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The Cost versus Price for Parking Spaces at Major Employment Centers: Findings from UC Berkeley

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ABSTRACT (236 WORDS)

In dense urban areas, surface parking often poses an opportunity cost, and reuse of the land for urban development with parking relocated to a multistory structure may be an attractive option. This paper analyzes the cost of replacing surface parking with a parking structure and finds that it may be equally cost effective to pursue travel demand management strategies. The paper analyzes what it costs to build a parking space in a multi-story structure (garage) using US average data as well as data from a substantially higher-cost case, the University of California, Berkeley. The Berkeley case illustrates how replacement of surface parking with structures can substantially escalate costs and necessitate price increases for everyone, unless costs can be offset through more efficient utilization rates (e.g., renting out employee parking for evening and weekend use) or the parking system is credited for the land value of former surface parking (not likely in the situation considered here). A transportation demand management (TDM) program offering incentives for other modes of commuting can reduce the need for new parking, and its annual costs are likely to be lower than the amounts needed to cover new parking construction. Parkers could be better off paying for TDM programs to reduce parking demand rather than paying to build new parking structures. The findings are case specific but are likely to resonate with many employers and institutions that provide parking in high-cost urban areas.

Keywords: Parking costs, Parking policy, Pro-forma analysis, Transportation demand management (TDM)

1.0 INTRODUCTION

In the United States, driving remains the principal means of travel to work, 91% of American commuters use personal vehicles according to the Bureau of Transportation Statistics (*1*), and this modal preference is both supported by and reflected in public and private parking policy. In many locations parking is made available in plentiful quantities and provided free or at a subsidy to the user (*2*). Even in downtowns, parking is often priced at fairly low rates; in a survey of 107 cities, parking prices averaged $1 for every two hours for on-street parking and $11 per day for parking in commuter lots (*3*). In addition, most American workers don't pay for their own parking; Shoup reports that 95% are provided a parking space free of charge (*2*).

Nevertheless, a number of cities and some employers have shown increasing interest in more rigorous parking management and pricing that better reflects costs. Several cities have been experimenting with parking pricing reforms carried out as federally funded demonstration projects (*4, 5*); many others have undertaken purely local efforts to deal with the high costs of parking and the auto use it supports (*6, 7*).

University campuses are among the employers that have been increasingly focusing on parking issues (*8, 9*). This interest is often based on cost control, specifically a desire to balance the costs of parking construction, operation and maintenance against a perceived need to provide parking to employees (and students, clients, and visitors) as a benefit and a business necessity. In some cases, university campuses are rethinking their parking policies because they have an interest in using surface parking lots as building sites. But removal of surface parking is a step that requires either parking replacement, often in higher-cost structures, or demand reduction. The latter option, demand management, has been the subject of some research, but has proven to be difficult to implement (*10*). Parking pricing has been found to be an important element of demand management, but it is not always readily accepted by employees, some of whom view affordable (inexpensive) parking as indispensable (*11*).

This paper presents an analysis of parking costs versus price in these circumstances, i.e., where to free up land for other uses, surface parking must be replaced by costlier structured parking unless demand reductions can be achieved. The paper begins with a brief review of the literature relevant to the study. It then presents an example analysis of what it costs to build a parking space in a commercial structure (garage) using US average data and a range of urban land prices. A case study of the University of California, Berkeley's parking dilemmas is then presented and used to illustrate how replacement of surface parking with structures can substantially escalate costs, but may also open up opportunities to consider demand management alternatives. The final section discusses implications and recommendations for parking providers who may find themselves in similar situations.

2.0 LITERATURE REVIEW: THE COST AND PRICING OF PARKING

Researchers have been studying the effect of parking on urban transportation and travel behavior since the problems of car usage started to be researched in the 1950's. William Vickrey's work on dynamic pricing for on-street parking (*12*) initiated a discussion on the relationship between parking cost and its price. Recent parking pricing reforms, carried out as federally funded demonstration projects, have created additional opportunities for assessments of the benefits that pricing parking correctly may bring to society (*5*, *13*).

Donald Shoup has forcefully argued that "free" parking is not only not free (since its provision requires land and other capital investments as well as ongoing operations and management expenses) but it is a key contributor to many negative environmental, social, economic and aesthetic externalities. Several studies have shown that charging for parking will lead some travelers to move to other commute options (*14, 15*). However, parking price elasticity tends to be quite low, in the range of -.1 to -.3 (*16*, *17*). Thus, even if price increases substantially, many travelers are likely to continue to drive and park. In addition, city officials, businesses and employers often see readily available parking as a necessity for economic development and commercial success, and so continue to plan for parking despite its high economic costs and associated externalities (*18*).

The tensions between the high costs of parking and the continued interest in having it available have posed a dilemma for many parking providers. The literature on parking reveals, on the one hand, a growing critique of common practices, and on the other, a complex and difficult terrain for change from current practices. In this context, it is useful to look at the impact of parking costs under circumstances where employers must decide whether to consolidate parking in garages or to pursue other transport strategies.

