Assessing the Impact of Parking Pricing on Transportation Mode Choice and Behavior

By

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Abstract

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This dissertation examines the impact of parking pricing on transportation demand and behavior, using the University of California (UC), Berkeley campus as a study site. Parking pricing is often implemented to recover costs or to serve as a source of revenue for cities or private parking operators. However, parking pricing can also be an effective transportation demand management tool. Parking price can be set at market rates or can be set to meet other objectives, such as reducing emissions or traffic congestion. In either case, by increasing the direct cost of driving, parking pricing can lead travelers to shift to public transportation or non-motorized modes. Parking pricing can also help to reduce total distance traveled through cruising reduction, trip reduction or consolidation, and in so doing it can decrease congestion, air pollution and other transportation externalities. Understanding the role of parking pricing in influencing travel demand and behavior is crucial for determining whether a flexible and variable pricing structure can be effective in managing parking demand and scarce land resources, yet at the same time, generating adequate economic revenue.

The main objective of this dissertation is to analyze whether and to what extent changes in parking policies can alter commuters' mode choice and parking preferences given different travel constraints, options and needs. Changes in parking policies examined in this dissertation not only include price, but also payment type (i.e. monthly, daily, or hourly), proximity of parking location to workplace and other incentives bundled together with specific parking options. Therefore, parking preference is defined as the pricing type and location of the chosen parking space. The types of parking pricing analyzed in this dissertation include paying by month, day, or hour, together with transit incentives bundled with different types of parking pricing options, while parking location is broadly divided into on-campus and off-campus parking. In order to better evaluate the impact of parking pricing and other transportation policies on travel behavior and demand, it is also necessary to understand how travel and parking behavior can be influenced by employment type and its respective flexibility of work schedule. In addition to accounting for the socioeconomic characteristics of UC Berkeley employees, this dissertation investigates their job characteristics and the flexibility of their work schedule, both of which affect transportation mode choice and parking location because of their effects on time of travel, duration of stay at the workplace and frequency of commute trips.

The UC Berkeley campus was selected as a study site to reevaluate current parking policies and to improve parking pricing to lower transportation demand and to reduce cruising for parking. The University is situated adjacent to the City of Berkeley's downtown, in the inner suburban ring of the San Francisco Bay Area. The campus is served directly by several AC Transit bus routes and a Bay Area Rapid Transit (BART) station. UC Berkeley is one of the largest employers and trip generators in the region, with more than 36,000 students, 1,377 faculty members, and more than 12,000 non-academic staff. As a result, it generates more than 50,000 trips per day, whereas there are only approximately 5,000 parking spaces available on campus. There is a clear constraint on parking availability and transportation demand management tools are vital in maintaining a relatively low driving mode share. Current parking policies are designed to cover existing operating costs, but fall well short of replacement costs, with an annual budget of approximately $13 million, except for bond payments. Furthermore, there is a wide range of employment types, job levels, work schedules, residential locations, and socioeconomic characteristics at UC Berkeley, which reflect varying employee attitudes, commute and parking choices. Therefore, findings from this dissertation can be more broadly applied to other regions.

A total of four different research methods were used to investigate attitudes and behavior, namely, open-ended interviews, focus groups, a transportation and parking survey, and discrete choice analysis. The combination of quantitative and qualitative methods provides complementary yet independent observations, as each method examines different facets of the research question. The survey was designed to examine current transportation demand and parking behavior, as well as potential changes in behavior under various parking pricing scenarios. Hence, it was used to collect both revealed preference (RP) and stated preference (SP) data.

In-depth one-on-one interviews were conducted with a total of 86 UC Berkeley employees. The open-ended interviews were designed to understand the linkages amongst travel behavior, parking preferences, work schedule, and employment type. The purpose of interviewing is to understand the valuable lived experience and actions of a small sample of UC Berkeley employees, to gain a clearer perception of their current travel behavior, habits and preferences. An additional 10 focus groups with eight faculty members and 105 staff members were then conducted, prior to the final execution of the survey. Focus groups were used in this dissertation to allow a deeper understanding of the underlying reasons contributing to any potential changes in mode choice that cannot be captured by the interviews and survey alone. Findings from the interviews and focus groups were then incorporated into the final transportation and parking survey. The online version of the survey was mailed electronically to all campus faculty and staff members (approximately 12,000 employees) in December 2013, with a response rate of approximately 30 percent (n = 4,188). Data collected from the survey were used to develop multinomial logit (MNL) models for mode choice and parking choice. Together, these research approaches illustrate current travel behavior and parking preferences. They also help determine the role of parking pricing in shifting transportation mode and parking location choices, show the differences in travel behavior and parking preferences according to University affiliation and provide insights into future UC Berkeley parking policies, as well as for other campus communities.

Results from this study show that a considerable number of employees (23 percent) use a combination of various modes when commuting to campus, while others rarely switch to something other then their most preferred mode (77 percent). Most regular users of transit or non-motorized modes would drive occasionally too, with driving frequency ranging from once or twice a week to a few times a year. Employees who drive alone to campus are categorized by their frequency of car use in this dissertation, i.e. regular drivers, regular but flexible drivers and occasional drivers. Results show that regular drivers drive every day of the workweek mainly because of convenience, comfort, safety, low transit accessibility, and having dependents. Regular but flexible drivers live in residential locations without the availability of comparable transit services, or where biking or walking to campus is not a feasible option. However, they would use transit if services have improved or other transportation modes and not drive if they could. Hence, they are more flexible than regular drivers in terms of their driving frequencies and mode choice. They tend to not have any dependents and have arrival and departure times that are not affected by someone else's schedules. Lastly, occasional drivers are employees who have multiple transportation options and they could either be more cost sensitive or prefer to use transit or non-motorized transportation modes for other non-cost related reasons. In both cases, occasional drivers drive to campus under special circumstances, such as being late for work, bad weather, having to carry bulky and heavy belongs, or having to attend certain events after work.

Results from the survey show that more employees in higher household income categories drive to campus than employees in lower income groups. Carpool and biking are two transportation mode choices that are not affected by income, as there are no substantial differences in the percentages of employees who carpool or bike across all income categories. On the other hand, the number of employees who use the bus is significantly higher for lower income groups than higher income groups and walking as a primary mode choice is most common for the lowest and highest income categories.

Work schedule and employment type have been found to affect parking location more than transportation mode choice. Driving alone is the most popular choice amongst all University affiliates and job categories as found in all three data sources, i.e. interviews, focus groups and survey. In general, almost half of the respondents drive alone to campus (49 percent), followed by transit (23 percent) and non-motorized transportation modes (16 percent). The remaining respondents carpool (seven percent), ride motorcycle (one percent), or use other forms of transportation, including being dropped off (four percent). However, not all University affiliates who drive have the same parking location preferences. Approximately 30 percent of employees who drive choose to park at of-campus parking locations. The flexibility of work schedule, which is directly related to employment type or University affiliation affects where an employee chooses to park more than transportation mode choice. Arrival and departure times, the number of hours spent on campus per day and the number of days on campus can all influence parking location. Lower income groups have been found to park less on campus than higher income groups. Changes in parking pricing are most likely to affect the parking location of employees with flexible work schedules more than their mode choice. Hence, employees who currently drive alone to campus will continue to do so, but may choose to park at a different location from where they currently park as parking pricing increases.

Results from the transportation mode choice models show that employees prefer alternatives with lower travel cost and time, which was expected. Staff members tend to prefer driving alone more compared to faculty members, while female respondents drive alone more than male respondents do. Older employees with higher household income also prefer driving alone to campus compared to younger employees and employees with lower household income.

The average annual salary at UC Berkeley is approximately $65,000 or $34 per hour. Comparing this value with the value of time estimates from the MNL models, it was found that the RP value of travel time of $16 per hour is 47 percent of the average hourly income. When comparing the value of travel time across income groups, low income groups have the lowest value of time ($14 per hour) but medium income groups have the highest value to time ($18 hour) in the RP model.

The parking choice model shows that an hourly parking payment is the most preferred parking option. The greater the parking fee refund and the availability of free transit passes, the greater the utilities of the monthly parking permits. When the transit pass also includes BART, it increases the utilities of the parking options. Survey respondents find parking options with shorter walking time more attractive and the longer an employee stays on campus, the greater the preference to drive and park on campus using a monthly parking permit option. Faculty members are less likely to choose a monthly parking permit over hourly parking option compared to staff members. However, it is important to note that adjunct professors and other non-professor titled academic staff are also included in the "faculty" category in the discrete choice analysis.

The value of walking time from parking location to workplace is estimated to be $15 per hour, which is slightly lower than the value of travel time. The value of walking time shows that employees are willing to spend $0.25 to park a minute closer to their primary workplace on campus. Walking distance is thus a significant factor in influencing parking choices, in addition to parking costs, and it should be considered when pricing future parking facilities.

The findings of this dissertation show that parking pricing plays an important role in regulating transportation demand by shifting mode choice, especially in a campus environment, where the majority of the employees who drive alone have restricted parking alternatives and mostly use on-campus parking spaces. However, it has a greater impact on influencing parking location, which can lead to changes in parking revenue for the University. Unlike existing studies, this dissertation examines the impact of parking pricing with the consideration of various payment type, parking location, transit incentives, flexibility of work schedule, income, and the willingness to walk from a parking space to the final destination. The use of qualitative research methods to complement results from a discrete choice analysis has also provided further insights to transportation mode choice and parking behavior.

To Mr. Meter, Lee Schipper
(1947 – 2011)

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CHAPTER 1

INTRODUCTION

Parking pricing is a potentially potent transportation policy and has been widely used by public and private suppliers of parking for revenue generation. The price of parking is a direct cost of driving and is one market based transportation pricing policy that can effectively manage travel demand. To the extent that it reduces demand for auto travel, parking pricing can help to reduce vehicle trips, as well as vehicle miles traveled (VMT) through mode shift and/or trip reduction or consolidation. To the extent that it frees up parking spaces, pricing can also reduce the added VMT due to cruising for parking. Such trip reductions and VMT reductions may also reduce congestion, air pollution and other transportation externalities (McShane and Meyer, 1982; Vaca and Kuzmyak, 2005; Shoup, 2005; Schaller et al., 2010; Anderson and de Palma, 2004). In particular, variable pricing or dynamic pricing that changes with demand, when applied to parking can have great potential for moderating travel demand, just as it has been successfully shown in congestion pricing or peak period tolling (Hensher and Puckett, 2007). It has even been suggested that parking pricing could provide greater welfare gains compared to just implementing road pricing alone, and generate even higher levels of social welfare when combined with road pricing (Calthrop et al., 2000). In addition, efficient parking pricing can also serve as a source of revenue for cities or private parking operators, depending on the supply of parking facilities.

Despite the well-recognized potential of parking pricing, it has not been widely used as a transportation demand management (TDM) strategy. Researchers have long been advocating for pricing parking spaces at a market rate to regulate parking demand, reduce congestion and increase revenue (Vickrey, 1954; Smeed et al., 1964; Roth, 1965; Kulash, 1974) and more recently for the inclusion of robust parking pricing policies to complement other forms of transportation and land use policies (Shoup, 2005; Barbour and Deakin, 2012), yet the politics and economics of parking pricing have made its application as a TDM tool difficult to accomplish. Shoup (2005) has estimated that in the United States (U.S.), 90 percent of parking is provided free of charge to the user.

In most cities, local residents and merchants have strong opinions on how their cities are managing parking spaces intended for their use, i.e. mostly wanting it to be convenient for use by residents of residential districts and by customers and employees in commercial districts. Local governments usually determine the prices of on-street parking spaces and publicly owned garages and lots, while the prices of off-street parking garages and lots owned by private companies are implemented by individual businesses. In most cases, the price structure depends on the location of the parking spaces, as well as local policy and practice. For example, on-street parking spaces in commercial areas are often regulated through time limits and may also be priced at a level that encourages frequent turnover, while parking in less convenient areas are priced at a lower level or may be available at no cost to the driver. Since the cost of parking is heavily subsidized by most governments, employers and businesses, parking spaces are not often

a useful element in TDM strategies to reduce congestion and vehicular emissions, and encourage mode shifts. Furthermore, even where pricing is used, a common approach, especially for parking owned by public entities, is to price parking to cover operating costs rather than total costs. For example, the land devoted to parking is not considered when setting the price. In almost all cases, the social costs of driving contributed by parked vehicles and the externalities incurred as a result of searching for parking are excluded from consideration (Small and Verhoef, 2007). Variable parking pricing that reflects actual parking demand at different times of a day is also rarely implemented, apart from a few cities in California, Washington and Oregon (Shoup, 2005).

1.1 RESEARCH OBJECTIVES

The main objective of this study is to investigate consumer responses to alternative parking pricing strategies that account for location (which in turn affects demand) and provide incentives for travelers to reduce their use of parking. The study examines whether such parking pricing strategies can effectively alter mode choice and trip frequency, and thus reduce parking demand. This dissertation will contribute to the literature on parking pricing by evaluating its efficacy and consumer interest in incentives, such as a parking fee refund for days not parked and by examining the interaction of parking pricing with incentives for the use of other transportation modes and the flexibility of work schedule. In addition, the dissertation will provide a detailed analysis of user groups who will be affected by the parking strategies, a consideration not previously examined in any detail in current literature.

1.2 RESEARCH HYPOTHESES

The focus of this dissertation is to analyze the impact of parking pricing on transportation mode choice and parking preferences at the University of California (UC), Berkeley campus. The changes in parking pricing that were examined include, 1) increased daily rates, 2) reduced or eliminated monthly discounts for parking every day and 3) incentives for transit use coupled with parking pricing changes. Such changes in the current parking pricing structure are hypothesized to cause a shift in transportation mode, e.g. from driving to public transportation, carpool, walk or bike and affect parking location decisions for UC Berkeley faculty and staff members. The degree of potential change for each user group would differ according to different demographic and socioeconomic factors, as well as their current transportation demand and behavior.

In addition, this dissertation includes variables, such as parking location and planned and contingent activity patterns throughout the day as factors that could determine the magnitude of pricing impact on mode choice and parking behavior. Thus, it contributes to the literature by going beyond the focus of current transportation pricing studies, which tend to focus on income and travel time as primary factors affecting mode choice (Levinson, 2010).

The following sections describe the research hypotheses and relevant research questions in this dissertation. There are four main hypotheses, which are mostly specific to the context of the UC Berkeley case study.

1.2.1 Mode Shift is Most Likely to Occur for University Staff and Middle Income Respondents

A change in the current parking pricing structure is likely to cause a shift in transportation mode, e.g. from driving to public transportation, carpool, walk or bike, especially if there is an increase in parking prices. The impact of changes in parking pricing on mode shift would be greater for University staff than faculty members, as most of them are more likely to have fixed schedules and regular working hours, when public transportation services are available. In addition, staff incomes are for the most part lower than faculty incomes and therefore, staff members are more likely to be price sensitive than faculty.

Studies on congestion pricing and tolling have shown that middle income groups can, in some circumstances, be more price sensitive than lower income groups, because they have more discretion over the time of travel. In addition, lower income groups tend to have less flexible work schedules, and thus, they tend to place a relatively high value on commute time (Sullivan, 2000; Plotnick et al., 2009).

Parking pricing could result in a similar outcome. Medium income groups on campus, regardless of employment type, could be more price sensitive than lower and higher income groups and choose alternative transportation modes if such options are available. Hence, if parking pricing increases, medium income groups could be most affected and most likely to switch to alternative transportation modes, especially for medium income groups who are able to choose to commute by modes other than drive alone, either due to housing location or flexible work schedules.

1.2.2 More Faculty Would Choose New Flexible Parking Permits Than University Staff

Faculty members are more likely to have flexible work schedules and some are not required to be physically present on campus every day during the week. Most are paid for nine months a year and only receive summer salary if they secure additional summer work, such as extramural contracts or summer teaching. Hence, depending on their frequency of visits to campus, faculty could be more attracted to flexible parking permits than staff members, assuming that the type of parking permits available matches with the number of days they park on campus per week. However, flexible parking permits could also be desirable for University staff members who are unwilling to drive daily to campus and to use other forms of transportation on days they choose not to drive alone. Faculty with flexible work schedules are also more likely to continue to drive alone to campus even if they choose the new flexible parking permits. Since most faculty are not required to be on campus for a specific amount of time during regular working hours, unlike most staff members, they could choose to park at locations not on campus, e.g. on-street parking, which would cost less than campus parking, on days when they are only on campus for a short period of time.

1.2.3 Lower Income Respondents May Not Change Their Transportation Behavior Significantly

If the impact of parking pricing is similar to other forms of transportation pricing, including highway tolls, congestion pricing, and VMT fees (Svadlenak and Jones, 1998; Deakin and Harvey, 1996; Safirova et al., 2003), then it is likely that lower income groups would be least affected compared to other income groups. In particular, assuming higher parking charges only apply during the regular workday, e.g. from 8:00AM to 5:00PM, University employees who are usually on campus outside of these regular working hours may be unaffected. Such off-peak employees include many with low paying jobs, such as janitorial staff. Those who are already taking public transportation, walking or biking are also likely to not be as affected compared to commuters who drive and choose to park on campus. On the other hand, existing transit or non-motorized mode users may drive occasionally and would be affected by changes in parking pricing.

Employees who are currently driving to campus during regular working hours on a daily basis are most likely to be affected by changes in parking pricing and permit type but whether they will be better off or worse off in the short and long term will depend on their specific circumstances. Some examples are whether they can find a parking space faster due to its greater availability or whether they must now spend more time getting to the campus using different transportation modes or park at different locations not on campus but at a lower cost.

1.2.4 Flexible Parking Options Could Induce Campus Parking Demand

Depending on the pricing policies assessed and the type of parking pricing to be implemented, mode shift from transit to driving could occur. If a more flexible parking pricing structure is implemented, such as by replacing a one time monthly or annual fee with a "pay as you park" approach that reflects actual demand, current transit users could switch to driving and parking on campus more regularly than they would have otherwise. However, since the quantity of parking supplied will not increase and will most likely stay constant in the short term, the price of each parking permit has to be set at a level that is attractive enough for current parking permit holders to switch to driving less or using other transportation modes, yet still high enough to not significantly increase the number of new drivers.

1.3 Dissertation Outline

The next chapter gives an overview of current studies relevant to parking pricing, while Chapter 3 presents the rationale for the selection of the study site, as well as qualitative and quantitative methods used in this dissertation research. Chapter 4 describes the transportation and parking behavior at UC Berkeley based on the analysis of survey data collected for this specific research study. Chapter 5 explains the results of the discrete choice models, including transportation mode choice and parking choice. Chapter 6 explores the relationship between the flexibility of work schedules and mode choice, as well as parking location choice. Chapter 7 discusses underlying factors for mode choice and parking location choice based on results from one-on-

one interviews and focus group discussion sessions. Lastly, Chapter 8 provides key findings from this dissertation research and suggests policy implications.

CHAPTER 2

CURRENT STUDIES ON PARKING PRICING

Parking pricing policies can apply to commuter, non-commuter and residential parking, and can address a variety of financial, social, economic, and environmental objectives. In particular, parking pricing policies can generate revenue for operators, serve as tools to support commercial success and residential quality of life, and at the same time help manage travel demand, reduce congestion and travel time (Shoup 2005), as well as decrease vehicular emissions (Greene and Schafer, 2003). Pricing is also one of the most effective measures in lowering transport carbon dioxide (CO_2) emissions (Parry and Small, 2005; Cambridge Systematics, Inc., 2009; Barbour and Deakin, 2012).

2.1 THE ECONOMICS OF PARKING PRICING

Increasing parking pricing raises the total cost of a motor vehicle trip, which could lead to a variety of changes in travel and location choices (Deakin and Harvey, 1996). By raising the cost of motor vehicle use, parking pricing would be expected to affect the number of trips made (trip generation), trip chaining patterns and mode choice. Since price is likely to vary by location, for many trips, destination choice could be affected as well (and if so, route choice will also be affected). Over the longer run, parking pricing could affect the number of vehicles owned and the types chosen (e.g. price-sensitive consumers might buy a vehicle with lower ownership costs and higher fuel economy if parking costs are high, or might decide to reduce the number of vehicles owned). Both residential and business locations might be affected in the long run, e.g. residents could decide to reduce their car holdings and use transit or walk for most trips and car-dependent businesses could choose to locate to places with lower parking prices. In this fashion, parking policies have the potential to increase the use of alternative modes and reduce VMT, congestion, emissions, and other externalities.

