and off-street parking. The elasticity is low when curb parking is relatively cheap, which means that raising the price—say, doubling it from 10¢ to 20¢ an hour—will have little effect on curb vacancies. This result may lead some to conclude that the demand for curb parking is inelastic, and that raising the price of curb parking will not produce vacancies. But as the price of curb parking approaches the price of off-street parking, a small increase can create curb vacancies and reduce congestion. The demand for curb parking may be completely inelastic until its price exceeds that of off-street parking, at which point it can suddenly become very elastic.[12] Because the variables

[11] If drivers prefer curb to off-street parking, the price of curb parking must rise above the price of off-street parking to create curb vacancies and discourage cruising.

[12] For example, when the price of curb parking is 25¢ an hour and the price of off-street parking is $1 an hour, $\eta_p = -(.25)/(1-.25) = -0.33$; therefore, raising the price by 10 percent reduces the time drivers are willing to cruise by only 3.3 percent. But when the price of curb parking is 75¢ an hour, $\eta_p = -(.75)/(1-.75) = -3$; therefore, raising the price by 10 percent reduces the time drivers are willing to cruise by 30 percent. Even this large reduction in search time may not produce many curb vacancies, however. If curb parking is cheaper than off-street parking, the main effect

that affect the elasticity vary from place to place and according to the time of day, we cannot estimate a single price elasticity of demand for curb parking at even one location, let alone all locations.

Second, when curb parking is free ($p = 0$), the elasticity of search time with respect to the price of off-street parking (m) is always $+1$. Therefore, reducing the price of off-street parking by 10 percent reduces the time you are willing to cruise by 10 percent.

Third, the elasticity of search time with respect to parking duration (t) is always $+1$. A longer parking duration justifies a proportionally longer cruise. For example, a driver who wants to park twice as long as another is willing to hunt twice as long to find a curb space, all else equal. Curb parking is best suited for short stays, but drivers who want to park for a long time have a stronger incentive to search for the curb spaces.

Fourth, the elasticity of search time with respect to fuel cost (η_f) depends on the relative values of fuel (f), the number of people in the car (n), and the value of their time (v). If fuel cost is much lower than time value, an increase in fuel cost has little effect on willingness to cruise. If cruising costs $1 an hour for fuel, and time is worth $9 an hour, a solo driver's elasticity of cruising with respect to price of fuel is only -0.1. Raising the price of gasoline by 10 percent therefore reduces the time drivers are willing to cruise by only 1 percent.[13]

Finally, the elasticity of search time is the same with respect to the number of people in a car (n) and the value of their time (v). More people in a car and a higher value of their time thus have the same effect on willingness to cruise. The lone motorist who values time at $8 an hour and a carpool of four persons who each value time at $2 an hour are both willing to cruise for the same length of time, all else equal.