3.0 COST PER PARKING SPACE USING UNITED STATES' 30-CITY MEDIAN COST DATA

This inquiry begins by reviewing the cost of providing a parking space in a parking garage. The analysis accounts for the costs of land as well as for construction costs, "soft costs" including design services and environmental review, and recurring operations and maintenance costs for a 30 to 40 year period. It assumes that the parking provider must cover costs at minimum; some providers would expect to turn a profit as well. The method used involves setting up a simplified pro-forma to compute parking structure costs and revenues for several scenarios. As in any such analysis, a series of assumptions are made. Here, the intent is to illustrate the issue rather than estimate the actual costs for a particular project, so national average data sources and a highly simplified set of assumptions and projections are applied as follows:

1. The total area required per surface parking space is assumed to be 340 sq. ft. While the actual parking space itself is likely to be much smaller, approximately 8-9 ft. wide by 18 -20 ft. long, the total area required per space includes a proportionate share of the space devoted to aisles, entry and exit gates, ticketing machines, walkways, utility closets, etc.
2. The project is defined as a 520-space, five story parking structure to be built on a one acre parcel with no complexities in parcel shape, soils, water table, slope, sensitive abutting uses, etc. (i.e., without any special conditions that would increase costs). At 340 sq. ft. per space, a one acre parcel can provide as many as 128 parking spaces. In practice, however, it is often the case that irregularities in the shape of the parcel, the need for setbacks from buildings or streets, landscaping requirements, etc. reduce the amount of parking per acre that is actually delivered. In addition, parking structure ramps, elevators, stairways, etc. can reduce efficiencies somewhat. The 520 space assumption is based on observations of parking layouts in several standard garage designs.
3. Construction costs are based on data from a national database which reports a 30-city national median cost of $20,000 per parking space (*19*).
4. Taking into consideration that soft costs vary across the nation, two scenarios are tested, with 15% and 30% of the construction costs as the value of soft costs.

5. Operations and maintenance (O&M) costs are based on industry standards as reported in a recent consultant study (*20*). These O&M costs include "enforcement, insurance, labor, administration, security, and various maintenance needs (cleaning, lighting, repaving, landscaping, structural upgrades, etc.). These costs are also highly variable, but, on average, it costs $450-1,000 per space per year to operate and maintain a parking structure" (*20*). For this study, an average annual O&M cost of $650 per space is considered.
6. To illustrate the effects of land costs, scenarios are run with land costing from $1M to $10M per acre. The effects of taking land costs out of the equation are also examined, as is sometimes done in redevelopment projects and in some projects where a public entity owns the land.
7. To illustrate the impact of interest rates and finance on the project, costs are calculated using multiple interest rates, 3%, 4%, 5%, and 6%. However, a separate calculation for cost of money during the planning stage or the construction stage, which are usually higher, is not included.
8. In calculating revenue flows, a start-up period is not accounted for; instead it is assumed that the effective occupancy rate is achieved upon opening. An 80% occupancy rate for the garage is used in the analysis, considering this occupancy rate is applicable for nation-average projects in this category.
9. A residual value (terminal value) is not accounted for at the end of the loan period (which is the effective equivalent of assuming that the structure will require substantial reconstruction or replacement at that time.) This is a conservative assumption in that, if the structure actually has a design life that substantially exceeds the loan period (e.g. 50-60 yr. design life, 30-40 yr. loan), revenue flows will continue after the debt is paid off and only operating costs will have to be covered. On the other hand, no cost of structural removal is accounted for either, and such costs could be substantial, offsetting any gains made during the period between loan payoff and building retirement.

Using the set of assumptions listed above, this section provides a first-cut cost and revenue requirements analysis for this prototypical parking garage. Table 1 shows a summary of the characteristics for the project for a likely financing scenario with 30 and 40-year loan periods at 4% interest rate, with and without land costs.

TABLE 1 Assumptions and Results to Determine Cost of Parking for an Average Parking Structure (Garage) in the US