However, parking pricing is an imperfect way to reduce externalities. Since parking pricing does not vary according to distance traveled, its impact will be more sharply felt for short trips than for longer ones, as the parking fee will constitute a relatively larger portion of the total costs for the former than the latter (Button, 1993). At the same time, many motor vehicle externalities are at least in part a function of VMT. Hence, as a substitute for a VMT or emissions fee, parking pricing would tend to undercharge long distance travelers or overcharge short trips. In addition, the fixed nature of the parking charge suggests travelers commuting longer distances are less likely to be affected by changes in parking pricing, when compared to travelers living closer to their work destinations.

In practice, parking is rarely priced to cover externalities and often is priced at levels that do not cover the cost of production. Underpricing occurs among both private and public owners of parking. Some parking is priced at a level that provides private parking providers or local authorities' desired revenue yet low enough to still attract customers to park in certain areas that contain commercial activities (Marsden, 2006; Vaca and Kuzmyak, 2005). However, in many

other instances, the price is set below cost, at a highly subsidized rate, or is even made available at no cost (Breithaupt, 2002). Employee parking, parking in residential areas and parking in some commercial districts are frequently priced below cost or not priced at all.

However, parking is never free. There are significant land, construction, maintenance, and operation costs for both on-street and off-street parking. For example, the cost associated with the land developed for parking at commercial establishments is trickled down from land developers to retailers or employers and ultimately to consumers or employees, in the form of higher retail prices or lower wages (Shoup, 2005). When drivers do not pay the full cost of their parking spaces, the cost burden is passed to all consumers, even those who use other forms of transportation modes, instead of just vehicle owners, who will utilize parking spaces provided by the developer (Shoup, 2005). Likewise, on-street parking spaces consume land that could be used for travel lanes (for motor vehicles, or for bike paths and sidewalks), could be landscaped and serve as a community amenity, or could even be sold to abutting landowners for their private use. When parking is not priced or priced below its actual cost, such costs must be covered in other ways, e.g. through the general tax revenues of the community. In practice, then, the failure to efficiently price parking is pervasive, and the resulting subsidies entail opportunity costs, which can be significant.

2.2 PARKING SUPPLY AND PRICING

In most cities a combination of public and private off-street parking and on-street parking spaces are available. Some of the off-street parking spaces are restricted to specific users (e.g., occupants of a particular building or customers of a particular establishment), while other off-street parking is available for use by the general public. Likewise, on-street parking is sometimes regulated or restricted (e.g., through time limit enforcement for certain time periods of the day), sometimes it is priced through parking meters or permits and sometimes it is free depending on the street or time of day. Parking supply in residential areas near retail, office or institutional uses often serves as free parking for non-residents if it is not regulated. Subsidized parking facilities available to the public and parking in residential areas can become an alternative parking location for travelers who wish to avoid paying for parking in the nearby retail or employment centers. Therefore, efficient parking pricing must account for the interaction of public and private policies.

As heavy non-resident use of residential areas for parking can disturb the quietude and livability of residential areas, many cities allow residents to petition for resident permit parking. Residential permit parking programs allow parking to be restricted to residents only or to limit non-resident use of the parking spaces. The programs are typically managed through the use of resident permits, parking time constraints, or visitor permits requirements for non-residents. Some programs also provide permits in limited numbers to local businesses and public institutions, such as schools. A few install meters on streets that are otherwise restricted for resident use only and require visitors to use the metered spaces. These measures are implemented to prevent spillovers of vehicles looking for free and available parking spaces in residential neighborhoods (Kuzmyak et al., 2003). However, their efficacy depends in large part on the success of enforcement, which is costly and is not always effectively deployed.

Due to the various types of parking supply, there is competition between different parking services. Kunze et al. (1980) conducted a study on the impact of parking pricing in Chicago and concluded that users of public parking garages will switch to private parking if a price increase makes private parking garages more attractive. Employees will find alternative parking, such as free on-street parking to avoid paying for parking at work (Kunz et al., 1980). In the long term, if parking pricing is not implemented systematically over an area, it could lead to an increase in trips to destinations that offer free parking or at a lower price (Vaca and Kuzmyak, 2005). The management of public parking, public incentives, such as parking tax and transit alternatives can all influence the impact of parking pricing.

A common conflict seen in most cities lies between public policies set to regulate parking supply and the objectives of parking pricing. Cities frequently require developers to provide parking for employees and customers (Vaca and Kuzmyak, 2005). In turn, building managers often bundle parking into the rent or lease for office, retail space and for housing rather than renting it separately. Employers frequently offer parking at no charge to their workforce, as an employee benefit, and retail and service establishments provide free parking to their clientele. Under these circumstances, charging for publicly owned parking can be controversial.

However, free or low-cost on-street parking promotes driving and may also lead to increased VMT, as drivers will cruise around looking to park at a free or low cost curb space rather than pay for more costly off-street parking. Some cities have attempted to coordinate on street parking prices with off-street prices, or to use on-street time limits to encourage employees to park at off-street garages. Due to enforcement difficulties, such regulations are often only partially effective, as employees resort to meter feeding or moving cars around to take advantage of low-cost on-street parking spaces.

2.3 THE IMPACT OF PARKING PRICING ON DEMAND

A number of studies have observed the short term impact of parking pricing. Three separate studies in San Francisco, Toronto, and Dublin have shown that for every 10 percent increase in parking price, there would be an average of three percent decrease in demand for parking spaces (Kulash, 1974; Gillen, 1977; Kelly and Clinch, 2009). This elasticity estimate is the most commonly found, but there are studies showing larger decreases in parking demand as price increases. For example, Dueker et al. (1998) found that in urban Portland, the price elasticity of demand for commuter parking was -0.58 for single occupancy vehicles and -0.43 for carpools. Therefore, the overall impact may depend on the type of parking studied, i.e. on-street, off-street parking garages for commuter or shopping, how parking demand is defined, i.e. number of vehicles parked (Kulash, 1974) or number of auto trips (Gillen, 1977), time of day studied, or whether there is alternative free or lower priced parking available, as is sometimes the case. When alternative parking is available, parking demand can fall at the same rate as the price increase, as shown in Hensher and King's (2001) study in the Sydney central business district (CBD). The high price elasticity (-1.015) was estimated for travelers who chose to park elsewhere in the CBD, rather than choosing to park closer to their final destinations (Hensher and King, 2001). This could imply that travelers who chose to park in the fringe areas of the CBD are more price sensitive than travelers who chose to park closer in.

When alternative parking, such as a lower priced facility or free off-site parking, is available, raising the price of parking at a particular location may simply shift parking to nearby parking sites or change parking duration. In other words, the availability of parking options will limit the effectiveness of parking prices and could lead to higher elasticity estimates, which are misleading, as they do not reflect the actual changes in parking demand.

2.4 THE IMPACT OF PARKING PRICING ON MODE CHOICE

Most current parking pricing studies have focused on its impact on parking space demand (Kulash, 1974; Gillen, 1977; Kelly and Clinch, 2009) and fewer empirical studies of parking pricing changes have considered mode choice impacts. Surveys tracking parking pricing changes in Los Angeles city center and suburbs have shown that when employers stopped paying for parking, the number of solo drivers decreased substantially, between 19 and 81 percent depending on the location. Likewise, the use of private vehicle as a commuting mode had decreased by 15 – 38 percent after the removal of parking subsidies (Willson and Shoup, 1990; Surber et al., 1984).

Modeling studies have also estimated potential impacts of parking pricing. In an Los Angeles modeling study, Willson (1992) estimated that there would be 23 to 24 percent fewer automobile commute trips overall if employees are expected to pay market rates for parking, as opposed to receiving free parking. Free parking led to a 70 percent chance of solo commuting, but this percentage dropped to only 39 percent when drivers were asked to pay a daily parking fee (Willson, 1992). Solo car trips will decrease as parking cost increases, resulting in higher transit mode share.

A similar trend occurred in Portland, Oregon when on-street parking stopped being free and when transit discounts were given to commuters (Bianco, 2000). Using a multinomial logit model, Hess (2001) found that with free parking, 62 percent of commuters will drive alone and 22 percent will use transit, while when there is $6 daily parking fee, the percentage dropped to 46 percent for driving alone and increased by 50 percent for transit in Oregon and Southwestern Washington. In his study, land use variables, such as pedestrian amenities and access to light rail were taken into account, but they were found to be insignificant in affecting mode choice decisions (Hess, 2001), implying that pricing is a stronger influence in reducing solo car trips.

Additional studies have considered parking pricing policies' impact on congestion. Free parking reduces the financial incentives to drive less (Jansson, 2010) and increases congestion both from increased traffic flow and the search for parking, also known as cruising. A review of 16 studies on 11 cities conducted between 1927 and 2001 have found that about 30 percent of the vehicles in the central business districts were cruising for parking (Shoup, 2007). Cruising, i.e. driving to find parking, should be reduced when possible, as it could lead to substantial increases in distance traveled, fuel use and emissions (Shoup, 2005).

2.5 PARKING PRICING AND INCOME

Empirical studies that have focused on the impact of parking pricing across income groups are scarce. Clinch and Kelly (2004) conducted a survey in the center of Dublin, where they found

that after a 50 percent increase in on-street parking price, there was a 24 percent decrease in the share of on-street parkers who were in the highest income groups, while upper medium income groups increased their share by 24 percent. The data collected for this study were unable to provide any further insights on equity concerns. Lower income groups did not seem to be affected, most probably because they were not parked in the center of Dublin or because those who were driving to Dublin center did not have any other alternatives. Another study on how parking pricing can affect different trip purposes by the same authors (Kelly and Clinch, 2006) used engine size as a proxy for income, and found that as engine size increases, the probability of a change in parking behavior due to a price change decreases. If the assumption that higher income groups drive vehicles with larger engines is accurate, then it could be concluded that as income increases, parking pricing will be less effective in influencing behavior.

Similar results were shown in two other studies on responses to different parking pricing strategies in Washington DC and Athens, Greece, where as income increases, the willingness to pay for parking increases, as well as the percentage of travelers who do not change their behavior (Kuppam et al., 1998; Tsamboulas, 2001). Kuppam et al. (1998) have also found that in the Washington DC metropolitan area, travelers who shifted to transit when parking price increased were mostly from higher and lower income groups, while travelers who switched to carpool mode were from the medium income groups. These results were based on the availability of alternative transportation modes to different income groups.

Theoretically and empirically, lower income households tend to be more sensitive to parking prices than higher income groups, and could change their behavior to avoid paying for parking, as they could not afford to pay for the additional cost. However, empirical studies have not provided much evidence that parking pricing can have a greater negative impact on lower income households than other income groups. This is likely due to the fact that lower income households are already priced out of auto driving and parking, especially in the central city markets that have been most frequently studied.

2.6 PARKING PRICING AND THE VALUE OF TIME

Apart from parking duration and vehicle occupancy, the value of time or the value of time savings is another factor that can affect parking choices. According to Small (2006), the value of time is defined in terms of compensating variation, which means that it is a particular amount an individual could pay without affecting the individual's level of welfare. It is the ratio of coefficients of time and money and represents the monetary value travelers place on an incremental time saving (Small, 2006). A common calculation of the value of time is based on a utility maximization approach developed by Becker (1965), where time is a constraint. Becker's theory has resulted in the value of time being associated with wage rate (Small, 2006).

This value is different for each individual as it depends on observed travel time and wage rate and could change as trip purpose changes. Since the value of time changes according to the characteristics of the traveler, trip purpose, time of travel, and trip duration (Small, 2006), there are many different estimations of the average value of time. The Wilbur Smith studies for the Transportation Corridors Agencies estimated the average commuter value of time in Orange County, California to be $10.68 per hour in 1995 ($16.13 in 2013 price), $12.54 per hour in 2000

($16.76 in 2013 price), and $15.48 per hour in 2005 ($18.27 in 2013 price) (Smith, 1991). Small and Yan (2001) have assumed that higher occupancy vehicles have a higher value of time per vehicle and have calculated the value of time of non-carpool vehicles traveling along SR91 in Southern California to be $13.80 ($18.15 in 2013 price) per hour, which was 59 percent of the average wage rate. Mode choice models designed by the Metropolitan Transportation Commission (MTC) have estimated the average value of time to be $9.65 ($13.91 in 2013 price) per hour, which was 46 percent of the average Bay Area wage rate (Purvis, 1997).

The higher the value of time, the more an individual could be willing to pay for a parking space that is closest to the final destination. It is generally accepted that the value of time for a specific trip increases with income (Raux and Souche, 2004; Nakamura and Kockelman, 2002). The elasticity of value of time with respect to income has been estimated to be 0.72, while it is 0.13 with trip distance (Wardman, 2001). In Wardman's study (2001), bus travelers were found to lower value of time than rail users. Walking and waiting time have a higher value than in-vehicle time, and can be more than twice as high, while the value of time is also higher for business trips than leisure (Small, 2006).

Anderson et al. (2006) have found that higher income individuals are willing to spend $0.70 ($0.81 in 2013 price) to park each additional minute closer to the destination, while lower income individuals were only willing to spend $0.35 ($0.40 in 2013 price). The value of time across income groups depends on various factors, as described above, and there could be circumstances where a low value of time does not necessarily imply low income and vice versa. All travelers, regardless of income, could have a high value of time under certain circumstances (Ward, 2001). When studying the demographics on the SR 91 Express Lanes, Sullivan (1998) found that lower income groups travel on the Express Lanes, which are tolled, and they have a high value of time when choosing to do so. Although lower income groups do not travel on the Express Lanes as frequently as higher income groups (Sullivan, 1998), there are situations when their value of time is just as high as travelers in higher income groups. This could also apply to parking, where a high value time is not necessarily always an indicator of high income.

As summarized above, the impact of parking pricing has not been studied as extensively as other forms of transportation pricing, such as congestion pricing. Existing studies on the impact of parking pricing on mode choice tend to focus on free parking, which have generated a wide range of results. Instead of analyzing the differences in mode choice or parking demand between free parking and a fixed price point, this dissertation contributes to current literature by creating four parking payment and location types, in addition to different levels of prices, to examine their impact on mode choice and parking demand. Each parking option is also coupled with other transportation incentives to provide choices that are more multidimensional.

The mode choices included in this study also go beyond existing studies'. There are nine alternatives altogether, which are more comprehensive than what have been studied in current literature. These alternatives include "Work from home" that reflects the possibility of a flexible work schedule. Again, the linkages between the flexibility of work schedule and parking pricing have not been thoroughly studied. This dissertation examines the flexibility of work schedule in detailed and incorporates it into the mode choice and parking choice analyses.

The impact of parking pricing on different income groups is another area that is understudied. In this dissertation, income is categorized into three groups, which can then better predict potential changes in mode choice and parking behavior of each of these groups when parking pricing changes. The findings of this dissertation will not only be able to inform UC Berkeley campus officials but also other campus communities and employers that are located in regions with several transportation alternatives and parking options.

CHAPTER 3

METHODOLOGY

There were four main research methods used in this study to examine current transportation mode choices and parking preferences at UC Berkeley, as well as to assess potential changes in behavior under different parking pricing scenarios. These methods are, 1) exploratory interviews; 2) focus group discussion sessions; 3) a transportation and parking survey, and 4) discrete choice analysis using data collected from the transportation and parking survey. This chapter starts with a description of the case selection rationale, followed by an overview of each research method. Methodological approaches that are relevant to specific discrete choice models are described in greater detail in Chapter 5.

3.1 CASE SELECTION AND RATIONALE

The UC Berkeley campus is an appropriate case because the University is a major employer in the San Francisco Bay Area with substantial parking supply located in a community and region, where travel alternatives are readily available for many University affiliates. UC Berkeley currently manages its parking services through a combination of price and regulation. Under University rules set by the UC Regents for all 10 UC campuses, parking and transportation services are an auxiliary function that must be self-supporting. Thus, the University's parking and transportation prices must be in the aggregate to cover operating and maintenance costs. Additional management goals include reducing cruising, congestion and related environmental impacts. Also, because the UC Berkeley campus wishes to use existing parking sites as future development sites and does not wish to invest in costly parking replacement projects, the campus wants to reduce overall parking demand in order to ultimately reduce the need for new investments in parking spaces. The University has also been seeking different measures to encourage the use of public transportation and non-motorized transportation modes as part of a University wide campaign to decrease greenhouse gas emissions to 1990 levels by 2020.

At the same time, despite the high capital and operation costs of parking infrastructure, the University aims to provide fairly priced parking for employees who choose to drive to campus. The University currently allocates parking permits according to the status of the employee (e.g. faculty or staff). It does not provide low-cost permits to low-income staff, except for those who work in the afternoon and evening shifts when significant discounts are available.

3.1.1 CURRENT PARKING PERMIT TYPES AND COSTS

UC Berkeley currently has over 5,000 parking spaces serving the central campus. The parking pricing structure at UC Berkeley is designed to recover costs of parking and transportation operations, in accordance with UC Regents' policy. A variety of permits are available, but for employees, annual parking permits are the most common choice. Daily parking permits are also available but they are priced at a rate that does not encourage their use for employees who drive regularly to campus. The type of parking permit purchased will determine which parking lots

and garages an employee is eligible to use, but employees are not assigned specific parking locations or spaces.

The current parking pricing scheme raises a number of policy issues. One such issue is that the sale of annual permits may "lock in" a preference for driving, even while the campus is trying to reduce parking demand (both so that it can use the land for other development purposes and to reduce community and environmental impacts). Once an employee has purchased an annual parking permit, there is no incentive to not choose to drive to campus every day, since parking has already been paid for. A second issue is that the current prices barely cover current costs and do not allow for a reserve to be developed that could be used to replace aging structures or provide new parking garages, as surface lots become building sites. While campus officials are aware of these issues, they are hesitant to raise rates at a time when university salaries are lagging.

UC Berkeley currently relies on a parking permit system to charge faculty and staff members for the use of its parking facilities on campus. These parking permits vary in cost and in most cases, the costs of different parking permits are based on University affiliation, which then subsequently decides the location and type of parking spaces that each employee is eligible for. Table 3.1 shows the costs of UC Berkeley employee parking permits available in 2013-2014.

Table 3.1. Current Campus Parking Pricing For Employees 2013-2014

Faculty/Staff Permits	**Cost**
Central Campus Annual, "C"	$124/Month
Carpool: Central Campus Annual	$44/Month
Faculty/Staff Annual, "F"	$90/Month
Carpool: Faculty/Staff Lots	$29/Month
Night/Weekend Permit (M-F, 1:30 PM - 2:00 AM)	$45/Month
Emeriti	$456/Annual
Other Permits	**Cost**
Department Reserve Annual	$2285/Annual
Department Pool Annual	$1488/Annual
University Vehicle Annual	$1488/Annual
Hill Area Annual	$67/Month
Satellite Annual	$5/Month
Motorcycle Annual	$24/Month
Night and Weekend Temp	$45/Month
Hill Temp	$67/Month
Faculty Staff Temp	$90/Month
Central Temp	$124/Month
Daily Permit Types	**Cost**
Central Campus Daily Scratch-off Hangtag, 'C'	$16/Each
Emeriti Daily Scratch-off Hangtag	$4/Each
Faculty/Staff Daily Scratch-off Hangtag, 'F'	$12/Each
Alternative Transportation Daily Scratch-off Hangtag "F"	$6/Each
Night/Weekend Daily Scratch-off Hangtag (M-F, after 4:30 PM and on weekends)	$10/Each
Hill Area Daily Scratch-off Hangtag, 'H'	$8/Each
Contractor Scratch-off Hangtag	$20/Each

Note. Parking Permit Price List (Fiscal 2013 – 2014 Rates), UC Berkeley (2014a). Satellite Annual permits are valid Monday through Friday, 7:00 AM to 5:00 PM for off campus locations, such as Richmond Field Station.

All "Temp" parking permits are monthly parking permits that are restricted to six per employee per year, as they are meant for employees with short term contracts with the University or for employees who do not need an annual parking permit. Another type of parking permit that the Department of Parking and Transportation has a restriction on is the Alternative Transportation Daily Scratch-off Hangtag, which faculty and staff members are only allowed to purchase a maximum number of 48 per year, at a rate of $6 each.