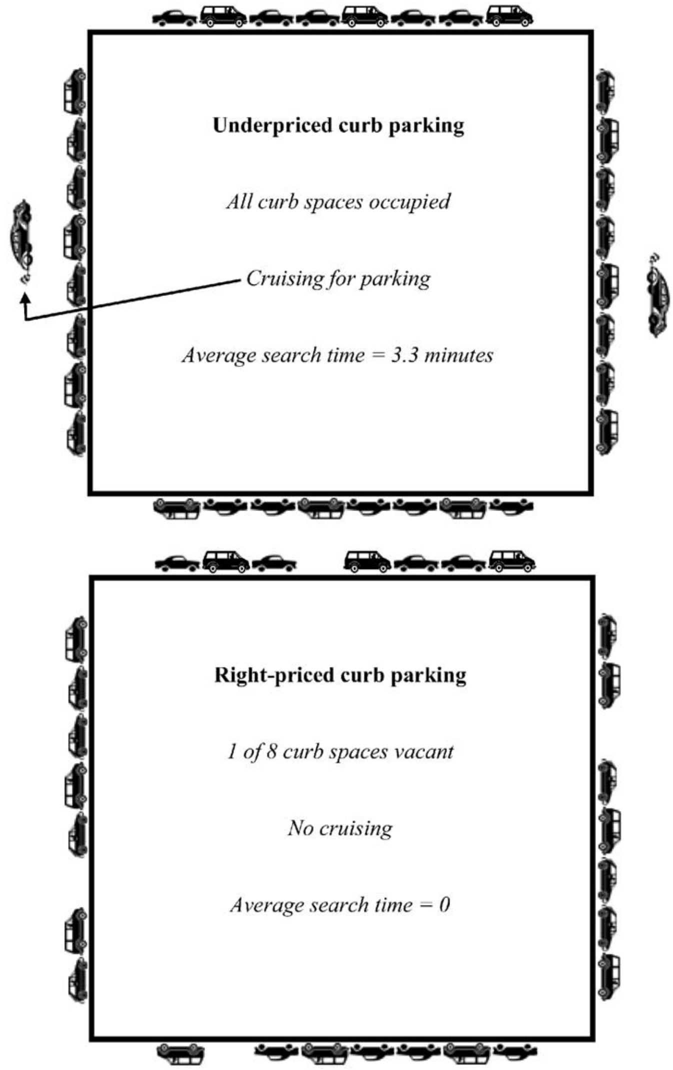

Fig. 1. Curb parking prices and crusing.

8. Right-priced curb parking: an illustration

The top panel of Fig. 1 illustrates the case where curb parking is underpriced, all spaces are occupied, and cars are circling the block looking for a space. It is based on observations in Westwood Village, a commercial district in Los Angeles next to the UCLA campus.[14] The average block has eight curb spaces on each side, the average cruising time before finding a curb space is 3.3 min, and two cruisers are circling each block.

The small distances cruised by each driver add up quickly because the turnover rate is 17 cars a day per space. With 470 meters in the Village, 7990 cars park at the curb each day (17×470). Because so many cars park at the curb, a small cruising time for each driver creates an amazing amount of traffic. Although the average driver cruises only 3.3 min before parking, cruising in the aggregate creates 440 vehicle-hours of cruising every day. At an average speed of about 8 miles per hour, cruising around the 15 blocks in the Village creates more than 3500 VMT every day, or more than the distance across the United States.

In contrast, the bottom panel of Fig. 1 illustrates what happens if the price of curb parking is set high enough to produce one vacancy for each eight spaces (a 12.5 percent vacancy rate). There is no incentive to cruise because drivers can find a vacant curb space anywhere they want to park, or they can pay to park off-street, and the search time is therefore zero. Now imagine that the price of curb parking varies in response to parking demand to keep roughly one out of every eight spaces vacant in the Village throughout the day. Underpriced curb parking creates an

(*footnote continued*)
of raising the price of curb parking is to reduce cruising, not to produce curb vacancies, because drivers continue to take any curb spaces that become available.

[13]If raising the price of gasoline by 10 percent reduces the search time by 1 percent, it shaves 3.6 s off the 6 min (360 s) you were previously willing to cruise.

[14]Shoup (2005, Chapter 14).

astonishing amount of cruising, and right-priced curb pricing can eliminate cruising.

9. Complications

The decision to cruise is far more complex than a simple model can portray, of course, and I will suggest six complications. First, the value of time savings is not constant. Different people place different values on time savings, and the same person may place different values on saving time on different days, at different hours, and for different trips. Even for a specific trip, the value of saving time may increase as you cruise, because the likelihood that you will arrive late at your destination increases the longer you hunt for curb parking. You may therefore drive around for a while and then, growing desperate, pay to park off-street.