Physical characteristics				
Total number of parking spaces	520			
Area per parking space inclusive of stall, aisles, structure, access, and attendant's office, etc. (sq.ft./space)	340			
Total built-up area (number of parking spaces x area per parking space) (sq.ft.)	176,800			
Costs				
30-City National Median construction cost per parking space (*19*) ($)	20,000			
Hard costs for the structure (number of parking spaces x national median cost per parking space) ($)	10,400,000			
Soft costs at 15% of hard cost ($)	1,560,000			
Total construction cost (hard + soft) ($)	11,960,000			
Land cost per acre ($)	No land cost	1,000,000	No land cost	7,000,000
Total cost of project (hard + soft + land costs) ($)	11,960,000	12,960,000	11,960,000	18,960,000
Financing scenarios				
Years	40	40	30	30
Number of payments per year	12	12	12	12
Number of periods	480	480	360	360
Interest rate	4%	4%	4%	4%
Monthly payment ($)	49,985	54,165	57,099	90,518
Annual payment ($) (monthly payment x 12)	599,825	649,978	685,186	1,086,215
Operating and maintenance expenses multiplier (*20*) ($650/340 sq.ft.) ($/sq.ft./year)	1.91	1.91	1.91	1.91
Annual operating and maintenance cost (total built-up area x $1.91) ($)	338,000	338,000	338,000	338,000
Effective Gross (annual payment + annual operating cost) ($)	937,825	987,978	1,023,186	1,424,215
Occupancy	80%	80%	80%	80%
Annual income shortfall from empty spaces [effective gross x (1 - % occupancy)] ($)	187,565	197,596	204,637	284,843
Required monthly gross [(effective gross + annual income shortfall from empty spaces) / 12] ($)	93,783	98,798	102,319	142,422
Required monthly gross per parking space (required monthly gross / number of spaces) ($)	180	190	197	274

Figure 1 shows the results of the pro-forma evaluation at different discount rates and project lifespans. It uses the 30-city nationwide median $20,000 (*19*) per parking space cost of construction and varies the cost of land, and presents output from the pro-forma analysis showing the marginal cost per month for one parking space. In other words, if such a project was constructed by a developer who borrowed capital from the market, these installments per month per space would have to be paid. Thus, for $5M/acre land cost, with 15% in soft costs, and a 30-year loan, the cost of production per space would be between $230 and $300 per month. Note that if land values were omitted entirely the cost of the parking structure space would still be between $180 and $230 per month for a 30-year loan, depending of the interest rate.

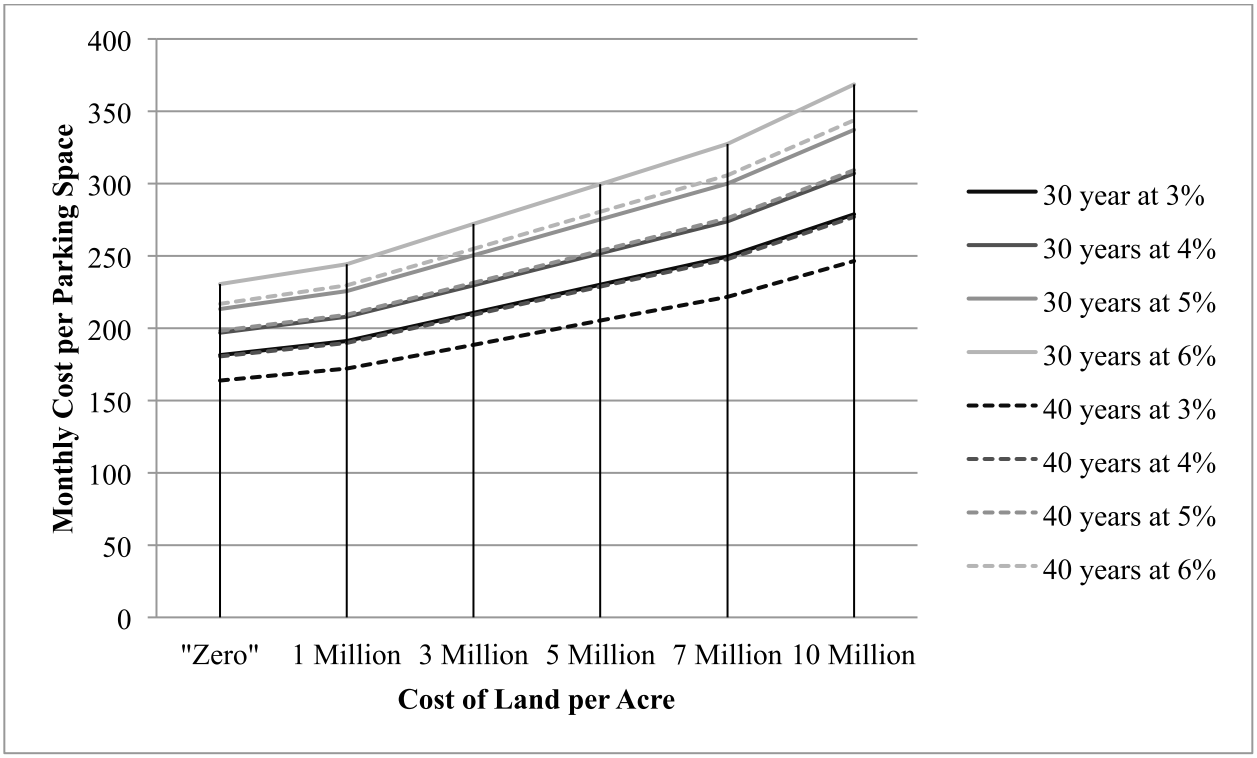

FIGURE 1 Monthly cost per parking space for various land values and interest rates.