In the "Other Permits" category, there are three types of permits that are available for departments instead of individuals, unlike all the other parking permits. These three permits are, 1) "Department Reserve Annual," which is a parking space purchased by a department just for their exclusive use; 2) "Department Pool Annual," which is a transferable permit to be used within a department and valid for any "C" or "F" parking space on campus and 3) "University

Vehicle Annual," which is a parking sticker for department owned vehicles and is valid for any "F" parking space on campus.

Campus data for fiscal year 2012 showed sales of 2,028 annual "F" permits and 1,060 annual "C" permits. In addition, there were sales of 649 "F" carpool permits and 127 "C" carpool permits. An additional 800-900 permits were sold to students each semester, 242 annual permits were sold to emeriti and a total of 442 permits were sold for departmental pool, university vehicle, or departmental reserved spaces. Note that if each of these permits were used every day, they would require all of the available parking spaces. However, many users do not in fact park on campus every day, which allows for thousands of daily parking permits sales each year. In fiscal year 2012, 34,439 "Faculty/Staff Daily" permits and 18,809 "Central Campus Daily" permits were sold (UC Berkeley, 2013). It should be noted that individuals eligible for campus parking permits can choose to buy daily permits, but so can campus units purchase them for visitors. No information could be obtained on exactly what percentage of the daily permits is for visitors, since they are usually not reported. However, it is known that approximately 89 percent of "Central Campus" and 90 percent of "Faculty/Staff Regular Rate" daily permits were sold to departments and not individuals (UC Berkeley, 2013).

Professors and employees with certain job titles, which are mostly senior professional staff members, are eligible for the purchase of "C" permits, while "F" permits are available to any faculty or staff member. A "C" permit currently costs $124 per month, which is equivalent to approximately $6 per day (excluding weekends), while an "F" permit costs $90 per month (or $4.50 per day excluding weekends). Carpool permits are also divided into "C" and "F" and are priced at a discounted rate of $44 and $29 per month respectively. Daily scratch-off permits range from $6 to $16 depending on its type (Table 3.1).

3.1.2 TRENDS IN PARKING PRICING AND PERMIT SALES

The costs of parking permits are not based on actual parking demand and they have not changed since 2010. In fact, the costs of all parking permits were reduced by an average of six percent in 2010 from 2009, apart from daily permits, which have been kept at a constant rate. Some permits had an almost 9 percent cost reduction (Figure 3.1). Figure 3.1 shows the changes in permit costs over the past 11 years.

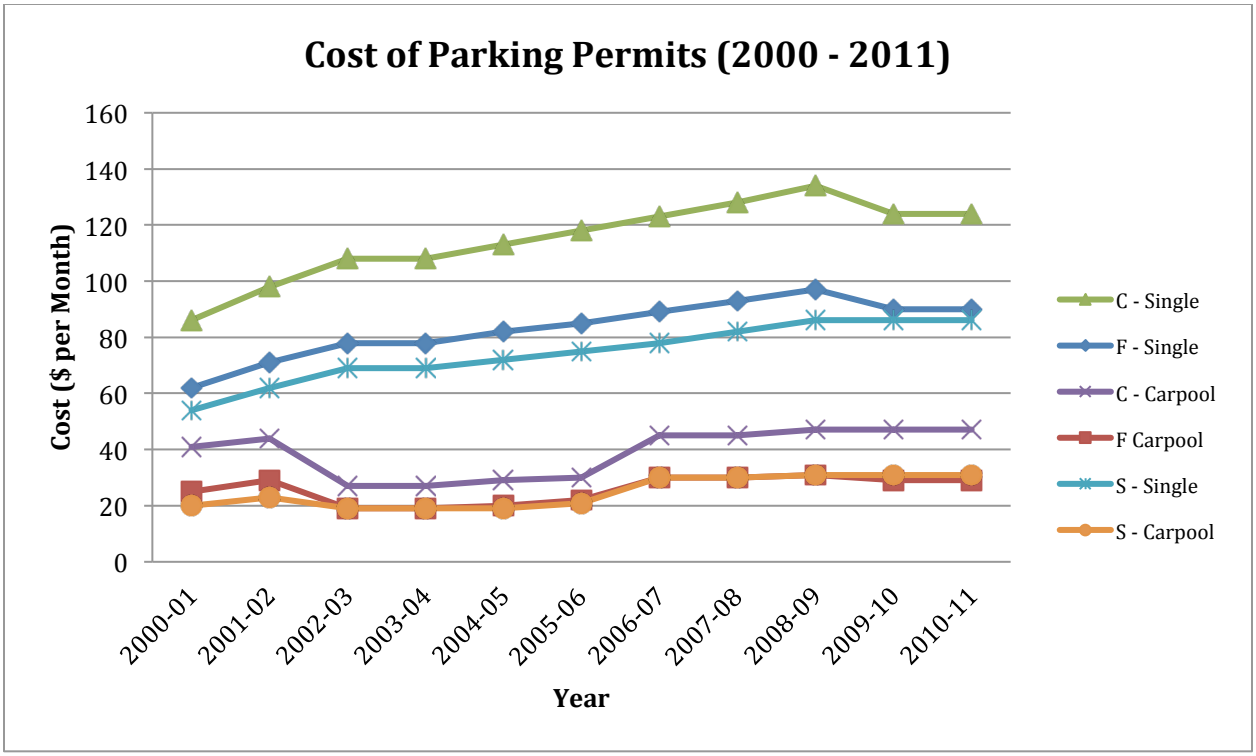

Figure 3.1. Changes in Parking Permit Pricing.
Note. Data collected from UC Berkeley (2014a). "C – Single" refers to a parking permit for central campus lots, "F – Single" refers to a parking permit for faculty or staff, "C – Carpool" is a carpool parking permit for central campus, "F – Carpool" is also a carpool parking permit but for faculty and staff lots, "S – Single" is a student parking permit for the Fall/Spring semester, and "S – Carpool" is a student carpool parking permit. The costs of all non-student parking permits are presented in monthly costs.

Although the costs of parking permits have remained constant over the past few years, the number of parking permits sold has been decreasing since 2009. In 2012, the total number of parking permits sold was 42 percent less than in 2009. Out of the 29 types of parking permits available, the demand for 12 permit types has increased between 2009 and 2012, while the rest have encountered a decrease in demand by as high as more than 100 percent. The number of "Central Campus – Annual," "Faculty/Staff – Annual" and every type of daily parking permits sold have all decreased (Figures 3.2 and 3.3). "Central Campus – Daily" permit sales have decreased substantially over the past few years, at a much greater rate than "Faculty/Staff – Daily." Since the majority (90 percent) of the "Central Campus – Daily" permits were purchased by University departments, this decline in sales could be due to changes in departments' budgets and a decrease in the willingness to provide campus parking spaces for visitors.

Some of the parking permits that have increased in demand include "Faculty/Staff Carpool – Annual" and "Motorcycle – Annual" (Figure 3.2). The most popular type of annual parking permit sold in 2012 was the "Faculty/Staff Annual" permit (Figure 3.2), which is not surprising as any UC employee is eligible for this type of permit unlike the "Central Campus Annual." Similarly, the most popular type of daily parking permit sold in 2012 was the "Faculty/Staff Daily" permit (Figure 3.3).

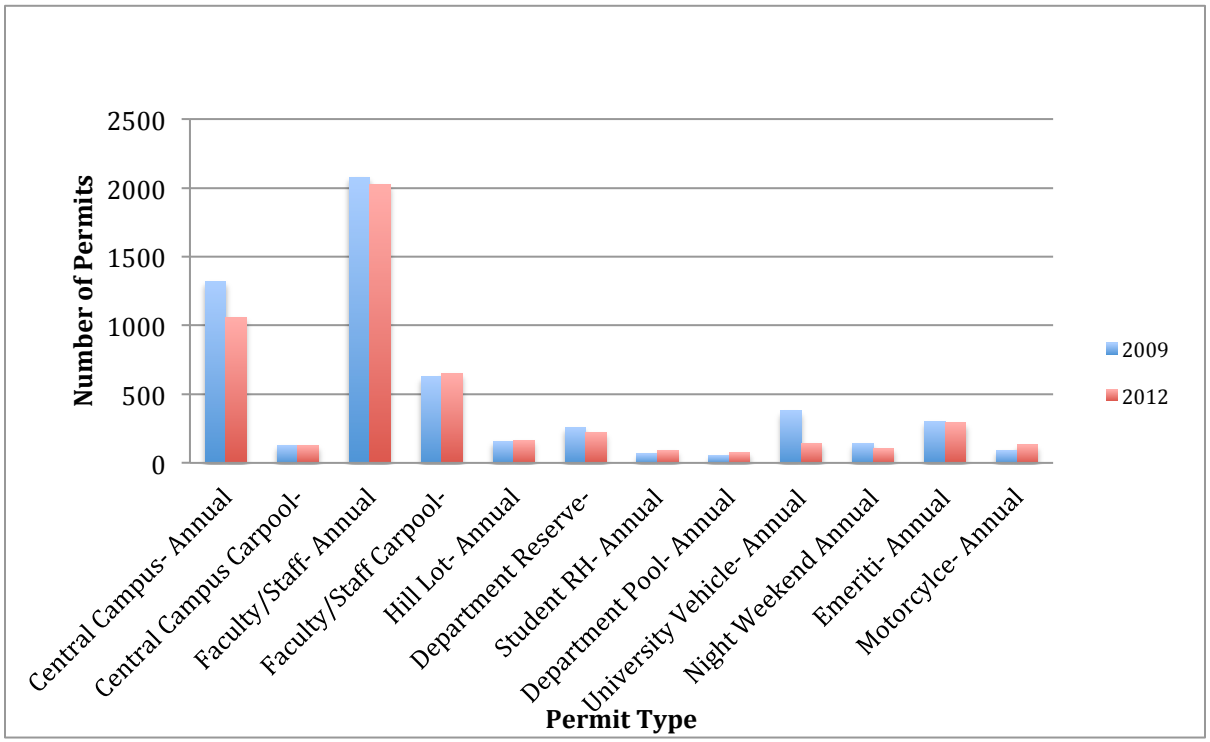

Figure 3.2. Annual Parking Permit Sales in 2009 and 2012 by Permit Type.
Note. Data collected from the Department of Parking and Transportation, UC Berkeley (2013).

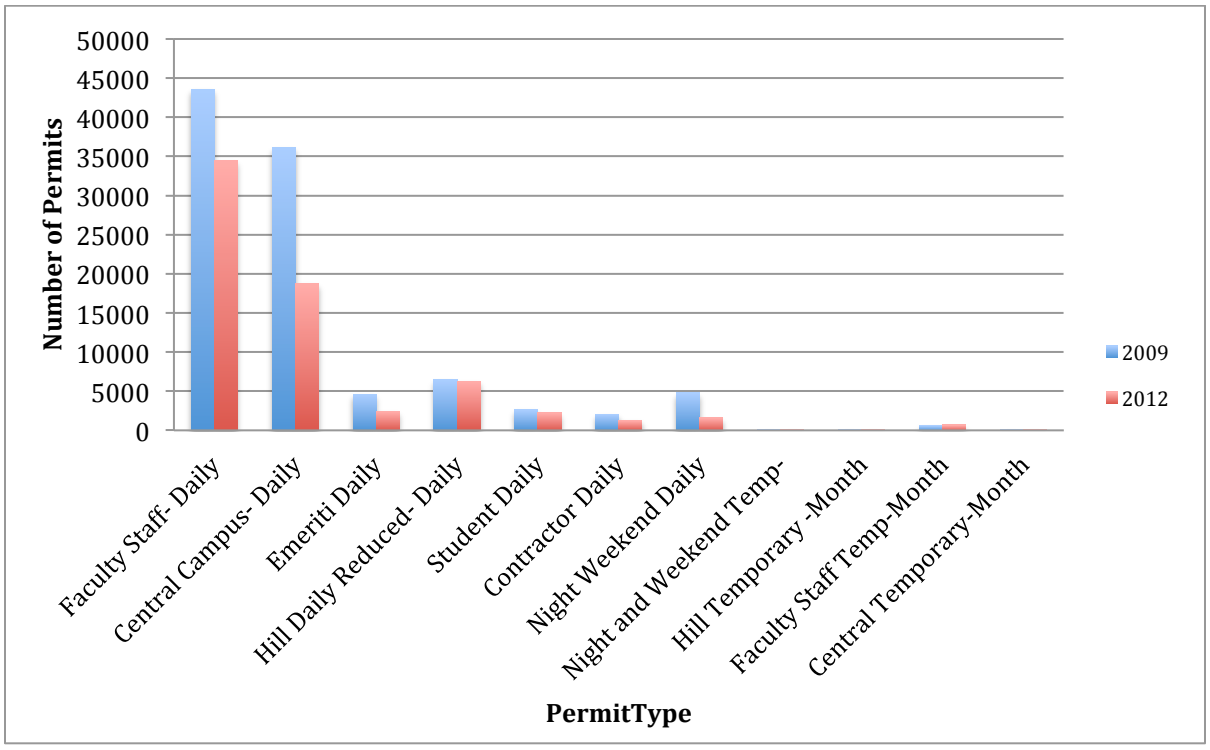

Figure 3.3. Daily and Monthly (Temporary) Parking Permit Sales in 2009 and 2012 by Permit Type.
Note. Data collected from the Department of Parking and Transportation, UC Berkeley (2013).

3.1.3 COST OF PARKING FACILITIES

The total capital cost of parking construction on campus is between $33,250 and $76,563 per space, depending on the garage type. Additional operations, maintenance and insurance costs were estimated to be $536 per space per year (Nelson\Nygaard Consulting Associates Inc., 2011). If converted to a total monthly cost, the total cost per space will be between $244 and $544. These cost estimates usually do not include the value of land, which can be as high as $10 million per acre. The high cost of parking construction also does not consider opportunity costs, as land used for parking facilities can be used for other purposes, such as offices, classrooms, research centers, or laboratories. Compared to the prices set for parking permits on campus, as described in Section 3.1.1, the total cost of parking structure clearly exceeds the current price of campus parking.

Annual sales of various parking permits and hourly parking, special event parking fee, parking citations, shuttle fare, student Class Pass transit fee, and AC Transit Bear Pass purchased by campus faculty and staff all contribute to the UC Berkeley Department of Parking and Transportation's revenue. This annual revenue of approximately $13 million (fiscal year 2012) is used to operate and maintain parking facilities and to also support transportation demand management programs. In addition, the Department of Parking and Transportation also has to pay $2.9 million in debt service for existing parking facilities per year (Nelson\Nygaard Consulting Associates Inc., 2011).

By providing low price parking facilities on high cost land, which leads to high parking demand, the campus is catering to the parking preferences of drivers, yet the campus currently only provides limited assistance to employees who choose to use public transportation or who are unable to afford to drive to campus. In other words, drivers who park on campus are enjoying the benefits of low cost parking but non-drivers are not given an equivalent form of transportation benefit. Further, the current fixed parking pricing structure is most advantageous for employees who drive to campus on a daily basis and stay on campus for the whole day, i.e. eight hours or more. It does not cater to the needs of employees who drive alone to campus a few days a week or those who only stay for a few hours a day.

3.1.4 ALTERNATIVE PARKING LOCATIONS

Apart from managing its own parking demand and supply, the University is also under pressure from the City of Berkeley to reduce parking spillover into nearby residential neighborhoods that surround the campus. The City of Berkeley offers unmetered on-street parking spaces in residential neighborhoods surrounding the campus that are free, but subject to a two-hour time limit enforcement for vehicles without a residential permit.

Campus parking facilities are priced at a lower rate than off-campus parking facilities, which serve as alternative parking locations for UC Berkeley employees. Privately owned garages or public parking facilities owned by the City of Berkeley have a daily rate that ranges from $9 to $15 per day, depending on the time of entry, and monthly rates, when available, are between $125 and $170 per month. The City of Berkeley also offers on-street metered parking within

close proximity to the campus at a standard rate of $1.50 per hour. However, certain zones in the City of Berkeley have different hourly parking rates, ranging from $1.25 to $3.50 and have varying time limit enforcements (City of Berkeley, 2014).

Given all these different interests and constraints, it is necessary to revaluate the current parking pricing structure on campus and to create a more efficient and flexible pricing structure that can help better manage parking demand and scarce land resources, and to reduce private vehicle use, energy consumption and emissions levels, without compromising economic revenue. Findings from this study will be able to provide insights to other major employers in urban regions as well.

3.2 EXPLORATORY INTERVIEWS

Interviewing can be described as a basic mode of inquiry (Seidman, 2006). It is the first research method carried out in this dissertation, before conducting a series of focus group discussion sessions and a transportation and parking survey. The purpose of interviewing is to understand valuable lived experience and actions (Van Manen, 1990) of a small sample of UC Berkeley employees to gain a clearer perception of their complex travel decisions, their work schedules and to understand if their travel behavior could be affected by employment type. The data collected were also used to refine questions asked in the focus groups and survey, especially to provide insights to travel alternatives that should be included in the survey.

3.2.1 BACKGROUND AND RATIONALE

Interviewing was carried out to increase the understanding of the context of UC Berkeley employees' travel behavior and how it varies across user groups based on employment type and work schedule. Therefore, it provides the opportunity to understand what their subjective actions mean. Unlike survey methods, where the same questions are asked to each individual, each interview is different as questions are matched to each respondent's unique travel experience, preferences, university affiliation, knowledge, and what each respondent is willing to share. The process of one-on-one interview also creates a different dynamic from focus group discussion sessions, where respondents could affect one another. Interviewing affirms the importance and uniqueness of an individual.

The ultimate goal of the interviews conducted for this study was to examine how the flexibility of work schedule would differ across academic fields and offices, and to identify the characteristics of UC Berkeley employees who are on campus more often than others. Consequently, the preliminary interviews are also expected to provide further understanding as to whether job characteristics, including work schedules, are the only factors affecting the frequency of commute and whether other variables, such as the culture and norms within colleges, professional schools, academic departments, or offices could also be influential.

In this dissertation, the flexibility of work schedule refers to the arrival time of each faculty and staff member, duration, i.e. how many number of hours are they required to be on campus, frequency, i.e. number of days on campus per week, and location, i.e. does an employee have the option to work off-campus. It is hypothesized that different academic disciplines, departments

and offices on campus would have different work schedules or norms for being at work either due to the nature of employment or due to other factors that are not directly relevant to employment type (e.g., managerial preferences, group behavioral norms). It was assumed that different academic fields have different levels of dependence on physical assets and resources that are located on campus, which could affect the ability of faculty and staff to work off campus. It was also assumed that in general, faculty members would have more flexibility in setting their own work schedules and in working off-site than most staff members.

3.2.2 QUESTIONNAIRE STRUCTURE

Although the main purpose of the interviews is not to test any hypotheses, predict or control experiences and actions of respondents (Van Manen, 1990) but to understand them and also to explore what different experiences and actions may imply, five assumptions were drafted to help guide the development of interview questions (Table 3.2). UC Berkeley employees were divided into faculty and staff members for this purpose. There are also different academic fields, job classifications and levels within each category.

An interview guide was created using the assumptions shown in Table 3.2, with a set of specific and focused questions pertaining to each respondent's academic field, type of office or department and work schedule. These questions consisted of main questions, follow-up questions and probes and were modified at each interview based on different responses. While most of the questions in the interview guide were asked to all respondents, the interviews were open-ended, so that additional questions specific to each respondent's circumstances could be added, and questions further exploring respondent's comments could also be included. Main questions were prepared before each interview and they reflect the study's research hypotheses. Follow-up questions were specific to the comments that respondents have made and can achieve depth and clarity when themes, concepts, ideas or even events that the respondents have described have been further explained. Probes, on the other hand, manage interviews by keeping them on topic and again, ensure depth and clarity (Rubin and Rubin, 2005).

Table 3.2. Assumptions for Preliminary Interviews

	Assumption	Faculty	Staff
1.	Flexibility of Work Schedules	Faculty members have irregular and flexible working hours, depending on their teaching load and academic field or department.	University staff members have regular and inflexible working hours, i.e. 9:00AM – 5:00PM, five days a week.
2.	Job Categories and Levels		University staff members with higher job levels have more flexible working hours than lower level staff members.
3.	Academic Disciplines	Faculty members in disciplines (e.g. natural sciences), who have laboratory-based research have more regular and less flexible working hours on campus than faculty in other disciplines that do not rely on resources that are only available on campus.	
4.	Campus Resources	Faculty members who have lab-based jobs or need certain campus resources stay on campus for longer hours than faculty in social sciences and humanities.	University staff members who have lab-based jobs or need certain campus resources stay on campus for longer hours than staff members with office-based jobs.
5.	Summer Schedules	Faculty members have a different work schedule in the summer.	University staff members have the same work schedule in the summer and during the Fall and Spring semesters.