Second, you don't know in advance how long it will take to find a curb space. In a normal queue you can see how many people are ahead of you and how fast the queue is moving, and you can roughly estimate how long it will take to be served. But to cruise is to wait in a queue of unknown length, where the next person called to the window is determined by lottery. You may find a curb space in the next minute, or it may take half an hour. How long it will take to find a curb space is therefore a random variable with a distribution and an expected value that are both unknown. Previous experience with cruising in the area may give you an idea of what to expect, but you don't know how many other drivers are cruising, or how frequently curb spaces turn over. Nevertheless, clues gathered while driving around may alter your guess about how long it will take to find a curb space. You may see that other cars ahead of you also appear to be cruising, and this information lowers the likelihood of finding a curb space soon. You may therefore drive around for a while to size up the probability of finding a curb space within a reasonable time.[15]

Third, curb and off-street parking are not perfect substitutes for one another, and drivers do not choose between them only on the basis of price. The walking time from the parked car to the final destination and back must also be considered. Off-street parking may be less convenient than curb parking because the added driving and walking time needed to access the higher levels of an aboveground garage may be significant, and underground garages may seem unsafe. W. Vickrey explained that curb parking is in most cases more convenient than off-street parking, and said that curb parking prices would therefore have to be higher than the prices for off-street parking to create curb vacancies and discourage cruising.[16] The right price for curb parking is thus the price that leads to a few vacant spaces, as illustrated in the bottom panel of Fig. 1, and this price may be higher than the price of adjacent curb parking.

Fourth, you may not know the cost of parking in all locations, or how far you will have to walk to the final destination. You may thus drive to your destination and then begin looking around, or if the price of off-street parking is low, you may simply park at your destination without making any comparisons.

Fifth, where curb parking is limited by the length of stay, this limitation will reduce cruising by those who want to park for a long time. Time limits are difficult to enforce, however, and surveys often show that more than half the cars parked in zones with time-limited free parking either violate the time limit or are in an illegal space. In Seattle, Washington, for example, a study of on-street parking in 35 neighborhoods found that the *average* parking duration in spaces with a one-hour time limit was 2.1 h.[17]

Finally, there are options beyond the simple choice between cruising and paying. You can also park in an illegal curb space and risk getting a ticket. Or you can drive to a nearby area where curb parking is readily available or where off-street parking prices are lower, and then walk farther to your destination. But despite these and other complications, the basic lesson is the same: if cities charge too little for curb parking, drivers will cruise.

Drivers do not use a mathematical model when deciding whether to cruise, but all the model's assumptions are reasonable, and all its predictions are testable hypotheses. A model cannot predict how everyone will behave, but it does suggest how to behave if you want to be rational in your own cruising. You can even test the model's predictions by referring to your own experience. Suppose that you want to park at a site where curb parking is free, but all the curb spaces are occupied. Off-street parking costs $1 an hour, but is immediately available. Would you be more likely to cruise if you have several passengers in your car? If you are in a hurry to reach your destination? If you intend to park for only a short time? If your answers to these questions are *no*, the model correctly predicts your choices.

10. Conclusion: an invitation to cruise

Where curb parking is underpriced and overcrowded, some drivers search for a curb space rather than pay to park off-street. Research throughout the last century showed that cruising is common in congested traffic, and a model of how drivers decide whether to cruise or to pay predicts that charging the fair market price for curb

[15]Thompson and Richardson (1998) develop a model of parking search behavior that explains how drivers choose among off-street parking facilities. They consider parking choice as a search process in which drivers make a number of linked decisions based on updated knowledge gained from experience. Surprisingly, their model suggests that long-term experience doesn't necessarily lead to better parking choices.

[16]Vickrey (1954, p. 64). Similarly, Topp (1993, p. 85) says, "The most convenient parking spaces are the on-street spaces where parking fees are also usually less than in parking garages. Those spaces—and even the illegal ones—generate more search traffic and waiting cars than spaces in parking garages."

[17]Shoup (2005, 297).

parking can eliminate cruising. City governments therefore play a large part in choosing whether drivers cruise, because they set the prices for curb parking. Cruising is simply a driver's individual response to the public pricing policy. Underpriced curb parking is a perverse subsidy because it encourages drivers to do something that harms other people and may not even benefit the drivers themselves. Cities must then throw good money after bad by spending more to fix the congestion and pollution problems they have created. Getting the price of curb parking right will benefit everyone, and every city can do it.

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