Construction costs dominate the costs in the ranges considered here. The $20,000 average per space construction cost is the largest cost element; for each space, about $95 per month would have to be collected to pay off a 4%, 30-year loan for this amount. O&M costs are estimated to add about $54 per month. With zero land costs, if soft costs are 30% rather than 15%, monthly gross payments per parking space go from $180 to $195, a small overall share of costs. For every million dollars in land costs that must be financed, a 4% loan over 30 years requires a monthly payment of $4,774. Thus, for each of the 520 parking spaces in the example, an additional $9 per month per million dollars in land costs must be collected.

Vacancies in the garage must be covered by higher prices for users. Using the assumptions in Table 1, a 20% vacancy rate on average would require users to pay an additional $33 per month if the land cost is neglected. If for urban land the value per acre were $5M, the parking charge attributable to land rent would need to be $42; the figure would be $46 if the land costs $7M per acre.

These calculations assume that the expected return on land would be the interest rate. Some would argue that a better way to think about land costs would be in terms of opportunity costs for the land, and for the money embodied in it. If a 10% average return were sought, a $5M 2investment should on average yield $500,000 a year, or for the 520 parking space example, about $80/space/month for land costs alone. At land values of $6M and up, land values begin to exceed average construction costs when opportunity costs are considered.

However, if land were readily available for prices under $1M/acre, surface parking might be the more cost-effective option. A 125-space surface lot built on an acre of land worth $1M translates to land costs of $8,000 per space. Adding $1,500-$2,000 per space for paving, striping, and landscaping and up to $3,000 additional for access and payment control technology, the surface space could be delivered for $12,500-$13,500. Maintenance costs and vacancies would still need to be covered so the user price would need to be about $100/month; below the cost of a structured space. If land is needed for other uses and is not readily available on the market, however, it may still make sense to build structured parking despite its higher cost. Likewise considerations such as walking distance from parking to destination may make structures attractive even if costs are high.

It also is important to note, however, that these numbers do not reflect the full social cost of a parking space. For example, these figures do not include such costs as greenhouse gas emissions associated with the production of the facility or its operation, nor do they account for effects on water runoff or for heat island effects (*21*). Shoup notes that the true social cost should at least include the average cost of congestion and emissions for each parking space, with estimates for external costs per parking space for congestion and emissions on the UCLA campus at $117 per month (*2*). Including social costs of this magnitude would greatly increase the cost of each parking space.

4.0 CASE STUDY: UC BERKELEY

Both public and private parking providers may find themselves facing a situation where replacement of surface parking must be considered. Universities, which often are major employers, are one such parking provider. The case of the University of California, Berkeley is used to illustrate how parking cost and price debates can play out.

UC Berkeley is an urban campus with almost 36,000 students and over 12,000 faculty and staff, located adjacent to the City of Berkeley's downtown. Most undergraduate students live on campus their first and second years, after which they find housing in the apartments and flats close to campus. Graduate student housing is more limited but most graduate students also live within a few miles of campus, many along bus or rail transit routes. The majority of faculty and staff likewise live within a few miles of the campus, although many reside in the steep hills to the East, from which walking and biking to campus is a challenge.

The City of Berkeley and the University have both been at the forefront of many progressive transportation policy initiatives including shifting to more sustainable transportation (*22, 23, 24*). Numerous bike lanes, bike boulevards, and bike parking facilities have been installed throughout the city and campus, and traffic calming installations restrain driving on most campus roadways and many city streets. All UC students have free, unlimited ride bus passes paid for through a deep discount bulk purchase funded by student registration fees (*25*). Faculty and staff also may obtain a deep discount bus pass for a small fee, and a small subsidy for rail transit passes. Carpools and vanpools can use reserved parking spaces and carpool parking permits are sold at a deep discount. These measures have resulted in high transit, walk, and bike mode shares, with the vast majority of students using bus, rail, bike or walk to get to school, and about half of the faculty and staff doing likewise (*26, 27*).

Even with a drive alone mode share well under 50%, UC Berkeley generates numerous auto trips. The campus currently provides almost 6,000 parking spaces, of which over 5,000 parking spaces are on or close to the central campus and are allocated primarily for faculty and staff, though a few lots and spaces also permit student and visitor parking (*28*). This parking is currently priced for most users at $95-131 per month and is heavily utilized, with recent field observations finding occupancies of 85-90% or higher at most locations for much of the workday (*29*).

One reason for such heavy utilization of existing parking is that over the years, parking supply at UC Berkeley has been reduced and relocated from surface lots on the central campus to structures at the campus periphery or some blocks away. In some instances parking was removed to restore landscaping on the central campus (where in earlier eras courtyards and front lawns had been converted to parking lots) and in other instances parking was removed in order to use the site for a building lot. In the last two years, for example, a 317-space parking garage was demolished to make room for a new art museum, and plans were approved to build an athletic facility and a replacement for a seismically unsound building on two additional surface parking lots (*10*). More parking removals are expected due to projects in longer-term planning phases. Campus policy (*30*) states that "(the) strategy to accommodate future campus growth requires, and in fact depends upon, existing surface lots being replaced by new buildings and open spaces."