The main interview questions were divided into, 1) job description; 2) work schedule and 3) preferred transportation mode choice. Follow-up and probe questions were focused mainly on participants' attitudes towards telecommuting, official and unofficial policies within their departments or offices on alternative work schedules, resources on campus that are crucial to their work, and their personal experience with different transportation modes. Questions on parking preferences were also asked when applicable. Although every participant was asked the same number of main questions, the number of follow-up and probe questions depends on each individual's responses. The interview guide is provided in Appendix A.

3.2.3 DATA COLLECTION PROCESS

Respondents for the interviews were selected based on University affiliation, job position and nature of employment type, in order to capture the anticipated range of flexibility in work scheduling. They represent different academic fields, disciplines, offices, and university services, which presumably will reflect different work schedules and hence, flexibility of work and travel time. Respondents were recruited from three broad categories of employees, namely faculty, administration and support staff. For faculty members, they were drawn from a range of academic fields to determine if there are disciplinary differences in travel patterns, e.g. the ability to work from home or the need to be physically present in a laboratory. Since UC Berkeley has over 60 academic departments, six main academic fields, as defined by the University was used to sample faculty. These six academic fields are, 1) Arts and Humanities; 2) Biological Sciences; 3) Mathematical and Physical Sciences; 4) Social Sciences; 5) Engineering, and 6) Professional Schools. Staff members were selected from all three official job categories, as defined by UC Berkeley's Human Resources, which include, 1) operational and technical; 2) professional and 3) supervisors and managers.

A list of all faculty members was first compiled using information (e.g. name, department, job title, and e-mail address) available on UC Berkeley's departmental web sites. This sampling method is similar to what Patton (1980) has described as "maximum variation sampling," which is a type of "purposeful sampling" technique that uses a few samples to represent a range of characteristics. Invitations to participate in the interviews were then sent electronically to 315 randomly selected UC Berkeley faculty and staff members across academic fields and departments or offices on campus. Out of the total sample size, 163 invitations were sent to faculty members and 152 to staff members. The response rate for faculty is 26 percent and slightly higher for staff members at 28 percent. Hence, 43 interviews were conducted with faculty (professors, associate professors and assistant professors), while the other half of the interviews were conducted with staff members. Since there are approximately 10 staff members to every faculty member, the faculty members were disproportionately represented here. However, it is important to include at least 40 faculty members in the sample as they are the disproportionate users of central campus parking and also are highly influential stakeholders. A total of 86 in-depth one-on-one interviews with UC Berkeley faculty and staff members were conducted over a period of four months from May to September 2013. Each interview lasted between 30 and 60 minutes, depending on the personal travel and parking experience of each participant, which determined the number of follow-up questions asked.

Respondents in the interviews were not compensated for their time. However, they were informed of the upcoming focus group discussion sessions and transportation and parking survey at the end of the interview, which they could choose to participate in and be compensated for their time and effort.

3.2.4 DATA ANALYSIS

The process of analyzing interview data involves classifying, comparing, weighing, and combining material from the interviews to derive patterns (Rubin and Rubin, 2005). In this

instance, the interviews were analyzed not only to produce findings about travel to campus but also to help structure the focus group discussion sessions and the transportation and parking survey that followed. The analysis of interview data included the preparation of transcripts and extraction of main concepts, themes and events related in the interview. The analysis then proceeded to look both for concepts and themes found in all interviews and differences across interviews.

3.3 FOCUS GROUP DISCUSSION SESSIONS

A series of focus group discussions was carried out after the preliminary interviews were conducted, but before the transportation and parking survey was finalized.

3.3.1 BACKGROUND AND RATIONALE

Unlike one-on-one interviews, focus groups are dynamic and allow group interaction, which encourages participants to share insights and observations (Krueger, 1994). The focus groups were used to explore underlying factors leading to individuals' decisions pertaining to mode choice and parking preferences that cannot be captured by a survey alone, to obtain more detailed information on respondents' attitudes, beliefs and behaviors regarding the quality and price of transportation and parking alternatives, and to gain deeper insights on attributes relevant to parking choices and options.

In the latter regard, the focus groups allowed the improvement of the design of the survey by testing whether the vocabulary, concepts and assumptions used in the survey are clear and easy to understand, as well as to ensure that the survey is as inclusive and comprehensive as possible (Wolff et al., 1993). In this way, the focus group discussion sessions also served as survey pretest sessions, to help uncover faculty and staff members' thinking patterns and present evidence to explain any peculiar results in the survey analysis.

3.3.2 QUESTIONNAIRE STRUCTURE

Every participant was handed a hard copy of a transportation and parking questionnaire at the beginning of each focus group session and was asked to complete it within the first 30 minutes of the meeting. The second part of the focus group consisted of open-ended questions on respondents' opinions of the survey, their primary mode choices and personal experiences with other transportation modes, parking location preferences, as well as their thoughts on parking prices and potential transportation and parking policies. A focus group guide was used but revised from session to session depending on previous comments and analysis.

Specific qualitative research questions that were addressed at the focus group discussions include some of the following shown in Table 3.3. The focus group guide can be found in Appendix B.

Table 3.3. Key Question Type and Examples for Focus Group Discussion Sessions

	Question Type	Example
Part 1	Opinions and Comments on Transportation and Parking Survey	Was the questionnaire too long, confusing, or irrelevant?
Part 2	Travel Options to Campus	How did you travel to campus today? What are your experience with your chosen mode and other alternatives?
	Flexibility of Travel Time and Work Schedule	Do you usually come to campus at the same time every day? Do you work from home sometimes during regular working hours?
	Travel Time and Mode Constraint	Does your travel schedule or transportation mode depend on other family members or events?
Part 3	Driving and Parking	Where do you usually park when you drive to campus?
	Lack of Parking Spaces	Do you find it difficult to find a parking space at your preferred parking location?
	Premium Parking Spaces	Would you be willing to pay more for a guaranteed parking space on campus?
	Discounted Parking Spaces	Would you be willing to pay less for a parking space that is further away from your office building on campus?
	Flexible Parking Pricing	Would you prefer to pay for parking by month or by day?
	Parking Supply and Pricing	Should the University build more parking spaces? How should parking on campus be priced?
Part 4	Other Travel Options	Would you be interested in tracking your own individual carbon emissions?
	Transit Passes	Would you be interested in receiving free AC Transit or BART passes?
	Walking and Biking	Would you be interested in walking or biking as a form of exercise?

3.3.3 DATA COLLECTION PROCESS

A total of 772 invitations to participate in focus groups were sent electronically to UC Berkeley faculty and staff members. The invited 772 employees were selected from a list of faculty and staff members that covers a wide range of departments and offices across campus as defined by UC Berkeley Human Resources (Table 3.4). This list was compiled using existing information available online, through departmental and other university web sites.

Table 3.4. UC Berkeley Workforce Profile

Career Compass Job Field
Communications
Educational Services
Engineering
External Affairs
Facilities Development/EH&S
Finance
General Administration
General Services
Health Care
Human Resources
Information Technology
Library Services
Museum Services
Performing Arts
Research Administration
Research and Laboratory
Security and Public Safety
Skilled Crafts and Trades
Sports and Recreation
Student Services

Source: Workforce Profile, Human Resources (UC Berkeley, 2012a).

Random sampling was deemed to be inappropriate for the focus group discussion sessions as the sample had to include faculty and staff with different travel or parking experiences, across a range of income, work schedule and employment type. Therefore, a list of faculty and staff similar to that created for the individual interviews was used for the recruitment of participants for the focus groups discussion sessions. A total of eight faculty members and 105 staff members from various departments and offices across campus participated in the focus groups.

Since it is easier to facilitate a focus group session where respondents have certain characteristics in common (Krueger, 1994), participants were assigned to sessions according to the participants' university's affiliation, i.e. faculty or staff, department or office, and job position. Care was taken to ensure that there were no superior-subordinate relationships among participants by not grouping any faculty and staff in the same focus group and by not grouping participants from the same academic department or job field in the same focus group discussion session.

Once the departments and offices to be included in each focus group session were identified, one to five participants were then randomly selected within one department or office, depending on its size, i.e. the total number of faculty or staff members hired at that particular department or

office. Participants were first approached via a personalized electronic message. A second personalized invitation letter was then sent electronically to each employee who has agreed to participate, to confirm his or her attendance. A reminder message was also sent to every participant the day before each focus group discussion session.

A total of 10 focus groups were conducted, one with faculty members and nine with staff members, in November and December 2013. Each group had eight to 15 participants and lasted approximately 90 minutes. Participants were each given a $50 American Express gift card for their time and effort at the end of each discussion session. The focus groups were neither video recorded nor audio recorded but at least one note taker was present at each discussion and the moderator has also kept notes on key points made.

3.3.4 DATA ANALYSIS

Analysis of the focus group data started as soon as each focus group discussion session ended, with notes from the focus group summarized and reviewed. When a session revealed a new issue or raised new questions, those issues and questions were included in the guide used to moderate subsequent focus group sessions.

The focus group data collected were used to identify recurring themes or concepts regarding employees' travel and parking behavior. Different pieces of the data were then compared and combined to develop key trends and patterns amongst the participants. Krueger's (1994) seven analysis factors were used as a general guide to develop a systematic and verifiable analysis strategy, 1) words and tone used by respondents and their respective meaning; 2) context of the comments made; 3) internal consistency; 4) frequency or extensiveness of comments; 5) intensity of comments; 6) specificity of responses, and 7) key findings as verified through an accumulation of evidence. The data collected from all 10 groups were analyzed both within a group and amongst all focus groups. The final output is a descriptive statement on key findings that are supported by available evidence.

3.4 TRANSPORTATION AND PARKING SURVEY

A transportation and parking survey was used as the core method in this dissertation to evaluate the potential shifts in transportation mode share and parking behavior across user groups as parking pricing changes. Although UC Berkeley has been conducting campus wide housing and transportation surveys every three years since 1980, new and original data were required to investigate stated preferences with respect to parking price and location.

3.4.1 BACKGROUND AND RATIONALE

The transportation and parking survey has three main sections, 1) revealed preference (RP), 2) stated preference (SP) and 3) socioeconomic and other questions. RP data reflect actual behavior, while SP data imply how respondents would behave under hypothetical scenarios. A SP component was designed for the survey to evaluate the likely shifts in transportation demand and parking behavior across user groups as parking pricing changes.

SP methods used in transportation can be defined as "a family of techniques which use individual respondents' statements about their preferences in a set of transport options to estimate utility functions" (Kroes and Sheldon, 1988, 11). SP methods can be used to obtain sufficient variation to examine all variables of interest, evaluate demand under conditions that have not occurred yet and are not restricted to only evaluating the impact of changes on primary service variables (Kroes and Sheldon, 1988). SP questions were included in the survey because they can provide a parking behavioral context that respondents can relate to and allow the examination of how they would respond to choices that are not yet available, e.g., different packages of parking price and location, together with different incentives.

Since SP methods ask respondents to indicate what they would do under hypothetical scenarios, they may result in findings that do not match realized behavior. To minimize this possibility, the SP questions in the survey were framed in an appropriate context to motivate respondents to respond as realistically as possible. In addition, the use of RP data collected in the survey could also show how both types of behavior would differ.

The SP component of the survey was used to examine how different employees would respond to new parking pricing measures, including price increases for the current parking permits and the creation of new flexible parking permits. However, it is uncertain whether any of these new parking pricing measures will be implemented in the future. Since this dissertation seeks to measure behavioral changes based on parking pricing policies that have not been implemented yet, it is necessary to derive preferences from hypothetical scenarios.

Both RP and SP data were collected from the survey and analyzed using discrete choice analysis. In discrete choice analysis, choice is based on the neoclassical theory of consumer behavior, which assumes individuals to maximize their utilities within their time and income constraints (Varian, 1999). The choice made by each respondent is his or her preference of one alternative relative to each of the other alternatives given in the survey.

The design of the choice set is described in the following section.

3.4.2 QUESTIONNAIRE STRUCTURE

The transportation and parking survey had a total number of 37 questions, though not every question was relevant to all respondents. The minimum number of questions a respondent would be asked was 32. This survey covered topics such as the respondent's personal and household characteristics, job characteristics, work-related travel for a week and parking choices on the day they last commuted to campus, and reactions to a series of parking pricing scenarios, which included transit incentives and other attributes. As described in the previous section, Section 1 of the questionnaire was designed to collect revealed preference data, Section 2 showed five stated preference choice sets and Section 3 included sociodemograhic and other questions pertaining to the respondents' characteristics. An example questionnaire is shown in Appendix C.

SECTION 1

The first section in the questionnaire asked respondents what their primary mode choice for their most recent commute trip to campus was. If they drove, they would then be asked where their parking location was. If they parked on campus, questions on specific campus parking garages and parking permits would be asked. In addition to the primary mode choice for a single day, this section also asked respondents what their mode choices to and from campus were for every day of the week before they took the survey. Other non-transportation related questions but questions relevant to the commute trips made were arrival and departure times to and from the UC Berkeley campus, the availability of off-campus trips made during the day and changes in the respondents' summer schedules.

SECTION 2

The second section of the survey presented stated preference questions in the form of five choice sets. The first question in the choice set was on parking option (Figure 3.4), which is of a higher decision level, followed by a transportation mode choice question (Figure 3.5). Respondents were asked to first consider several parking options, which is to first decide where to park or if they want to park. Every choice set had four parking options, each with four attributes, namely, the cost of parking, the refund if any for days not parked, whether there was a free transit pass provided, and how far a walk the parking was located from the final destination, e.g. primary workplace on campus. A constant fifth option (without any attributes), "None of the Options" was also provided for respondents who did not choose to drive to campus or drive but park elsewhere.

The mode choice question that followed the parking choice question offered 11 modal alternatives (listed in Figure 3.5) for each day of the week in every choice set. The design of the choice set is further explained in the following section.

In the following question, you will be shown four types of parking options and you will be asked to indicate which one of the four options would you choose, assuming that these are the only paid parking options available. *You may select "None of the Options" if you choose not to drive to campus or drive but park elsewhere.*

Option A: A monthly campus parking permit with unlimited access. If you are carpooling, a **carpool** permit costs **34%** of the cost of parking shown in the table below, which is comparable to the current campus parking pricing for each carpool user.
Option B: A monthly restricted campus parking permit for parking **3 days a workweek** (unlimited on weekends). If you are carpooling, a **carpool** permit costs **34%** of the cost of parking shown in the table below, which is comparable to the current campus parking pricing for each carpool user.
Option C: A daily campus parking permit, **without any restriction** on the number of permits that can be purchased annually. Daily permits can be purchased from parking machines at any campus parking garage/lot.
Option D: Hourly parking at an off-campus location with **no time limit enforcement**.

	Option A	Option B	Option C	Option D
Cost of Parking	$99/month	$71/month	$9/day	$1.25/hour
Parking Fee Refund for Days Not Parked	$2/day	0	0	0
Free Monthly Pass for AC Transit and BART	Yes	Yes	No	No
Walking Time from Parking Space to Office	1 min	1 min	18 min	5 min

Which one of the four parking options would you choose?

Option A ○ Option B ○ Option C ○ Option D ○ None of the Options ○

Figure 3.4. An example of a stated preference choice set for parking option.
Note. There were 384 choice sets in total (derived from a full factorial choice experiment based on the number of attributes and their respective levels) and each respondent was shown five randomly selected choice sets. Hence, the values shown in the table changed with each survey. In addition, the combination of the five choice sets was also different for each respondent.

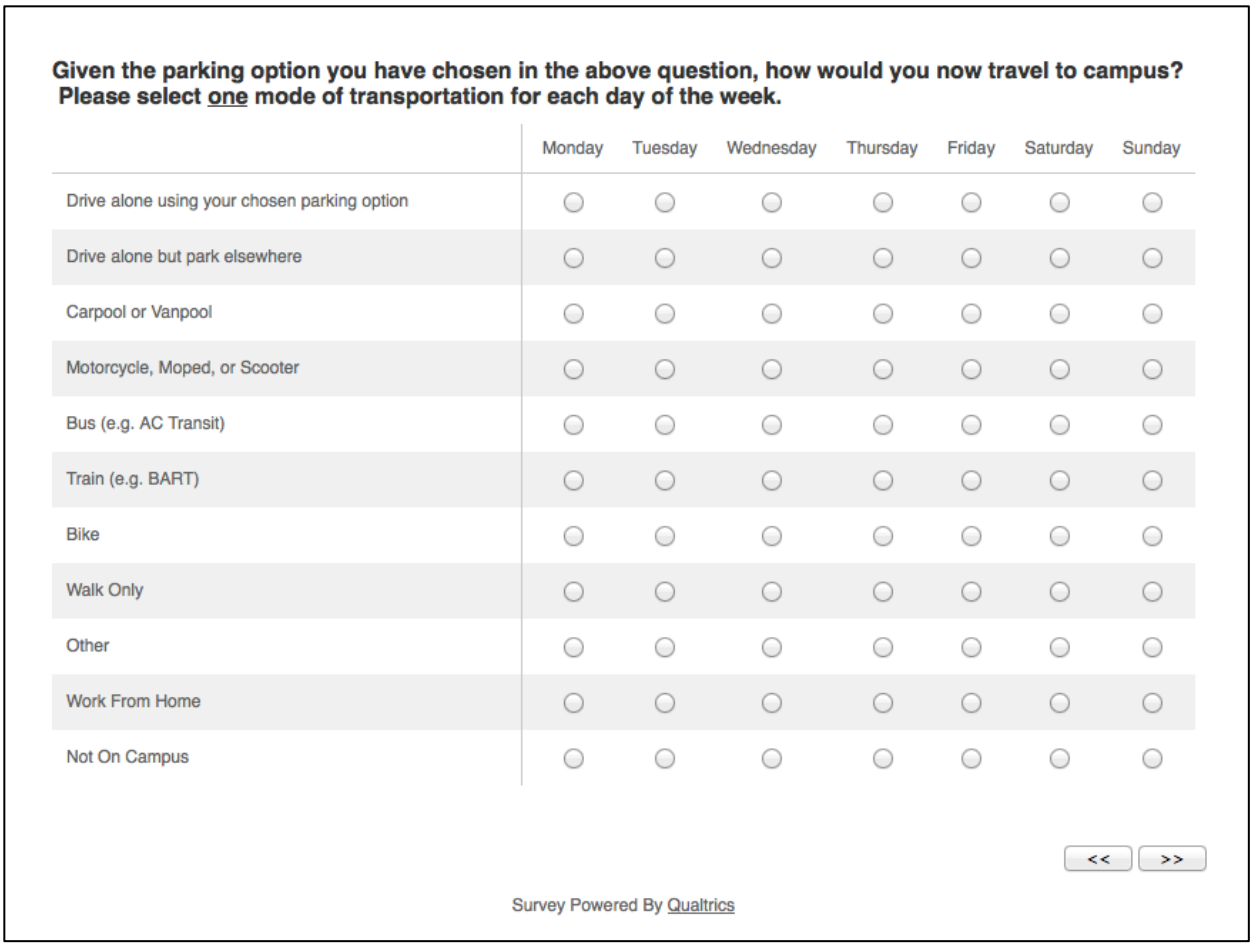

Figure 3.5. Stated preference transportation mode choice question.
Notes. This question did not vary by survey. Each respondent was shown the same transportation mode choice question after each parking option question.

Stated Preference Experiment Design

In stated preference surveys, attributes are specified and given to the respondents, together with their values, which are also called "attribute levels" (Louviere et al., 2000). Figure 3.4 shows an example choice set that includes both attributes and levels. Parking Option A is a conventional campus parking permit choice that offers unlimited parking at a monthly cost, Option B is a restricted monthly campus parking permit that allows for parking three days (B-3) a week or four days (B-4) a week (half of the choice sets had a three day a week parking restriction, while the other half had a four day a week restriction), Option C is a daily parking permit, and Option D is an hourly parking option. The "Parking Fee Refund for Days Not Parked" attribute only applies to Parking Option A, while the "Free Monthly Pass for AC Transit and BART" only applies to Options A and B. Half of the choice sets included in the survey excluded BART in the transit pass attribute to examine the significance of a free BART pass.

The costs of Parking Options B and C were pivoted against Option A to prevent one option from being distinctively more attractive than others. This is also to ensure that the monthly costs of Parking Options B and C will not be higher than the monthly cost of Parking Option A, since the

latter provides unlimited monthly parking. However, if the monthly costs for Options B and C were converted to daily costs, they could be higher or lower than the daily cost for Option A. This was deliberately designed to reflect the current campus parking structure, where annual or month parking permits have a lower daily rate than daily parking permits, as well as to provide new options and variability in the stated preference choice sets.

Values of all attributes were altered under different choice scenarios in the survey and are shown in Table 3.5. They were used to frame the questions in the stated preference part of the survey.

Table 3.5. Attributes and Levels for Stated Preference Choice Sets

Attributes	Levels
Parking Option	A, B, C, D
Cost	Percentage Increase (%):
Parking Option A $90/month (Base Price)	0, 10, 25, 40, 70, 100, 120, 150
Parking Option B-3 (3 days/week parking permit) Pivoted against Option A	Percentage Increase (%): 48, 50, 58, 60, 72, 78, 86, 95
Parking Option B-4 (4 days/week parking permit) Pivoted against Option A	Percentage Increase (%): 60, 65, 74, 80, 86, 89, 93, 97
Parking Option C Pivoted against Option A	Percentage Increase (%): 17, 18, 19, 20, 22, 27, 30, 36
Parking Option D $0.30/hour (Base Price)	Percentage Increase (%): 0, 100, 67, 25, 20, 17, 14, 13
Parking Fee Refund for Days Not Parked	0, $1/day, $2/day
Free Monthly Pass for AC Transit (and BART)	Yes, No
Walking Time from Parking Space to Office	1 min, 3 min, 5 min, 8 min, 10 min, 15 min, 18 min, 20 min

Note. There were eight levels for the cost of each parking option. However, since the costs of Parking Options B and C were pivoted against the cost of Parking Option A, there were 64 (8*8) possible parking costs for Parking Options B and C. The attribute "Parking Fee Refund for Days Not Parked" was only associated with Parking Option A. The availability of a free transit pass was either "Yes" or "No" regardless of whether it included BART or not. Half of the surveys had a free monthly transit pass for AC Transit and BART, while the other half excluded BART. This attribute was only associated with Parking Options A and B.

As shown in Table 3.5, eight levels were created for the price of each parking option (8), three levels for the parking fee refund attribute (3), two levels for the availability of a free transit pass (2), and eight levels for walking time (8). Since the costs of Parking Options B and C were pivoted against the cost of Parking Option A, there were 64 (8*8) possible parking costs for

Parking Options B and C. A detailed explanation of the cost categories of each parking option can be found in Appendix D. Based on the number of attributes and their respective levels, the total number of choice sets created using a full factorial experimental design was 384 ((8^2)*3*2). The profile combinations are orthogonal if every possible combination of the various attributes and their levels only occur exactly once (Street and Street, 1987). The full set of profile combinations is presented in Appendix E. While the number of choice sets shown to survey respondents could range from one to 20 or more (Bliemer and Rose, 2011), each respondent in this study was shown five randomly selected choice sets out of 384 possible choice sets to reduce the respondent's burden.

SECTION 3

The last section in the survey included socioeconomic and other questions pertaining to UC Berkeley affiliation, Lawrence Berkeley National Laboratory (LBNL) affiliation, the availability of a second office off or on campus, office location on campus (building name), vehicle accessibility (car, motorcycle and bicycle), and the ownership of a valid driver's license. Since LBNL affiliated faculty and staff members are eligible for free parking at their own parking lots, the question on LBNL affiliation was included to determine the possibility of free alternative parking off central campus. Specific socioeconomic questions included in the survey were on the number of household members, number of dependents, gender, age, highest education level obtained, annual household income level, and the type of smart phones used. Smart phones could be used to pay for parking on campus in the near future, which explains the smart phone question in this section. It is important to know the percentage of smart phone usage amongst UC Berkeley employees and what kind of smart phones do they use in order to develop appropriate technology (e.g. electronic gates and sensors at campus parking locations) and software for a smart phone parking application.

The final question in the survey was an open-ended question that asked for respondents' comments on the survey, parking pricing, or their travel behavior.

3.4.3 DATA COLLECTION PROCESS

There are several different ways to define the sample size for discrete choice research methods but there is no well-established sample size calculation (Louviere et al., 2000; Ben-Akiva and Lerman, 1985) and in general, it is best to have as many observations as possible to ensure reliable parameter estimates, as long as there are at least 30 observations for each alternative (McFadden, 1974). The sample size also depends on the total number of choice sets to be tested and how many of these choice sets will each respondent get in his or her own version of the questionnaire. While the number of choice sets shown to respondents could range from one to 20 or more (Bliemer and Rose, 2011), a decision was made to show only five choice scenarios to each respondent to avoid overburdening the respondents, which could lead to nonresponse or to less thoughtful responses.

Since this dissertation is focused on how UC Berkeley employees will respond to changes in parking pricing, transit options and incentives, prospective survey respondents had to be either a University staff or faculty member.

The questionnaire was pretested twice with a total of 18 UC Berkeley affiliates and subsequently revised each time based on the comments received. The final draft of the survey was then pretested by the 113 focus group participants, who were asked not only to fill it out but also to comment on the logic, concepts, vocabulary, assumptions, and choices presented in the questionnaire. Based on comments received, the survey was then revised a final time. A Monte Carlo simulation exercise was also conducted based on the stated preference choice sets, to test and ensure that the survey design would be able to estimate the choice models to be developed, before the final survey was mailed out.

Qualtrics, a web-based survey service, was used to create the online version of the survey.

The recruitment of respondents was done electronically. The UC Berkeley Associate Vice Chancellor of Business and Administrative Services mailed the link of the survey in a cover letter using CAL Messages, a campus-wide messaging service, to all UC Berkeley faculty and staff population with electronic mail accounts. The invitation to participate in the survey was mailed electronically during the second week of December 2013, and a reminder electronic message was sent to the same population a week after the first survey invitation was sent.

Survey respondents were not compensated for their time for completing the survey but each of them had a chance to win one of 25 $50 American Express gift cards. All focus group participants were informed before the formal survey invitation letter was mailed electronically to the campus faculty and staff population and were asked not to participate in the survey, so as to avoid any survey bias.

According to the most recent UC Berkeley Work Force Census, there were 14,286 paid employees, excluding student employees, in 2012 (UC Berkeley, 2012b). It is known that some UC Berkeley employees, mostly in the custodial, food services, groundskeeping and maintenance titles, do not have University e-mail accounts. Therefore, it is estimated that the survey was mailed electronically to approximately 12,000 employees. The total number of employees who responded to the survey was 4,188, implying that the response rate was approximately 35 percent (margin of error of ±1.22 percent significant at the 95 percent confidence interval). Out of all the 4,188 survey responses, 3,210 surveys were fully completed, i.e. the respondent responded to every question through the end of the survey. Approximately 10 percent of the respondents only answered one question before quitting the survey.

3.4.4 DATA ANALYSIS

The survey data were used to estimate disaggregate mode choice and parking choice models, which not only show formally how the various price, location and incentives options affect travel behavior but also allow the testing of additional options. Disaggregate demand models can capture the variation in individual characteristics and do not assume homogeneity among different consumers (Manheim, 1979, Ben-Akiva and Lerman, 1985) and can include a large set of transportation attributes (Small and Winston, 1999). Disaggregate models are sometimes also known as behavioral models because they depict individual travel choices (Small and Verhoef, 2007) and can explain behavior directly at the level of a person, household or firm. Since these

models often analyze choices among discrete and not continuous alternatives, they are also known as discrete choice models.

Disaggregate models are based on utility functions with a random component, which can be incorporated in the utility function as a random variable, representing the probabilistic error (McFadden, 1974). The addition of this random variable makes it less certain to know what the individual's choice will be as it is not known for sure what values of utility will this individual attach to each choice. Hence, only the probability that this individual will choose a particular alternative can be estimated (Manheim, 1979). A discrete choice model can range from a simple model with just two alternatives, i.e. binary choice model, to something more advanced such as nested logit and mixed logit models, which account for the multidimensional choice sets, where alternatives are combinations of underlying choice dimensions. For example, mode choices could be made jointly with other travel-related decisions, such as destination choice (e.g. for shopping trips). Nested logit models allow analyses of alternatives that are closely related by accounting for within-group correlation of errors and have a closed form probability function that includes a conditional probability and marginal probability.

A more detailed description of the discrete choice analysis and choice models can be found in Chapter 5.

CHAPTER 4

THE UNIVERSITY OF CALIFORNIA BERKELEY: TRANSPORTATION AND PARKING CHOICES

This chapter presents an overview of the UC Berkeley campus and its transportation options and policies, and then presents data on travel choices by faculty and staff employees based on the data collected from the transportation and parking survey conducted for the purpose of this dissertation research.

4.1 OVERVIEW OF THE STUDY AREA

The UC Berkeley campus was used for this study to assess the impact of parking pricing on transportation mode choice and behavior. The UC Berkeley campus is one of the largest employers and trip generators in the San Francisco Bay Area region, with more than 36,000 students, 1,377 faculty members, and more than 12,000 staff (UCOP, 2011; UCOP, 2012; UC Berkeley, 2012b). UC Berkeley has kept private vehicle use at a relatively low level through the provision of moderate parking pricing, promotion of regional transit services, discounted transit passes for employees, and ample bike parking. For example, pre-paid AC Transit passes (Bear Pass), which offer unlimited bus rides, are available for employees to purchase at a subsidized rate of $34 per month. A small discount ($10) is also available for BART passes (Clipper Card) purchased through the UC Berkeley Department of Parking and Transportation.

In addition, the University has partnered with car sharing service providers, such as City CarShare, Zipcar and Enterprise Rent-a-Car to provide car sharing services on campus and in the surrounding areas close to campus in the City of Berkeley. One benefit of access to car sharing is that employees who need a car for a short trip can participate in the program rather than use their own vehicle. These car sharing services are provided to all University affiliates (students, faculty and staff) at a discounted rate, apart from City CarShare who only offers student discounted rates. Vehicles in such car sharing services are parked close to campus. Free shuttle services (BearTransit) are also provided between campus and Downtown Berkeley, as well as parking lots and residence halls, starting as early as 6:45AM and ending as late as 2:00AM. The shuttles, as well as transit subsidies, must be covered from the Department of Parking and Transportation's revenues, so increases in incentives would have to come from parking fee increases.

The transportation mode choice of UC employees could also be a reflection of their housing location decisions. Many employees live relatively close to campus and in neighborhoods with relatively good peak period transit services. The campus is situated in an area that is well served by public transportation services, including AC Transit, which is a bus network serving the Western portions of Alameda and Contra Costa counties, and the Bay Area Rapid Transit (BART) with regional train stations serving Alameda, Contra Costa, San Francisco, and San Mateo counties.

4.2 DATA ANALYSIS AND DATA SUMMARY

Analysis of the survey data included the examination of the distribution of each variable and the cross tabulation of categorical (nominal or ordinal) data, in order to search for patterns of interaction and to identify relationships between variables. Cross tabulation allows the observation of how the frequency distribution of one variable relates to another. The data analysis conducted is categorized by transportation mode choice and parking preference, i.e. how does each of the two independent variables vary across user groups.

Chi-square (X^2) goodness of fit statistical tests were produced for each cross tabulation. The measures of association are also produced using the eta statistic to show the coefficient of the strength of association for nominal variables and tau for ordinal variables. All cross tabulations show strong relationships with $p = 0.00$, except for parking location choice and total annual household income, where $p = 0.05$, which is still significant. All the cross tabulations and statistical tests presented in this chapter were conducted using SPSS.

The descriptive statistics of selected socioeconomic variables are shown in Table 4.1, while the summary of the full set of variables is shown in Appendix F.

4.2.1 DISTRIBUTION OF VARIABLES

The distributions of key socioeconomic variables are described in this section. Staff members constituted 80 percent of the total number of survey respondents, while the rest were faculty members. This composition is comparable to the actual percentages of faculty (17 percent) and staff (83 percent) members as recorded in the Fall 2012 UC Berkeley Workforce Census (UC Berkeley, 2012b). In fact, faculty members were slightly over sampled by 3 percent. Faculty members include "Professor/Associate Professor," "Assistant Professor," "Adjunct Professor," "Visiting Faculty/Scholar," "Lecturer," and "Other Faculty/Academic" positions, which include emeriti professors. These categories are grouped as "Faculty" because of their relative flexible work schedules compared to regular staff members. As for the different employment categories of staff members, "Professional Staff" and "Staff (classified and represented)" combined have the highest response rate (77 percent, excluding faculty employment categories), which is representative of the actual UC Berkeley workforce profile for these two categories. However, the "Management and Senior Professionals/Senior Management Group" category was under sampled at approximately 10 percent (excluding faculty employment categories), as this category was approximately 14 percent of the total UC Berkeley workforce in 2010 (UCOP, 2010).

Specific job categories were included in the survey to determine university affiliation. Out of all the survey respondents, 80 percent are staff members, while 20 percent are faculty members. For the purpose of this study, faculty members include academic positions that are relatively more flexible than positions held by staff members and hence, will not be restricted to the conventional definition of members of the academic senate. Therefore, the category of faculty members include "Professor/Associate Professor," "Assistant Professor," "Adjunct Professor," "Visiting Faculty/Scholar," "Lecturer," and "Other Faculty/Academic" positions, which include emeriti

professors. At 32 percent, professional staff is the largest job category in the survey sample (Table 4.1).

The gender composition is slightly biased towards female employees, as 62 percent of the respondents are female, while 38 percent are male (Table 4.1). However, according to the UC Berkeley Human Resources, as of Fall 2012, 58 percent of the workforce is female, while 42 percent is male (UC Berkeley, 2012a). Therefore, the gender split of the respondents is still relatively comparable to the actual workforce profile. The survey results for age have a similar distribution to actual workforce profile too, where the largest age group is from 50 to 59, followed by 40 to 49. However, the survey has a larger 30 to 39 age group (25 percent) than the actual workforce (20 percent).

The majority of the respondents (40 percent) live in households with two members including themselves, while 22 percent live in one-member households, 34 percent in three to four member households, and four percent live in five to six member households (Table 4.1). Most of the respondents (64 percent) do not have any dependents who would require their transportation assistance, while 33 percent have either one or two dependents. The survey sample is highly educated, with 88 percent of the respondents having at least a four-year college degree and 50 percent having a Masters or Doctoral degree. The largest income group sampled is between $50,000 and $89,999 (30 percent), followed by $90,000 to $119,999 (15 percent). Approximately two percent of the respondents reported having a household income of under $30,000, 13 percent of the respondents reported a household income of less than $50,000, while 36 percent reported having a household income of $120,000 or greater (Table 4.1).

Table 4.1. Frequency Distributions of Selected Variables in Survey

Variable	Count	Percent	Total Responses
University Affiliation			**3,253**
Professor / Associate Professor	252	7.75%	
Assistant Professor	41	1.26%	
Adjunct Professor	20	0.61%	
Visiting Faculty / Scholar	17	0.52%	
Lecturer	97	2.98%	
Other Faculty / Academic	232	6.39%	
Management and Senior Professionals / Senior Management Group	251	7.72%	
Professional Staff	1,121	32.06%	
Operational / Technical Staff	130	4.00%	
Staff (classified and represented)	872	26.81%	
Contract	34	1.05%	
Postdoctoral Scholar	186	5.72%	
Number of Household Members			**3,218**
1	698	21.69%	
2	1,296	40.27%	
3 - 4	1,091	33.90%	
5 - 6	117	3.64%	

More than 6	16	0.50%	
Number of Dependents			**3,211**
0	2,048	63.78%	
1	600	18.69%	
2	436	13.58%	
3 - 4	115	3.58%	
5 - 6	11	0.34%	
More than 6	1	0.03%	
Gender			**3,201**
Male	1,222	38.18%	
Female	1,979	61.82%	
Age			**3,196**
Under 21	2	0.06%	
21 - 29	425	13.30%	
30 - 39	787	24.62%	
40 - 49	665	20.81%	
50 - 59	793	24.81%	
60 - 69	408	12.77%	
70 and over	116	3.63%	
Education			**3,208**
Less than High School	0	0.00%	
High School / GED	32	1.00%	
Some College	209	6.51%	
2-year College Degree	114	3.55%	
4-year College Degree	1,100	34.29%	
Masters Degree	814	25.37%	
Doctoral Degree	798	24.88%	
Professional Degree (e.g. JD, MD)	141	4.40%	
Annual Household Income			**3,166**
Under $30,000	53	1.67%	
$30,000 - $49,999	341	10.77%	
$50,000 - $89,999	954	30.13%	
$90,000 - $119,999	486	15.35%	
$120,000 - $149,999	337	10.64%	
$150,000 - $179,999	242	7.64%	
$180,000 - $199,999	148	4.67%	
$200,000 - $249,999	180	5.69%	
$250,000 - $299,999	89	2.81%	
$300,000 and over	105	3.32%	
I prefer not to answer	231	7.30%	

4.3 TRANSPORTATION MODE CHOICE

Using data collected from the transportation and parking survey conducted in December 2013, it was found that on a randomly selected day, 49 percent of the respondents drove alone to campus, seven percent carpooled, 23 percent used public transportation, and 16 percent used non-motorized transportation modes, i.e. bicycling and walking (Figure 4.1). The percentages of these mode choices are slightly different from the 2012 official UC Berkeley Housing and Transportation Survey. The percentage of employees who drive alone to campus has increased since 2009, as the percentage of employees who drove alone was 44 percent in 2012 (UC Berkeley, 2012c) and 42 percent in 2009 (UC Berkeley, 2010). The percentage of employees who use public transportation as a primary mode is similar to what was found in the 2012 survey (22 percent in 2012). Out of all the public transportation users surveyed by the campus in 2012, 41 percent indicated that they used BART all the time or occasionally, while 43 percent of the respondents selected AC Transit (UC Berkeley, 2012c). However, bus ridership (seven percent) reported in this study's survey is much lower than train ridership (16 percent). This could be due to the differences in how the questions were phrased in both surveys. The transportation and parking survey in this study asked for one primary mode choice for a specific day, while the UC Berkeley 2012 official survey asked for the type of public transportation mode choices usually used for a typical week in the semester, where there could be more than one selection. The percentages of faculty and staff who carpooled (11 percent in 2012, 7 percent in this study) and used non-motorized transportation modes (20 percent in 2012, 16 percent in this study) were higher in the 2012 UC Berkeley Housing and Transportation Survey than reported in this study's survey.