The campus justifies using surface parking for building lots because of the high cost of land in Berkeley and the difficult town-gown relations that sometimes result from university expansion into the community. While the campus owns considerable land in the Berkeley Hills east of campus and has located research facilities, a museum, and a botanical garden there, steep slopes, earthquake faults and creeks running through the area make much of it a difficult building site. The hill areas where parking can be installed are beyond convenient walking distance of the campus core and thus must be served with shuttle buses. The campus does purchase or lease land and buildings in the city for its own use and has relocated a number of administrative services off campus; the costs are not inconsiderable. The flatter areas along the North, West and South sides of campus are already built up, and parcels are small and expensive, currently selling for the equivalent of $7-10M an acre (*31*). Thus, outward expansion is limited by topography, community concerns and price. Building on surface parking that the University already owns, replacing surface lots with parking structures, and encouraging even greater use of commute alternatives, is seen as the best way forward.

Unlike many employers that pay for or subsidize parking costs as an employee benefit, the University of California requires parking costs to be covered by parking revenues. Thus, as costs increase, so too must employee parking fees unless other revenue sources can be secured. Parking charges have increased as O&M costs have risen and as surface parking is replaced by structures. To some extent the cost increases have moderated parking demand, but in part these added costs have resulted in shifting the demand to off-campus sites. Recent surveys confirm that several thousand campus affiliates park in residential neighborhoods (where resident permit parking restrictions are weakly enforced), in off-campus public and private parking garages, or for trips of short duration, in metered on-street parking close to campus (*32*).

Replacement parking has also proven to be far more expensive to build in Berkeley than the national average figures cited earlier. For example, a new garage being built as a public-private partnership with the university has been reported to cost $55,000 per space not including the value of the University-owned land. An estimate for a garage on downtown land owned by the University penciled out at over $65,000 per space, again not including land costs. One reason for these high costs is that the sites are difficult to build on, one with an underground creek and the other with an irregularly shaped lot nestled between occupied, privately owned buildings. However, given the built-up nature of the area, these circumstances may not be exceptional. In addition, UC Berkeley must comply with California's strong environmental review and mitigation laws. This increases the soft costs associated with building construction.

To date, the campus parking officials have not included land costs in their parking calculations. However, it is clear that if the campus builds on a surface parking lot, it is avoiding having to buy parcels in the community that could costs millions to acquire, prepare, and develop. If the campus should have to purchase land for a new parking garage, or arrange for parking through leasing with third parties, under most circumstances land costs would have to be included.

Figure 2 applies the spreadsheet model shown earlier to compute monthly payments using Berkeley-specific data. The example shows cost per space (construction and soft costs) ranging from $45,000 to $75,000, land costs at $7M per acre, 30 and 40-year loans paid monthly at 4% rate of interest, and 90% occupancy rates. The higher occupancy rate is used in this case because for high-cost parking, operators will try to keep parking full whenever possible. The example also shows what per month costs for each parking space would be without land prices for the same assumptions. Note that the costs shown in Figure 2 do not account for taxes or fees, both of which would likely apply for privately built garages.