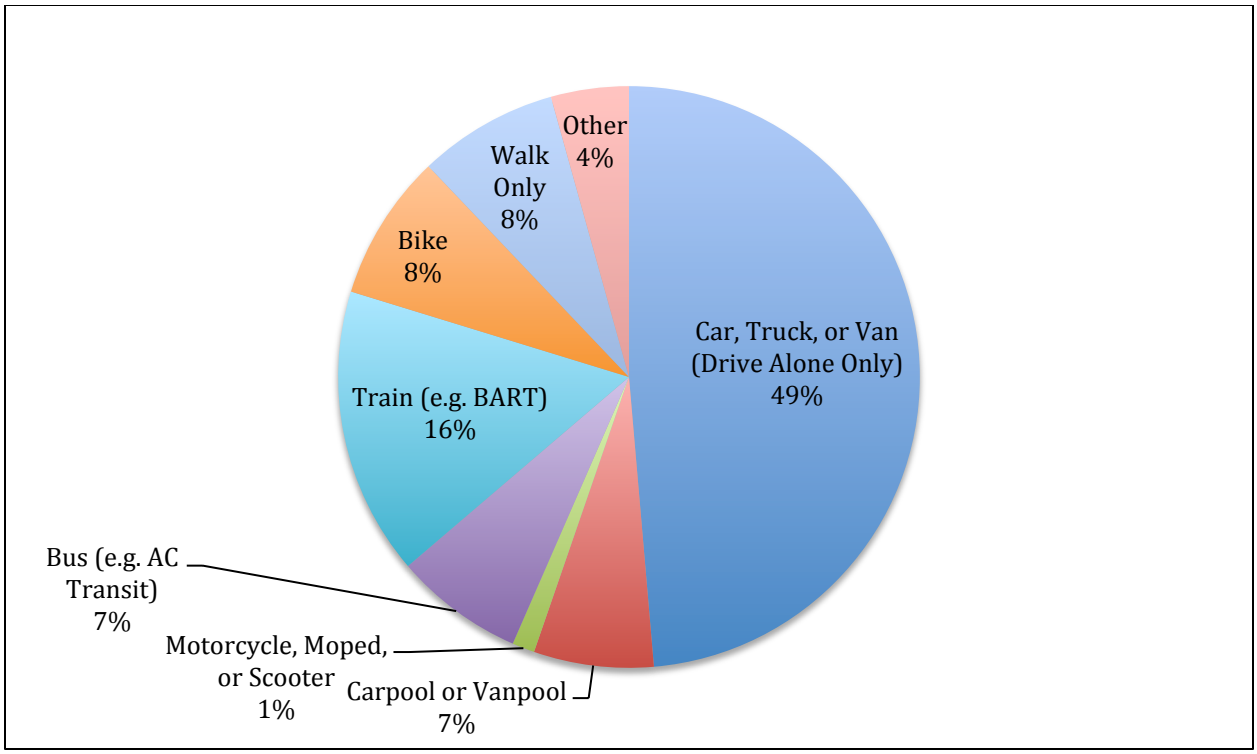

Figure 4.1. The primary transportation mode choice on the most recent commute trip to the UC Berkeley campus (n = 3,767).

Note. The "Other" category (four percent) includes being dropped off, traveling equal distances on more than one transportation mode, using a combination of different modes, and using campus shuttles or UC Berkeley shared vehicles to travel to campus.

The survey also asked for transportation mode choices of each day of the week before the respondents took the survey. In order to compare these two types of mode choice data sets, the alternatives "Work at home" and "Not on campus" that were included in the weeklong mode choice question were omitted in Figure 4.2. The mode shares for a five-day workweek (Figure 4.2) are almost identical to the primary transportation mode choice shown in Figure 4.1, with a one percent difference for most modes. Driving alone is still the dominant mode, constituting 48 percent of the total mode share, public transportation is 24 percent and non-motorized transportation mode share equals 17 percent. Data collected from the primary mode choice question are therefore a good representation of the most commonly used transportation mode.

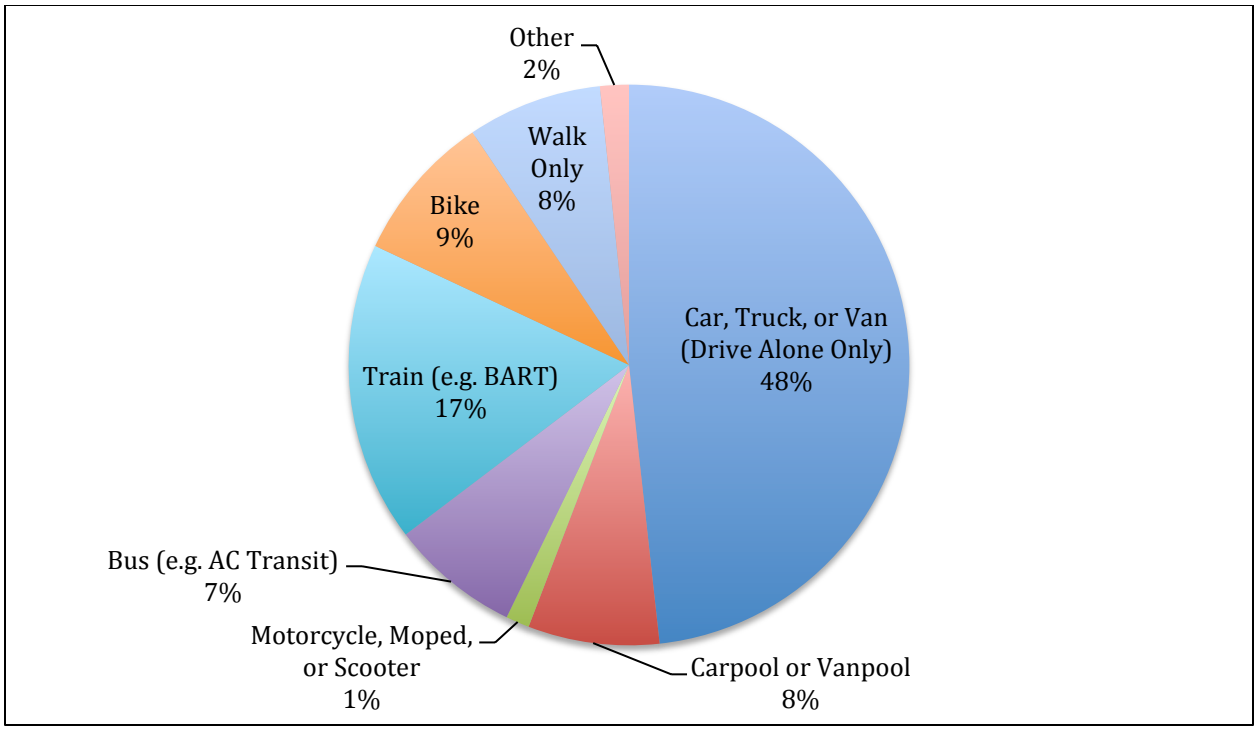

Figure 4.2. Transportation mode choice for a five-day workweek, excluding "Work at home" and "Not on campus" alternatives.

Note. The total responses are 3,596, 3,591, 3,595, 3,589, and 3,592 for Monday, Tuesday, Wednesday, Thursday, and Friday respectively. The "Other" category (four percent) includes being dropped off, traveling equal distances on more than one transportation mode, using a combination of different modes, and using campus shuttles or UC Berkeley shared vehicles to travel to campus.

Most of the survey respondents (77 percent) reported using the same transportation mode for all five days of the workweek, while the rest use a combination of different modes on different days of the week. The survey results show that the majority of the respondents who choose to drive to campus drive five days of the workweek (48 percent), but a significant number of them drive occasionally. Table 4.2 shows the driving frequency of all respondents, excluding non-drivers.

Table 4.2. Driving Frequency for a Five-Day Workweek

Driving Frequency (Number of Days per Week)	Number of Respondents	Percentage (%)
1	331	17
2	217	11
3	188	10
4	258	13
5	931	48
Total	**1925**	**100**

Cross tabulation results show that arrival and departure times seem to affect transportation mode choice. The later the arrival time, the higher the percentage of employees drive alone to campus,

while the percentages of employees who use train are higher in the morning, i.e. anytime before 12:00PM. Higher percentages of carpoolers arrive earlier in the morning, between "Before 7:00AM" and "8:00 – 8:59AM" (Table 4.3). Departure time has a greater impact on train ridership than any other modes. The percentage of employees who ride the train after work decreases as the departure time increases. Most train users depart from the campus between 4:00PM and 5:59PM (Table 4.4). This is the only mode choice that has an uneven distribution based on departure time. All other transportation mode choices have similar percentages of use regardless of departure time (Table 4.4).

Employees in the job categories "Operational / Technical Staff" and "Postdoctoral Scholar" drive less than employees in other job categories. Employees from the "MSP / SMG" (Managerial Management and Senior Professionals / Senior Management Group) category drive the most, followed by employees in the "Other Faculty / Academic" and "Professor / Associate Professor" categories. Carpoolers are mostly from "MSP / SMG" and "Postdoctoral Scholar" job categories, while the highest percentage of employees who ride motorcycles to campus are from the "Operational / Technical Staff" category. Although most postdoctoral scholars drive alone to campus, they also have the highest bus, biking and walking mode shares across all University affiliation categories. Assistant professors form the second largest group of bus users (Table 4.5).

More male employees use train as their primary transportation mode choice than female employees, while more female employees use the bus (Table 4.6). Male employees also bike and walk more than female employees. More employees from younger age groups use the bus, bike or walk to campus than employees from older age groups. However, a similar percentage of employees from all age groups use the train, except for the "70 and over" age group, which has the lowest share. Employees from the "21 – 29" age category has the highest walking and biking mode shares (16 percent and 11 percent respectively) across all age categories (Table 4.7).

More employees in higher household income categories drive to campus than employees in lower income groups (Table 4.8). Carpooling and biking do not appear to be related to income, as there are no substantial differences in the percentages of employees who carpool or bike across all income categories. On the other hand, the number of employees who use the bus is significantly higher for lower income groups than higher income groups (Table 4.8). This is different for the use of train, which is relatively evenly distributed across all income categories under the "$180,000 - $199,999" category. The percentages of respondents who use the train start to decline for all income categories above "$180,000 - $199,999." Most of the respondents who walk to campus are in the "Under $29,999" (26 percent) and "$30,000 - $49,000" (13 percent) income categories. However, it is shown that 10 percent of the respondents who walk to campus also fall under the "$300,000 and over" income category.

Table 4.3. Transportation Mode Choice by Arrival Time to Campus (n = 3,665)

	Arrival Time on Campus											
Primary Transportation Mode Choice	**Before 7:00AM**	**7:00 - 7:59AM**	**8:00 - 8:59AM**	**9:00 - 9:59AM**	**10:00 - 10:59AM**	**11:00 - 11:59AM**	**12:00 - 12:59PM**	**1:00 - 1:59PM**	**2:00 - 2:59PM**	**3:00 - 3:59PM**	**4:00 - 4:59PM**	Total
Car, Truck, or Van (Drive Alone Only)	135	380	614	347	121	61	31	42	25	20	8	1784
	60%	50%	45%	46%	49%	54%	48%	58%	58%	77%	89%	49%
Carpool or Vanpool	17	70	104	34	10	4	3	2	2	0	0	246
	8%	9%	8%	5%	4%	4%	5%	3%	5%	0%	0%	7%
Motorcycle, Moped, or Scooter	3	8	14	13	1	3	1	1	1	0	0	45
	1%	1%	1%	2%	0%	3%	2%	1%	2%	0%	0%	1%
Bus (e.g. AC Transit)	9	54	107	61	15	6	0	6	2	1	0	261
	4%	7%	8%	8%	6%	5%	0%	8%	5%	4%	0%	7%
Train (e.g. BART)	41	142	235	116	32	16	5	2	2	2	1	594
	18%	19%	17%	15%	13%	14%	8%	3%	5%	8%	11%	16%
Bike	6	32	125	74	32	9	12	4	3	3	0	300
	3%	4%	9%	10%	13%	8%	19%	6%	7%	12%	0%	8%
Walk Only	6	39	103	74	27	9	11	12	7	0	0	288
	3%	5%	8%	10%	11%	8%	17%	17%	16%	0%	0%	8%
Other[a]	9	38	51	31	7	6	1	3	1	0	0	147
	4%	5%	4%	4%	3%	5%	2%	4%	2%	0%	0%	4%
Total	226	763	1353	750	245	114	64	72	43	26	9	3665
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note. Since only 32 employees who responded to the survey (0.9 percent) reported arriving on campus after 5:00P, this table only shows arrival time to campus before 5:00PM.

[a]The "Other" mode choice category includes being dropped off, traveling equal distances on more than one transportation mode, using a combination of different modes, and using campus shuttles or UC Berkeley shared vehicles to travel to campus.

Summary Statistics.

$X^2 = (105, n = 3{,}665) = 245.39$, $p = 0.00$

Eta Mode Choice = 0.10

Eta Arrival Time = 0.13

Table 4.4. Transportation Mode Choice by Departure Time from Campus (n = 3,574)

	Departure Time from Campus											
Primary Transportation Mode Choice	**11:00 - 11:59AM**	**12:00 - 12:59PM**	**1:00 - 1:59PM**	**2:00 - 2:59PM**	**3:00 - 3:59PM**	**4:00 - 4:59PM**	**5:00 - 5:59PM**	**6:00 - 6:59PM**	**7:00 - 7:59PM**	**8:00 - 9:00PM**	**After 9:00PM**	Total
Car, Truck, or Van (Drive Alone Only)	26	31	27	66	122	389	646	294	86	31	39	1757
	79%	56%	49%	69%	54%	53%	44%	51%	50%	46%	53%	49%
Carpool or Vanpool	2	0	1	3	20	62	111	29	7	3	2	240
	6%	0%	2%	3%	9%	8%	8%	5%	4%	4%	3%	7%
Motorcycle, Moped, or Scooter	0	1	0	1	4	7	19	6	3	1	4	46
	0%	2%	0%	1%	2%	1%	1%	1%	2%	1%	5%	1%
Bus (e.g. AC Transit)	2	6	2	4	12	37	127	42	16	3	5	256
	6%	11%	4%	4%	5%	5%	9%	7%	9%	4%	7%	7%
Train (e.g. BART)	1	4	5	6	38	132	269	82	19	9	6	571
	3%	7%	9%	6%	17%	18%	18%	14%	11%	13%	8%	16%
Bike	0	2	8	8	10	46	115	62	22	5	11	289
	0%	4%	15%	8%	4%	6%	8%	11%	13%	7%	15%	8%
Walk Only	0	10	8	2	12	31	130	44	17	11	6	271
	0%	18%	15%	2%	5%	4%	9%	8%	10%	16%	8%	8%
Other[a]	2	1	4	5	7	33	61	23	3	4	1	144
	6%	2%	7%	5%	3%	4%	4%	4%	2%	6%	1%	4%
Total	33	55	55	95	225	737	1478	582	173	67	74	3574
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note. Only departure times from campus after 11:00AM are shown in this table.

[a]The "Other" mode choice category includes being dropped off, traveling equal distances on more than one transportation mode, using a combination of different modes, and using campus shuttles or UC Berkeley shared vehicles to travel to campus.

Summary Statistics.

$X^2 = (105, n = 3,574) = 224.13$, $p = 0.00$

Eta Mode Choice = 0.13

Eta Departure Time = 0.05

Table 4.5. Transportation Mode Choice by University Affiliation (n = 3,253)

	UC Berkeley Affiliation											
Primary Transportation Mode Choice	**Professor / Associate Professor**	**Assistant Professor**	**Adjunct Professor**	**Other Faculty / Academic[b]**	**MSP / SMG[c]**	**Professional Staff**	**Operational / Technical Staff**	**Staff (classified & represented)**	**Contract**	**Postdoctoral Scholar**	**Other[d]**	Total
Car, Truck, or Van (Drive Alone Only)	139	19	10	187	151	539	50	403	19	35	51	1603
	55%	46%	50%	58%	60%	52%	38%	46%	56%	19%	50%	49%
Carpool or Vanpool	10	2	1	10	21	82	5	54	1	15	6	207
	4%	5%	5%	3%	8%	8%	4%	6%	3%	8%	6%	6%
Motorcycle, Moped, or Scooter	5	1	0	6	2	12	7	6	0	1	1	41
	2%	2%	0%	2%	1%	1%	5%	1%	0%	1%	1%	1%
Bus (e.g. AC Transit)	7	5	1	14	17	70	4	77	3	31	6	235
	3%	12%	5%	4%	7%	7%	3%	9%	9%	17%	6%	7%
Train (e.g. BART)	19	3	4	36	33	176	40	161	7	28	18	525
	8%	7%	20%	11%	13%	17%	31%	18%	21%	15%	18%	16%
Bike	40	6	2	38	10	70	10	56	2	39	5	278
	16%	15%	10%	12%	4%	7%	8%	6%	6%	21%	5%	9%
Walk Only	27	5	0	24	11	52	7	67	2	35	8	238
	11%	12%	0%	7%	4%	5%	5%	8%	6%	19%	8%	7%
Other[a]	5	0	2	7	6	42	7	48	0	2	7	126
	2%	0%	10%	2%	2%	4%	5%	6%	0%	1%	7%	4%
Total	252	41	20	322	251	1043	130	872	34	186	102	3253
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note. [a]The "Other" mode choice category includes being dropped off, traveling equal distances on more than one transportation mode, using a combination of different modes, and using campus shuttles or UC Berkeley shared vehicles to travel to campus. [b]The category "Other Faculty / Academic" includes visiting faculty, scholars, lecturers, emeriti professors, and UC Berkeley extension. [c]MSP is Management and Senior Professionals and SMG is Senior Management Group. [d]The "Other" University affiliation category includes survey respondents who hold dual or multiple positions, recalled retirees and respondents who are unsure of their job category. This is a relatively small percentage of respondents, constituting three percent of the total number of respondents.

Summary Statistics.

$X^2 = (84, n = 3,253) = 342.30, p = 0.00$

Eta Mode Choice = 0.18

Eta University Affiliation = 0.15

Table 4.6. Transportation Mode Choice by Gender (n = 3,201)

	Gender		
Primary Transportation Mode Choice	**Male**	**Female**	Total
Car, Truck, or Van (Drive Alone Only)	542	1030	1572
	44%	52%	49%
Carpool or Vanpool	74	132	206
	6%	7%	6%
Motorcycle, Moped, or Scooter	25	16	41
	2%	1%	1%
Bus (e.g. AC Transit)	77	154	231
	6%	8%	7%
Train (e.g. BART)	215	296	511
	18%	15%	16%
Bike	155	124	279
	13%	6%	9%
Walk Only	100	135	235
	8%	7%	7%
Other[a]	34	92	126
	3%	5%	4%
Total	1222	1979	3201
	100%	100%	100%

Note. [a]The "Other" mode choice category includes being dropped off, traveling equal distances on more than one transportation mode, using a combination of different modes, and using campus shuttles or UC Berkeley shared vehicles to travel to campus.
Summary Statistics.
$X^2 = (7, n = 3,201) = 68.47, p = 0.00$
Eta Mode Choice = 0.07
Eta Gender = 0.15

Table 4.7. Transportation Mode Choice by Age (n = 3,196)

	Age							
Primary Transportation Mode Choice	**Under 21**	**21 - 29**	**30 - 39**	**40 - 49**	**50 - 59**	**60 - 69**	**70 and over**	Total
Car, Truck, or Van (Drive Alone Only)	2	142	340	362	416	222	85	1569
	100%	33%	43%	54%	52%	54%	73%	49%
Carpool or Vanpool	0	26	66	32	56	22	3	205
	0%	6%	8%	5%	7%	5%	3%	6%
Motorcycle, Moped, or Scooter	0	4	10	10	13	4	0	41
	0%	1%	1%	2%	2%	1%	0%	1%
Bus (e.g. AC Transit)	0	51	71	36	49	22	2	231
	0%	12%	9%	5%	6%	5%	2%	7%
Train (e.g. BART)	0	78	135	106	117	65	9	510
	0%	18%	17%	16%	15%	16%	8%	16%
Bike	0	45	80	59	68	24	2	278
	0%	11%	10%	9%	9%	6%	2%	9%
Walk Only	0	67	65	37	32	28	8	237
	0%	16%	8%	6%	4%	7%	7%	7%
Other[a]	0	12	20	23	42	21	7	125
	0%	3%	3%	3%	5%	5%	6%	4%
Total	2	425	787	665	793	408	116	3196
	100%	100%	100%	100%	100%	100%	100%	100%

Note. [a]The "Other" mode choice category includes being dropped off, traveling equal distances on more than one transportation mode, using a combination of different modes, and using campus shuttles or UC Berkeley shared vehicles to travel to campus.

Summary Statistics.

$X^2 = (42, n = 3,196) = 183.43$, $p = 0.00$

Kendall's tau-c = -0.10, $p = 0.00$

Table 4.8. Transportation Mode Choice by Total Annual Household Income (n = 3,166)

	Total Annual Household Income											
Primary Transportation Mode Choice	**Under $30,000**	**$30,000 - $49,999**	**$50,000 - $89,999**	**$90,000 - $119,999**	**$120,000 - $149,999**	**$150,000 - $179,999**	**$180,000 - $199,999**	**$200,000 - $249,999**	**$250,000 - $299,999**	**$300,000 and over**	**I prefer not to answer**	Total
Car, Truck, or Van (Drive Alone Only)	14	116	430	242	175	115	85	110	60	65	137	1549
	26%	34%	45%	50%	52%	48%	57%	61%	67%	62%	59%	49%
Carpool or Vanpool	4	16	59	29	29	27	9	10	5	4	12	204
	8%	5%	6%	6%	9%	11%	6%	6%	6%	4%	5%	6%
Motorcycle, Moped, or Scooter	1	2	15	12	2	3	1	3	0	2	0	41
	2%	1%	2%	2%	1%	1%	1%	2%	0%	2%	0%	1%
Bus (e.g. AC Transit)	9	46	87	22	20	10	8	7	2	4	12	227
	17%	13%	9%	5%	6%	4%	5%	4%	2%	4%	5%	7%
Train (e.g. BART)	6	58	176	93	47	39	16	18	9	7	37	506
	11%	17%	18%	19%	14%	16%	11%	10%	10%	7%	16%	16%
Bike	4	48	71	37	41	21	11	19	8	10	7	277
	8%	14%	7%	8%	12%	9%	7%	11%	9%	10%	3%	9%
Walk Only	14	44	73	32	9	16	11	6	4	10	18	237
	26%	13%	8%	7%	3%	7%	7%	3%	4%	10%	8%	7%
Other	1	11	43	19	14	11	7	7	1	3	8	125
	2%	3%	5%	4%	4%	5%	5%	4%	1%	3%	3%	4%
Total	53	341	954	486	337	242	148	180	89	105	231	3166
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note. The "Other" mode choice category includes being dropped off, traveling equal distances on more than one transportation mode, using a combination of different modes, and using campus shuttles or UC Berkeley shared vehicles to travel to campus.

Summary Statistics.

$X^2 = (70, n = 3,166) = 235.46$, $p = 0.00$

Kendall's tau-c = -0.10, $p = 0.00$

4.4 PARKING LOCATION AND PERMIT TYPE PREFERENCES

Of the 70 percent of survey respondents who park in campus parking facilities, more than half of them (55 percent) have a Faculty/Staff Annual "F" Permit, 18 percent have a Central Campus Annual "C" Permit and 8 percent use daily parking permits (Figure 4.3). According to the parking permit sales data presented in Chapter 2, the total number of "F" permits sold in 2012 was approximately twice as much as "C" permits. Hence, "C" permit holders may have been under sampled. Since the "C" parking permit is only entitled to certain job titles, mostly in management or senior professional levels and professors, this is consistent with the fact that the "Management and Senior Professionals/Senior Management Group" job category was under sampled as discussed in Section 4.2.1. Of all the professors with a parking permit, 58 percent have Annual "C" permits and 22 percent have Annual "F" permits. Employees who have carpool permits, both for Central Campus and Faculty/Staff, constituted 10 percent of the total number of respondents.

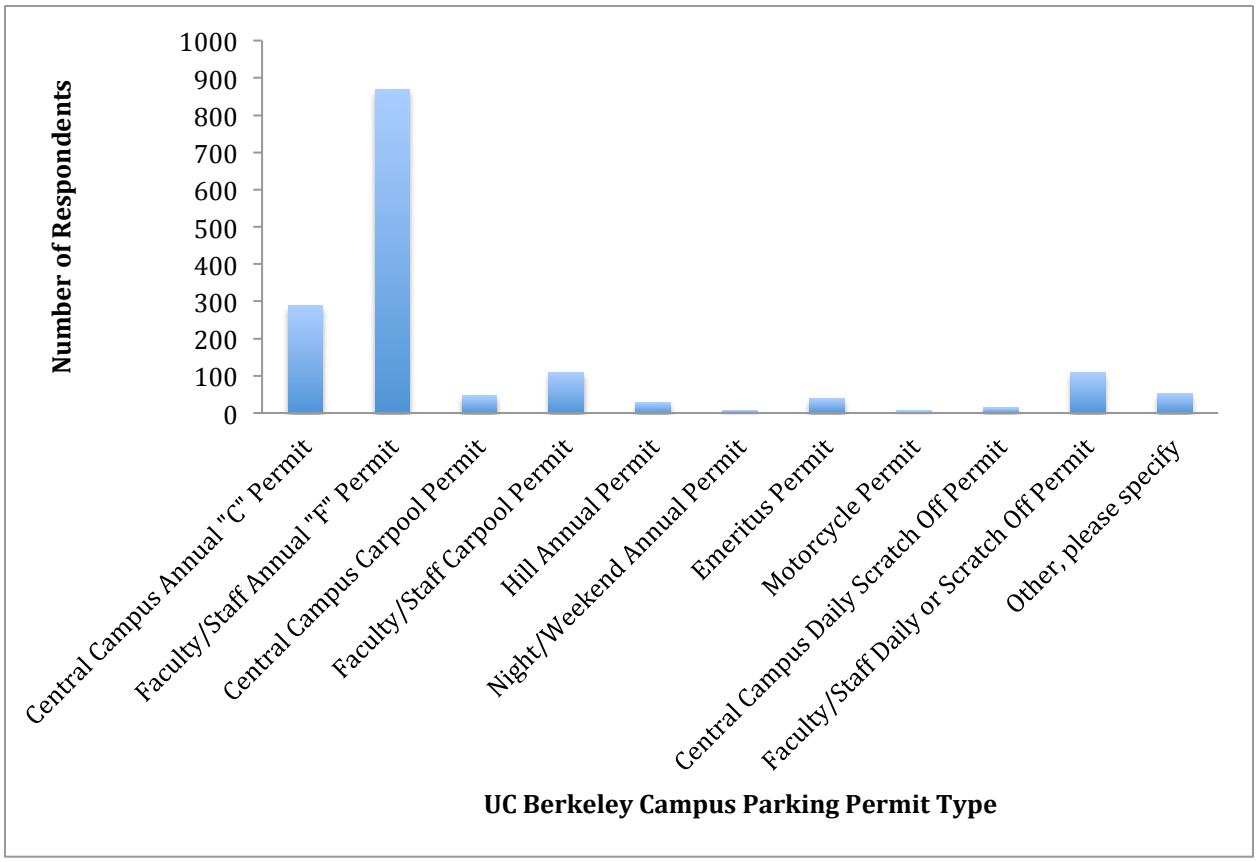

Figure 4.3. UC Berkeley parking permit type held by survey respondents.

As shown in Figure 4.1, of all the respondents sampled in the transportation and parking survey, 57 percent drove alone, rode a motorcycle, or carpooled to campus. The majority of drivers park on campus (70 percent) at a campus parking garage or lot, while the others park off campus at various types of parking locations, some that require a fee and some that do not (Figure 4.4).

Unmetered on-street parking is popular amongst employees, as nine percent of them reported to have parked their vehicles at unmetered on-street parking spaces either with or without time limit enforcement, the last time they drove alone, rode a motorcycle, or carpooled to campus.

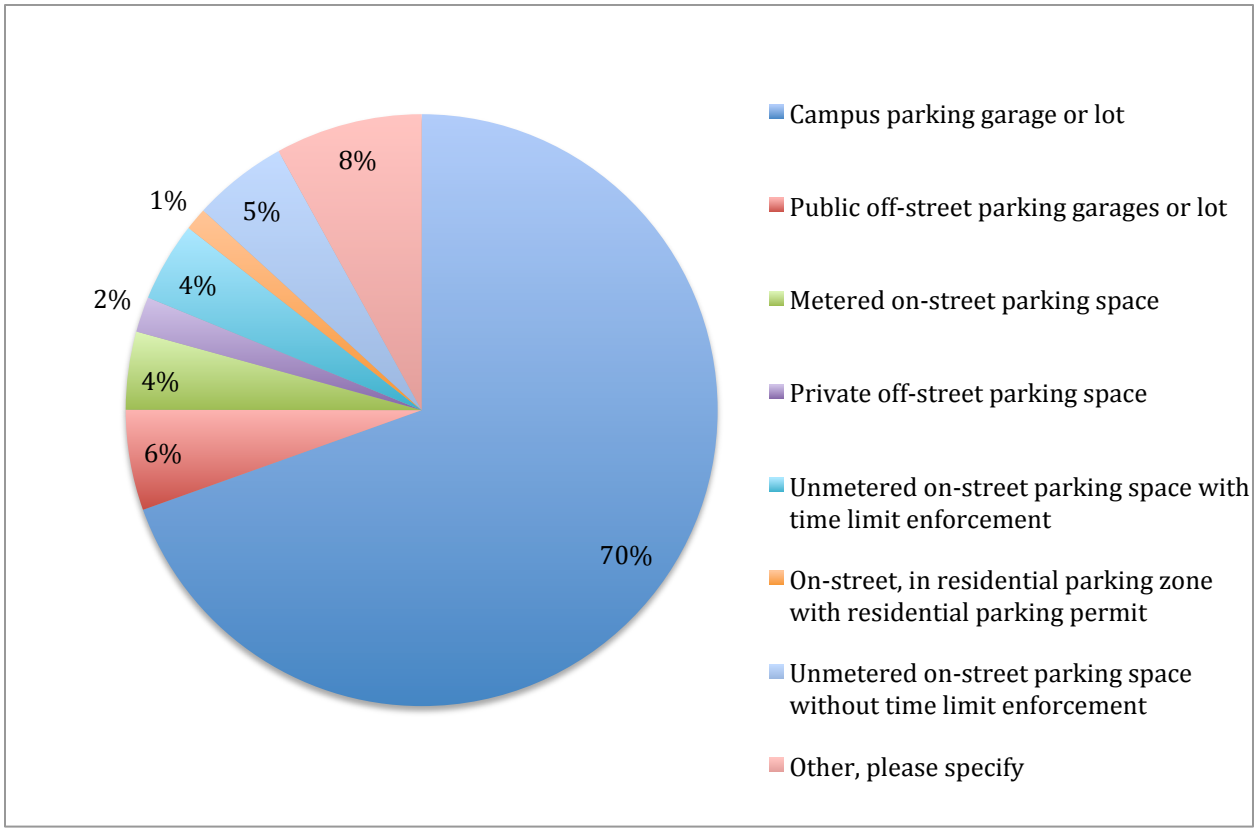

Figure 4.4. Parking location of UC Berkeley employees on the most recent commute trip to the UC Berkeley campus (n = 2,278).
Note. The "Other" category (eight percent) includes parking at BART stations, the Lawrence Berkeley National Laboratory, parking with disabled person placards or plates either on or off campus, private parking lots under contract with UC Berkeley, and parking on campus Nobel laureate (NL) parking space.

The frequency distribution of mode choice by parking location is presented in Table 4.9. Since parking location is only relevant to drivers, carpoolers and motorcyclists, all other modes have been excluded from Table 4.9. The percentage of drivers (Car, Truck or Van) who park on campus is 74 percent. The same percentage of employees who carpool park on campus, but the majority of motorcyclists (55 percent) park off campus, using unmetered on-street parking spaces without any time limit enforcement, which is free of charge.

Adjunct professors use off-street public parking garages the most across all job categories, most likely because many adjuncts are part-time employees with other jobs off campus. Employees in the "Contract" job category use off-campus parking the most, when compared to other job categories, apart from unmetered on-street parking spaces without time limit enforcement, which are heavily used by employees in the "Operational / Technical Staff" category (Table 4.10). Table 4.11 shows the campus parking permit type by University affiliation, where the results are

comparable with campus parking permit sales data presented, especially for the Annual "F" Permit, which is the most popular campus parking permit sold and reported in the survey. Even though the Annual "C" Permit was designed for professors and senior professionals, the percentage of employees in the "Management and Senior Professionals" (MSP) and Senior Management Group (SMG) category with an Annual "F" Permit (47 percent) is higher than the percentage of employees with an Annual "C" Permit (32 percent) in the same job category (Table 4.11).

The majority of employees choose to park at campus parking garages or lots across all income groups. However, lower income groups have lower percentages of employees who park on campus than higher income groups. In fact, the percentage of employees who park on campus is more than 70 percent from the income category "$90,000 - $119,999" upwards, while 65 percent of employees from the medium income category "$50,000 - $89,999" park on campus, yet only 35 percent of employees who are in the "Under $29,999" income category park on campus. The percentages of employees who use public off-street parking garages or lots are similar across income groups. Unmetered on-street parking spaces with time limit enforcement is the most popular among employees from the lowest income category "Under $29,999" (15 percent), so is on-street parking in residential parking zone with residential parking permit (10 percent) (Table 4.12). Less than 10 percent of employees from other income categories use both of these on-street parking choices. On the other hand, employees from all income groups park at unmetered on-street parking spaces without time limit enforcement, five percent for "Under $29,999" and seven percent for "$300,000 and over" income categories (Table 4.12).

The interrelations between parking location choice and time spent on campus per day are shown in Table 4.13. Since the majority of the respondents who drive to campus park at on-campus parking garages or lots (70 percent), the highest percentages of employees park at on-campus locations for all duration categories, i.e. one to 15 hours on campus. However, the percentage of employees who park on campus increases as the number of hours spent on campus increases. For employees who are on campus for less than five hours a day, no more than 60 percent of them chose to park on campus. This percentage increases to between 72 and 87 percent when the number of hours spent on campus is nine or more (Table 4.13). This trend has not been observed for public off-street parking garages, where the percentage of employees does not differ much by the number of hours spent on campus. Metered on-street parking is the second most popular choice for employees who are on campus for less than four hours a day. The percentage of employees who park at unmetered on-street parking space with time limit enforcement is quite consistent across all time duration, peaking at two, eight and nine hours.

Table 4.9. Parking Location Choice by Primary Transportation Mode Choice (n = 2,278)

	Primary Transportation Mode Choice				
Parking Location Choice	**Car, Truck, or Van (Drive Alone Only)**	**Carpool or Vanpool**	**Motorcycle, Moped, or Scooter**	**Other**	Total
Campus parking garage or lot	1361	184	8	31	1584
	74%	74%	17%	20%	70%
Public off-street parking garages or lot	100	12	2	11	125
	5%	5%	4%	7%	5%
Metered on-street parking space	91	4	1	1	97
	5%	2%	2%	1%	4%
Private off-street parking space	35	4	0	5	44
	2%	2%	0%	3%	2%
Unmetered on-street parking space with time limit enforcement	88	5	1	5	99
	5%	2%	2%	3%	4%
On-street, in residential parking zone with residential parking permit	20	3	0	5	28
	1%	1%	0%	3%	1%
Unmetered on-street parking space without time limit enforcement	61	7	26	24	118
	3%	3%	55%	15%	5%
Other[a]	71	30	9	73	183
	4%	12%	19%	47%	8%
Total	1827	249	47	155	2278
	100%	100%	100%	100%	100%

Note. [a]The "Other" parking location category includes parking at BART stations, the Lawrence Berkeley National Laboratory, parking with disabled person placards or plates either on or off campus, private parking lots under contract with UC Berkeley, and parking on campus Nobel laureate (NL) parking space.
Summary Statistics. $X^2 = (21, n = 2,278) = 726.74$, $p = 0.00$
Eta Parking Location = 0.44
Eta Mode Choice = 0.46

Table 4.10. Parking Location Choice by University Affiliation (n = 1,973)

	UC Berkeley Affiliation											
Parking Location Choice	**Professor / Associate Professor**	**Assistant Professor**	**Adjunct Professor**	**Other Faculty / Academic[b]**	**MSP / SMG[c]**	**Professional Staff**	**Operational / Technical Staff**	**Staff (classified and represented)**	**Contract**	**Postdoctoral Scholar**	**Other[d]**	Total
Campus parking garage or lot	135	21	5	144	152	495	32	332	10	29	39	1394
	85%	95%	38%	69%	84%	74%	46%	65%	50%	55%	60%	71%
Public off-street parking garages or lot	3	0	3	13	8	38	2	29	1	3	1	101
	2%	0%	23%	6%	4%	6%	3%	6%	5%	6%	2%	5%
Metered on-street parking space	3	0	1	15	5	26	3	19	2	6	5	85
	2%	0%	8%	7%	3%	4%	4%	4%	10%	11%	8%	4%
Private off-street parking space	1	0	0	3	3	16	1	9	2	1	1	37
	1%	0%	0%	1%	2%	2%	1%	2%	10%	2%	2%	2%
Unmetered on-street parking space with time limit enforcement	3	0	1	10	2	21	5	37	3	6	2	90
	2%	0%	8%	5%	1%	3%	7%	7%	15%	11%	3%	5%
On-street, in residential parking zone with residential parking permit	2	0	1	3	0	7	3	7	0	1	0	24
	1%	0%	8%	1%	0%	1%	4%	1%	0%	2%	0%	1%
Unmetered on-street parking space without time limit enforcement	4	1	0	12	3	34	13	23	1	2	4	97
	3%	5%	0%	6%	2%	5%	19%	5%	5%	4%	6%	5%
Other[a]	8	0	2	10	7	36	10	53	1	5	13	145
	5%	0%	15%	5%	4%	5%	14%	10%	5%	9%	20%	7%
Total	159	22	13	210	180	673	69	509	20	53	65	1973
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note. [a]The "Other" parking location category includes parking at BART stations, the Lawrence Berkeley National Laboratory, parking with disabled person placards or plates either on or off campus, private parking lots under contract with UC Berkeley, and parking on campus Nobel laureate (NL) parking space. [b]The category "Other Faculty / Academic" includes visiting faculty, scholars, lecturers, emeriti professors, and UC Berkeley extension. [c]MSP is Management and Senior Professionals and SMG is Senior Management Group. [d]The "Other" University affiliation category includes survey respondents who hold dual or multiple positions, recalled retirees and respondents who are unsure of their job category. This is a relatively small percentage of respondents, constituting three percent of the total number of respondents.

Summary Statistics.

$X^2 = (84, n = 1,973) = 230.47$, $p = 0.00$

Eta Parking Location = 0.21

Eta University Affiliation = 0.15

Table 4.11. Campus Parking Permit Type by University Affiliation (n = 1,391)

	UC Berkeley Affiliation											
UC Berkeley Campus Parking Permit Type	**Professor / Associate Professor**	**Assistant Professor**	**Adjunct Professor**	**Other Faculty / Academic[b]**	**MSP / SMG[c]**	**Professional Staff**	**Operational / Technical Staff**	**Staff (classified and represented)**	**Contract**	**Postdoctoral Scholar**	**Other[d]**	Total
Central Campus Annual "C" Permit	81	10	2	29	48	43	2	24	1	0	8	248
	60%	48%	40%	20%	32%	9%	6%	7%	10%	0%	21%	18%
Faculty/Staff Annual "F" Permit	29	5	0	56	71	331	21	230	7	15	13	778
	21%	24%	0%	39%	47%	67%	66%	69%	70%	54%	33%	56%
Central Campus Carpool Permit	6	2	0	2	10	15	0	5	0	0	0	40
	4%	10%	0%	1%	7%	3%	0%	2%	0%	0%	0%	3%
Faculty/Staff Carpool Permit	3	1	0	3	10	38	2	30	0	7	1	95
	2%	5%	0%	2%	7%	8%	6%	9%	0%	25%	3%	7%
Hill Annual Permit	0	0	0	8	0	12	1	6	0	0	1	28
	0%	0%	0%	5%	0%	2%	3%	2%	0%	0%	3%	2%
Night/Weekend Annual Permit	0	0	1	0	0	1	0	2	0	1	2	7
	0%	0%	20%	0%	0%	0%	0%	1%	0%	4%	5%	1%
Emeritus Permit	4	0	1	22	0	0	0	0	0	0	5	32
	3%	0%	20%	15%	0%	0%	0%	0%	0%	0%	13%	2%
Motorcycle Permit	1	0	0	0	0	3	1	0	0	0	0	5
	1%	0%	0%	0%	0%	1%	3%	0%	0%	0%	0%	0%
Central Campus Daily Scratch Off Permit	4	1	0	3	0	1	0	2	0	0	1	12
	3%	5%	0%	2%	0%	0%	0%	1%	0%	0%	3%	1%
Faculty/Staff Daily or Scratch Off Permit	5	2	0	12	9	35	3	25	2	5	4	102
	4%	10%	0%	8%	6%	7%	9%	8%	20%	18%	10%	7%
Other[a]	2	0	1	9	4	14	2	8	0	0	4	44
	1%	0%	20%	6%	3%	3%	6%	2%	0%	0%	10%	3%
Total	135	21	5	144	152	493	32	332	10	28	39	1391
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note. [a]The "Other" parking permit type category includes temporary parking permits, departmental permits, guest parking, and reciprocity parking permits from other UC campuses. [b]The category "Other Faculty / Academic" includes visiting faculty, scholars, lecturers, emeriti professors, and UC Berkeley extension. [c]MSP is Management and Senior Professionals and SMG is Senior Management Group. [d]The "Other" University affiliation category includes survey respondents who hold dual or multiple positions, recalled retirees and respondents who are unsure of their job category. This is a relatively small percentage of respondents, constituting three percent of the total number of respondents.