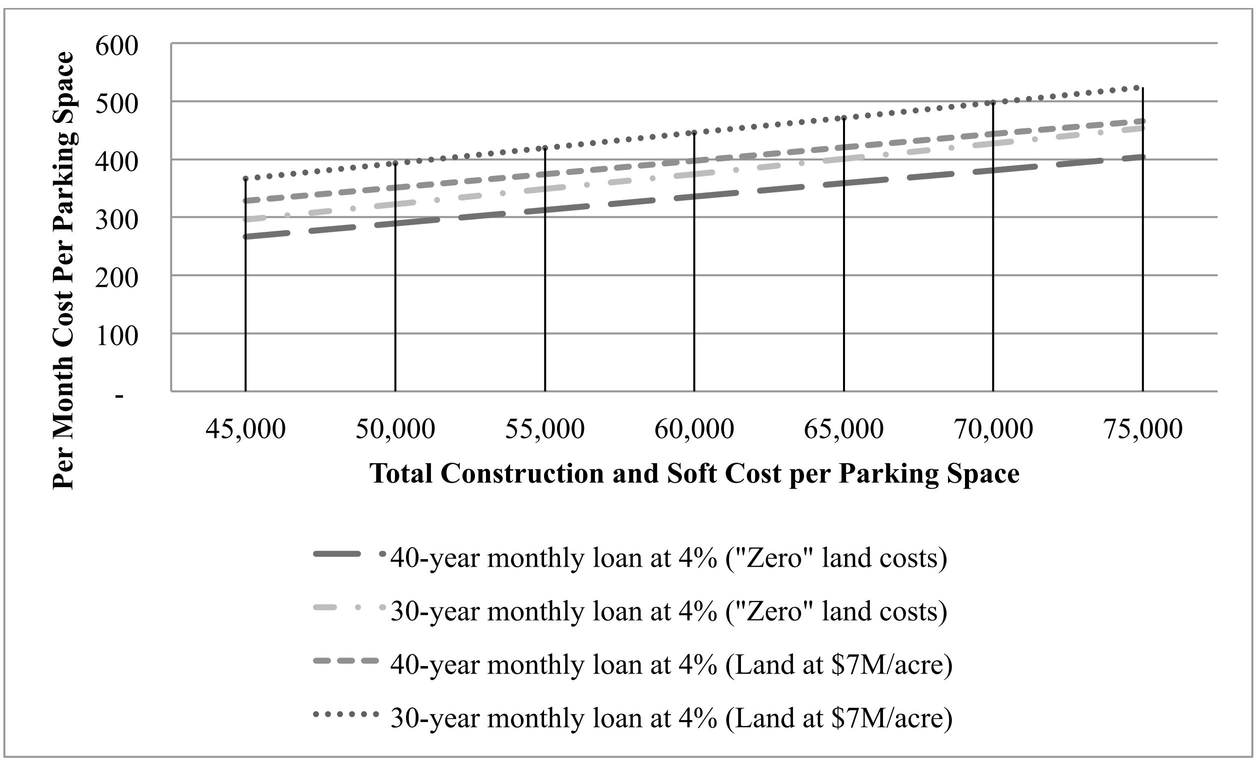

FIGURE 2 Per Space Parking Cost Sensitivity at UC Berkeley

Now, consider what replacing 1,000 surface parking spaces with 1,000 new structured parking spaces would do to the average cost of parking. Assume the total supply is 5,000, breaking even at a current average price of $100 per month. 1,000 of these spaces are replaced with spaces in parking structures. For illustration purposes, assume the 1,000 added parking spaces must collect $400 per month each to cover their costs. The parking operator must now collect the cost of operating 4,000 spaces costing $100/mo. each plus the new 1,000 spaces costing at $400/mo. each, for a total cost to be covered of $800,000/mo. The new average monthly cost across the 5,000 spaces would then be $160/space.

If the average cost of a new space were $450 a month, as is plausible if a space should cost $70,000 with a 40-year payback, then the new average price of a space would be 4,000 spaces at $100 plus 1,000 new spaces at $450, totaling $850,000, resulting in an average cost of $170 per space per month. In other words, adding new, high cost parking to the system has the potential to greatly increase costs for everyone who drives to campus.

One way to help keep these costs down would be to rent the spaces out for evenings, weekends, and for special events. For example, suppose parking could be rented after 5 p.m. for a $5 evening fee. This is the current rate in the City of Berkeley parking garages after 5 p.m. It is unlikely that full occupancy would be achieved every night, but suppose that the parking were utilized 50% of the time at such a rate. The 1,000 spaces in this example would bring in (1,000 spaces) x (50% occupancy) x 7 evenings a week x $5 per evening = $17,500 a week, or $70,000 a month. Assuming this could be accomplished with virtually no added costs, e.g., using automated technologies rather than labor to collect payment, this would allow the parking charge for employees to be reduced by up to $70 per month per space.

Such a strategy would only work, however, if the parking were to be located in areas where there is substantial and regular demand for evening parking. In the Berkeley case such demand does exist on the side of campus closest to downtown. However, it is unlikely that parking located elsewhere around the campus would attract substantial evening demand on an ongoing, weekly basis. Thus in the Berkeley case, there is probably some ability to offset costs by increasing utilization evenings and weekends, but only in particular locations.

Another strategy for cost reduction, used by the Berkeley campus, is to use the top floor of the parking structure for other purposes such as tennis courts or public plazas. While designing for such uses can increase construction costs, for UC Berkeley it provides a justification for not including the land value in the cost of the parking space. This can be a substantial cost savings where land is expensive; for example, a 500 car garage built on an acre parcel worth $7M entails land costs of $14,000 per space. However, not every garage is likely to be located where this would make sense.

A third strategy would be to require building projects to include the cost of replacement parking in their requirements when they build on parking lots (or alternatively, to credit the parking system with the value of the land being claimed for other uses). Such a policy (which would be the equivalent of "paying" for the parking that was removed) was actually in place at UC Berkeley for a few years, but was dropped. The reasons for its discontinuance were several. First, the main purpose of using the parking lots for building sites was to avoid having to pay market rates for the land; making an internal transfer for such purposes would defeat this objective. Second, because the costs of replacement parking were high, the policy inadvertently incentivized designing new projects to avoid taking parking (e.g., by proposing to build on open space instead), or to try to build replacement parking in locations that undermined the campus' overall design (e.g., by removing landscaping to make way for replacement surface parking spots.) Third, donors objected to the policy; they were interested in funding a laboratory or a new building for research and teaching, but did not want to pay for parking spaces or see the projects they were funding delayed while an additional $5 -10 million or more was raised to pay for parking. Finally, the (then)-chancellor was unwilling to enforce the policy if there were strenuous objections from donors or from the deans who stood to benefit from the new buildings.

Overall, then, if the Berkeley campus were to replace 1,000 surface parking spaces with new garage spaces, the average price for all users would have to go up substantially to cover costs — potentially by as much as $70/mo., a 70% increase. Even if the campus could keep its parking costs down to the national median levels shown earlier, converting 20% of its parking in and around the central campus to higher-cost parking structures would require a price increase of at least 16%.

Price increases of either magnitude also would reduce driving, even though parking price elasticities are quite low. Studies done using UC Berkeley survey data for faculty and staff have estimated the parking price elasticity to be in the -0.1 to -0.3 range (*35*). Thus, for example, if the price elasticity averages -0.2, a 30% price increase would reduce parking demand by about 6%. For the Berkeley campus, with about 5,000 cars a day coming to the central campus at current prices, a 6% reduction in demand for parking due to a 30% price increase would amount to about 300 cars a day. A 70% parking price increase would reduce demand by about 700 cars a day. In short, the price change necessary to cover the cost of additional parking can be expected to reduce demand for parking, with the magnitude of the reduction dependent on the size of the price increase.

5.0 COSTS FOR TRANSPORTATION DEMAND MANAGEMENT AND ALTERNATIVE TRANSPORTATION OUTREACH

Given the high costs of replacing parking when surface lots get repurposed for buildings, it is worthwhile considering whether other modes of transport might be a better way to go. For employment centers located in medium to high density urban locations such as Berkeley, realistic options for travel do exist. However, incentives to use these options may be missing or inadequate. Proulx et al. studied commuting to the Berkeley campus using a discrete choice model they developed using campus travel survey data (*27*). They concluded that if parking demand must be reduced, both prices and incentives to use different travel modes would need to be increased.

Sometimes the challenge is that employees are unaware of or confused about the travel options that are available, particularly their frequency, hours of service, locations served, subsidies available, and amenities provided. Riggs and Kuo (*10*) show that a “soft sell” approach providing better information on available travel options can nudge some drivers to switch modes. In an experiment they conducted when a UC Berkeley parking garage was removed to allow the land to be used for a new art museum, Riggs and Kuo found that individual marketing was able to reduce car use by 1-3%, depending on the particular user group (*10, 26*). They also found that active, targeted education and marketing are essential; the same information they provided was available on the campus’ website but had not been used by parkers even though they either had to find a new parking location farther from their offices or switch to transit, biking or walking.

In the Riggs and Kuo experiment, no additional incentives for mode shift were offered. Focus groups, interviews and a stated preference survey conducted in a later project by Ng (*35*) indicated that a larger mode shift might be possible if additional incentives were provided, particularly rail transit passes and alternative work hour programs. With such incentives plus marketing, Ng’s model results indicate that it might be possible to reduce faculty and staff driving to the Berkeley campus by an additional 5% (*35*). A 5% reduction in demand would mean that on a typical weekday about 250 fewer cars would be brought to campus.

One problem that the campus faces is how to fund such a TDM program. However, in some cases it may well be less costly for parkers to pay for TDM than to build parking.

Consider a scenario in which the campus wishes to use parking lots for building sites, resulting in a loss of 500 parking spaces. Currently the supply of 5,000 parking spaces covers costs at $100/space/ month. Suppose the cost estimate for replacing the lost spaces in a new parking garage is $400/space/mo. Introducing the new, higher cost replacement spaces would mean that prices would have to be raised by $30 a month in order to cover costs. At the same time, the $30/mo. increase would reduce demand by about 300 parkers a day, assuming the -.2 elasticity discussed earlier.

Now consider what would happen if the campus were to raise its parking fee by 30% but instead use the revenues to fund a TDM outreach and incentives program. If the TDM program could produce an additional 5% reduction in driving, as estimated by Ng (*35*), then the demand for parking spaces would be cut by an additional 250 cars each day. In other words, spending the same amount of money on TDM could make it unnecessary to expand the parking supply, and at the same time could be significant reward to those who choose to travel by other modes.

In this example, 4,500 (remaining) permit holders would pay an extra $30, generating $135,000 per month, or over $1.6M a year that could be used for TDM efforts. Parkers would pay no more than they would have had additional parking been built, and because the push of price and the pull of incentives would have reduced demand for parking, they will be as well off as they would have been had the lost parking been replaced. In sum, parkers would be equally well off and non-parkers would benefit from spending on TDM.

How might such a TDM program be carried out? Table 2 shows example TDM program costs at two levels, with the more generous budget allowing for larger incentives and more data collection, research, and events. In the example, it is further assumed that larger incentives and prices would result in further reductions in parking demand.

Both budgets provide for two full time staff positions, one for a TDM planner or marketing specialist and the other a program manager/administrator, with costs for salary, benefits, office space, and related expenses included. Additional funds are provided for temporary staff and consultants to assist with, e.g., data collection, website updates, and special projects. The more generous budget includes larger amounts for these activities, for materials, and for office space and supplies. Both budgets include a generous average amount for incentives and the higher budget assumes that the more substantial incentives will attract considerably more participants.

As Table 2 shows, if such a TDM program were funded through surcharges on parking for those who continue to drive and park, the costs would range from under $30 to about $61 a month. Note that even at the generous budget levels, these numbers are still below what it would have cost these parkers if their colleagues were not provided TDM incentives and instead 500-1,000 replacement spaces were added to the inventory. In other words, by funding TDM, both parkers and those who avail themselves of other travel modes would benefit.

It should be noted that incentives are the biggest cost for the TDM program sketched out here, which assumes that benefits would be offered to all participants who commute by walking, biking, or transit, and not just those who give up a parking permit. Equity issues would be raised by offering benefits only to those who give up a parking permit and not to those who are already using lower impact commute modes. However, the politics of parking pricing might well make charging parkers for incentives provided to others difficult to achieve; communicating that the alternative would be to add replacement parking at an even higher cost has proven difficult to convey (*35*). An alternative strategy would be to dedicate revenues from after-hour parking rentals (discussed in the previous section) to transportation demand management (TDM) programs. As noted earlier, after-hour parking offered to the public at well-located garages could generate substantial revenues, potentially sufficient to fund the more generous TDM budget shown in Table 2.

TABLE 2 Example of TDM Program Annual Costs

Cost Item	Modest Program	Generous Program
Staff planner / TDM marketing specialist - salary	$ 100,000	$ 100,000
Program manager / administrative staff - salary	$ 70,000	$ 70,000
Benefits on above salaries @ 36%	$ 61,200	$ 61,200
Work-study students, consultants, temporary staff	$ 75,000	$ 100,000
Marketing materials, events, website	$ 40,000	$ 50,000
Office space, utilities, telecom, supplies	$ 36,000	$ 50,000
Incentives: av. $200/yr./person * 6,000 participants	$ 1,200,000	
Incentives: av. $360/yr./person * 7,000 participants		$ 2,520,000
TOTAL	$ 1,582,200	$ 2,951,200
Monthly cost per permit @ 4,500 permits	$ 29	$ 55
Monthly cost per permit @ 4,000 permits	$ 33	$ 61
Monthly cost per permit if evening / weekend revenues used to cover TDM program costs	(potentially zero)	(potentially zero)

6.0 POLICY RECOMMENDATIONS

Both the national average analysis and the UC Berkeley case show the high cost of replacing surface parking with parking structures. Berkeley is located in a high-cost metropolitan region and its costs are well above the national average, making it quite urgent to find a way forward. However, there are many other cities with similar land and parking costs in their CBDs or in the employment centers of the high demand, fast growing suburbs. Such urban universities as UCLA, the University of Washington, MIT, Harvard, and Stanford also face high land and parking costs and sensitive town-gown relationships that propel them to consider alternative uses of the land on which surface parking is located. In addition, many urban employers may find themselves in a similar situation. Hence, while the specifics would vary with context, the main lessons from the analysis presented here have wider applicability.

Where land costs are high or land availability is constrained, parking structures are likely to be the most rational way to supply parking spaces for employees. Nevertheless, because the addition of structured parking will raise costs substantially in comparison to surface parking, it behooves policy makers to consciously factor in the cost of providing structured parking versus the cost of other alternatives that might reduce demand for parking.

Transportation demand management programs that focus on providing individualized incentives can only modestly change travel choices, but they can reduce the need for parking construction. As the example presented earlier showed, it may be possible in some cases to use a combination of parking pricing and TDM to avoid the need for replacement parking altogether. Analyzing the added costs of new parking uncovers the tradeoffs.

Given that the sensitivity to parking pricing for work trips is inelastic, pricing alone is not likely to make a big dent in parking demand, but pricing together with TDM incentives could produce congenial results. Alternatively, in urban areas where evening and weekend parking demand can be accommodated in facilities ordinarily used for employees and visitors, the additional revenues earned could be targeted to finance TDM programs. In short, urban employers and other institutional managers of parking should consider whether they have a range of options rather than simply assuming that parking lots converted to building sites must be replaced with parking garages. While simply replacing parking lots with parking structures may seem to bethe most obvious step, , it may necessitate unwelcome costs for everyone. A shift in policies using parking pricing to moderate parking demand and to finance TDM programs can be the more cost effective way forward.

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