Summary Statistics.

$X^2 = (144, n = 1,391) = 717.42, p = 0.00$

Eta Parking Permit Type = 0.20

Eta University Affiliation = 0.42

Table 4.12. Parking Location Choice by Total Annual Household Income (n = 1,915)

	Total Annual Household Income											
Parking Location Choice	**Under $30,000**	**$30,000 - $49,999**	**$50,000 - $89,999**	**$90,000 - $119,999**	**$120,000 - $149,999**	**$150,000 - $179,999**	**$180,000 - $199,999**	**$200,000 - $249,999**	**$250,000 - $299,999**	**$300,000 and over**	**I prefer not to answer**	Total
Campus parking garage or lot	7	91	355	214	157	114	82	97	56	56	119	1348
	35%	63%	65%	71%	71%	73%	80%	75%	85%	76%	76%	70%
Public off-street parking garages or lot	1	12	27	15	9	7	6	4	4	4	10	99
	5%	8%	5%	5%	4%	4%	6%	3%	6%	5%	6%	5%
Metered on-street parking space	1	10	26	10	7	6	1	8	2	4	6	81
	5%	7%	5%	3%	3%	4%	1%	6%	3%	5%	4%	4%
Private off-street parking space	1	2	9	6	5	4	2	3	2	0	3	37
	5%	1%	2%	2%	2%	3%	2%	2%	3%	0%	2%	2%
Unmetered on-street parking space with time limit enforcement	3	8	34	13	11	4	2	6	1	2	6	90
	15%	6%	6%	4%	5%	3%	2%	5%	2%	3%	4%	5%
On-street, in residential parking zone with residential parking permit	2	2	7	4	5	2	1	0	0	1	0	24
	10%	1%	1%	1%	2%	1%	1%	0%	0%	1%	0%	1%
Unmetered on-street parking space without time limit enforcement	1	8	40	16	8	6	2	4	0	5	3	93
	5%	6%	7%	5%	4%	4%	2%	3%	0%	7%	2%	5%
Other[a]	4	12	47	23	18	13	6	8	1	2	9	143
	20%	8%	9%	8%	8%	8%	6%	6%	2%	3%	6%	7%
Total	20	145	545	301	220	156	102	130	66	74	156	1915
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note. [a]The "Other" parking location category includes parking at BART stations, the Lawrence Berkeley National Laboratory, parking with disabled person placards or plates either on or off campus, private parking lots under contract with UC Berkeley, and parking on campus Nobel laureate (NL) parking space.
Summary Statistics.
$X^2 = (70, n = 1,915) = 90.33$, $p = 0.05$
Kendall's tau-c = -0.08, $p = 0.00$

Table 4.13. Parking Location Choice by Time Spent on Campus (n = 2,185)

	Duration on Campus (Hour)															
Parking Location Choice	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	Total
Campus parking garage or lot	12	21	36	28	44	50	109	240	562	280	108	23	12	4	2	1531
	41%	33%	60%	57%	66%	64%	76%	67%	72%	73%	83%	82%	86%	100%	100%	70%
Public off-street parking garages or lot	2	2	4	4	6	3	4	23	49	15	3	1				116
	7%	3%	7%	8%	9%	4%	3%	6%	6%	4%	2%	4%	0%	0%	0%	5%
Metered on-street parking space	11	19	11	5	2	8	3	8	18	10						95
	38%	30%	18%	10%	3%	10%	2%	2%	2%	3%	0%	0%	0%	0%	0%	4%
Private off-street parking space			1		2	2	3	3	20	10	1					42
	0%	0%	2%	0%	3%	3%	2%	1%	3%	3%	1%	0%	0%	0%	0%	2%
Unmetered on-street parking space with time limit enforcement	2	12	4	4	6	7	8	20	22	7	1					93
	7%	19%	7%	8%	9%	9%	6%	6%	3%	2%	1%	0%	0%	0%	0%	4%
On-street, in residential parking zone with residential parking permit	1	7	2	5	5	3	11	37	52	30	10	3				166
	3%	11%	3%	10%	7%	4%	8%	10%	7%	8%	8%	11%	0%	0%	0%	8%
Unmetered on-street parking space without time limit enforcement	1	1		1	1			6	9	7	2					28
	3%	2%	0%	2%	1%	0%	0%	2%	1%	2%	2%	0%	0%	0%	0%	1%
Other[a]		1	2	2	1	5	5	21	45	24	5	1	2			114
	0%	2%	3%	4%	1%	6%	3%	6%	6%	6%	4%	4%	14%	0%	0%	5%
Total	29	63	60	49	67	78	143	358	777	383	130	28	14	4	2	2185
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note. [a]The "Other" parking location category includes parking at BART stations, the Lawrence Berkeley National Laboratory, parking with disabled person placards or plates either on or off campus, private parking lots under contract with UC Berkeley, and parking on campus Nobel laureate (NL) parking space.
Summary Statistics.
$X^2 = (105, n = 2,185) = 399.54$, $p = 0.00$
Kendall's tau-c = -0.07, $p = 0.00$

4.5 RESIDENTIAL LOCATIONS OF EMPLOYEES

The transportation mode choice of UC employees could be a reflection of their housing location decisions. Many employees live relatively close to campus and in areas with relatively good peak period transit services. A detailed table that shows the 15 most popular cities (and their respective zip codes), where the survey respondents' residential locations are located can be found in Appendix G. Approximately 31 percent of the respondents live in Berkeley, 21 percent live in Oakland and 9 percent live in San Francisco, which are the three most popular cities to live in for UC Berkeley employees.

This finding is consistent with Kain and Quigley's (1975) theory that workplace location is key to the prediction of residential location decisions of urban households. Mode choice such as traveling by car, public transportation, bike, and walking can be directly affected by housing location decisions. Housing location decisions in turn are known to be affected by socioeconomic and demographic factors, such as age, income, gender, occupation, and education; neighborhood characteristics, including residential density, racial composition, crime rate, school quality, recreational services, and taxes, and the size, quality, condition, and price of the property (Weisbrod et al., 1980), as well as by the commute distances and travel options available for the journey to work.

The survey asked for the intersection address, city and the zip code of the respondents' primary residential location. These data were collected to estimate travel distance and travel time between the respondents' origin (residential location) and destination (building of primary work place on campus). Residential location and office building on campus were first geocoded using Google Maps Application Programming Interface (API) before estimating travel distance and time by driving, biking and walking, again using Google Maps API. Travel time by transit was estimated using the zip codes provided by each survey respondent. Since Google Maps API estimates travel time based on the most efficient route, transit mode includes all available bus and train services.

Table 4.14 shows the descriptive statistics and frequencies of travel distance by car. Data from two respondents who provided a non-Californian residential location were removed from this analysis. The majority of faculty and staff (84 percent) live less than 20 miles away from campus, while the mean travel distance is approximately 11 miles (Table 4.14). Further analysis of travel distance and University affiliation also shows that 50 percent of professors and associate professors live three miles within the campus, while assistant and adjunct professors, as well as staff members live further away (Table 4.15).

Table 4.14. Descriptive Statistics and Frequencies of Travel Distance

	Travel Distance (Miles)
Sample Size (n)	3,057
Minimum	0.02
Maximum	164
Mean	11.17
Std. Deviation	13.14
Skewness	3.46
Std. Error of Skewness	0.04
Kurtosis	20.75
Std. Error of Kurtosis	0.09
Percentiles	
25	2.82
50	6.50
75	15.41
85	20.36

Table 4.15. Travel Distance from Home to Campus by University Affiliation (n = 3,502)

	UC Berkeley Affiliation											
Travel Distance from Home to Campus (Miles)	**Professor / Associate Professor**	**Assistant Professor**	**Adjunct Professor**	**Other Faculty / Academic[a]**	**MSP / SMG[b]**	**Professional Staff**	**Operational / Technical Staff**	**Staff (classified and represented)**	**Contract**	**Postdoctoral Scholar**	**Other[c]**	Total
Travel Distance < 0.5	2	0	0	1	12	18	2	35	1	1	2	74
	1%	0%	0%	0%	4%	2%	2%	4%	3%	1%	2%	2%
Travel Distance < 1	6	1	0	11	10	25	1	28	1	15	16	114
	2%	3%	0%	3%	4%	2%	1%	3%	3%	7%	13%	3%
Travel Distance < 3	130	11	5	96	42	181	24	197	4	102	22	814
	47%	28%	25%	27%	15%	17%	19%	21%	10%	46%	17%	23%
Travel Distance < 5	56	6	4	75	22	144	21	155	8	42	16	549
	20%	15%	20%	21%	8%	13%	17%	16%	21%	19%	13%	16%
Travel Distance < 10	30	8	2	54	71	238	28	184	11	21	13	660
	11%	20%	10%	15%	26%	22%	22%	20%	28%	10%	10%	19%
Travel Distance > 10	50	14	9	121	120	470	50	346	14	39	58	1291
	18%	35%	45%	34%	43%	44%	40%	37%	36%	18%	46%	37%
Total	274	40	20	358	277	1076	126	945	39	220	127	3502
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note. [a]The category "Other Faculty / Academic" includes visiting faculty, scholars, lecturers, emeriti professors, and UC Berkeley extension. [b]MSP is Management and Senior Professionals and SMG is Senior Management Group. [c]The "Other" University affiliation category includes survey respondents who hold dual or multiple positions, recalled retirees and respondents who are unsure of their job category. This is a relatively small percentage of respondents, constituting three percent of the total number of respondents.

Summary Statistics.

$X^2 = (60, n = 3{,}502) = 411.19$, $p = 0.00$

Eta Travel Distance = 0.23

Eta University Affiliation = 0.18

4.6 OTHER TRAVEL BEHAVIOR AND CHARACTERISTICS

Apart from transportation mode choice and parking location or type preferences, the survey also captured some other UC Berkeley employees' travel behavior and socioeconomic characteristics. This section describes their arrival and departure times, time spent on campus, University affiliation, and the number of vehicles available for their personal use.

4.6.1 ARRIVAL AND DEPARTURE TIMES

As seen in Figure 4.5, the peak arrival time to campus is between 8:00AM and 8:59AM. Smaller peaks form from 7:00AM to 7:59AM and again from 9:00AM to 9:59AM. Therefore, most employees (84 percent) are on campus by 10:00AM. The majority of employees (60 percent) depart from campus between 5:00PM and 5:59PM, although a significant number leave between 3:00PM and 4:59PM and between 6:00PM and 6:59PM (Figure 4.6). The number of employees departing campus decreases considerably after 6:59PM.

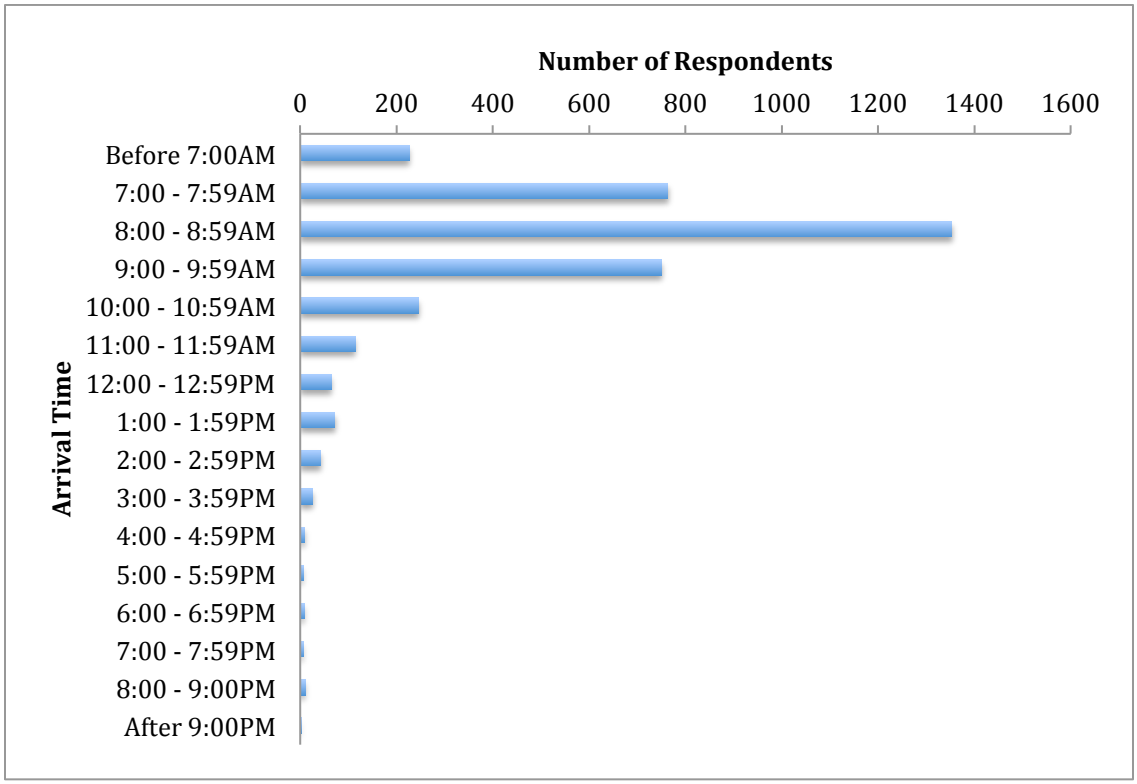

Figure 4.5. Arrival time to campus on most recent commute trip.

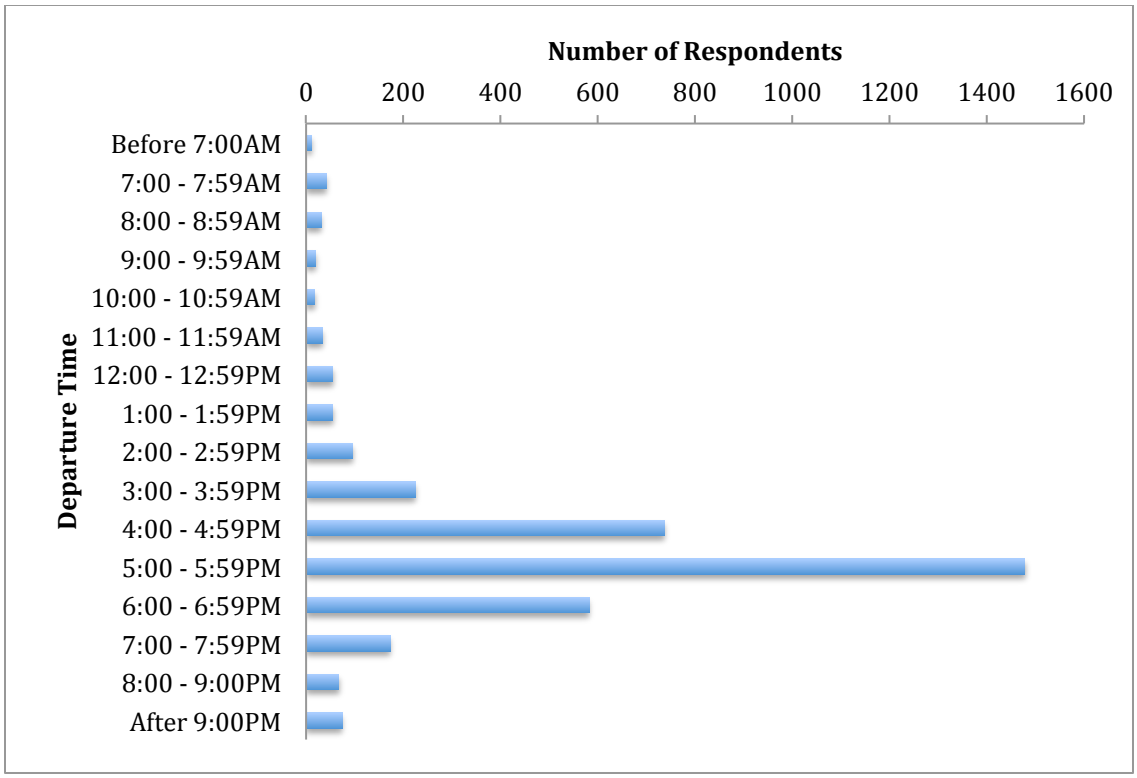

Figure 4.6. Departure time from campus on most recent commute trip.

Using data on arrival and departure times, the duration of the survey respondents' time spent on campus was calculated and presented in Table 4.16. Although the average number of hours spent on campus was 8.21, the time spent on campus ranged from one hour to 15 hours in a particular day. Almost 40 percent of the respondents reported being on campus for nine hours a day, 17 percent for eight hours a day, while approximately 21 percent of the respondents were on campus for less than eight hours (Table 4.16). A substantial percentage of respondents were on campus for more than nine hours (25 percent). The number of hours spent on campus indicates the duration of parking for employees who drive to their workplace. The time spent on campus will affect parking location choices, as the longer an employee stays on campus, the less likely the employee will choose hourly parking options.

Table 4.16. Time Spent on Campus Per Day

Duration (Hour)	Number of Respondents	Percentage (%)
1	37	1.04
2	81	2.27
3	89	2.49
4	77	2.16
5	101	2.83
6	132	3.70
7	227	6.36
8	610	17.10
9	1,308	36.66
10	626	17.54
11	203	5.69
12	44	1.23
13	25	0.70
14	6	0.17
15	2	0.06
Total	**3,568**	**100**

4.6.2 FREQUENCY OF TRIP TO CAMPUS

The frequency of work trip to campus is defined as the number of days an employee is on campus per week. Regardless of transportation mode choice, the mean frequency of trip to campus per week, including weekends, is 4.45. The majority of the survey respondents (88 percent) are on campus for at least five days a week. When weekends are excluded, the mean frequency of trip decreases to 4.22. The frequencies and descriptive statistics of the number of days on campus are shown in Appendix H, together with the cross tabulations of the number of days on campus and University affiliation, as well as academic discipline.

Results from the transportation and parking survey show that the driving frequency for annual "C" permit holders is 4.66 days per week (including weekends) on average, while annual "F" permit holders drive to campus 4.49 days per week on average. The current average number of days (including weekends) driven to campus by both "C" and "F" permit holders is 4.58. If weekends are excluded, the average numbers of days driven to campus for "C" and "F" permit holders are 3.97 and 4.29 respectively. Thus, "C" permit holders drive more to campus during the weekends than "F" permit holders. The average value for both "C" and "F" permit holders is 4.13 days per a regular Monday to Friday workweek.

Survey respondents reported travel behavior that ranged from not driving at all to driving seven days a week to campus, for both C and F permit holders. The majority of annual "C" permit holders (74 percent) drive five days a week to campus and approximately nine percent of permit holders drive more than five days a week to campus (Table 4.17). Among annual "F" permit holders, 60 percent drive five days a week to campus, while approximately 14 percent drive four days a week. More than 10 percent of "F" permit holders drive more than five days a week to

campus. There is a considerable number of permit holders who drive three or less days per week to campus for both annual "C" and "F" permit holder. Almost 12 percent of "C" permit holders drive three or less days per week, while 15 percent of "F" permit holders drive three or less days a week. The results presented in Table 4.17 were collected for a random week, i.e. the week before each respondent took the survey. Hence, if the respondent did not drive (Number of Days Driven = 0) in that week, it does not necessarily imply that it is true for other weeks.

Table 4.17. Number of Survey Respondents by Frequency of Driving Trip for One Random Week

Number of Days Driven	Percentage of Respondents (%) (Including Weekend Trips)		Percentage of Respondents (%) (Excluding Weekend Trips)	
	Central "C" Campus Permit	Faculty/Staff "F" Permit	Central "C" Campus Permit	Faculty/Staff "F" Permit
0	4.15	6.44	6.57	6.60
1	2.42	0.92	4.84	1.06
2	1.38	1.73	4.50	2.71
3	3.74	6.10	11.42	3.82
4	4.84	13.58	14.19	14.38
5	74.12	60.30	58.48	71.43
6	5.88	5.98	N/A	N/A
7	3.46	4.95	N/A	N/A

If weekends, i.e. Saturday and Sunday, were excluded from the analysis, the percentages of respondents who drive to campus for five days a week (Monday to Friday) are still the highest for both "C" and "F" permit holders. Similarly, there is a relatively high percentage of "C" and "F" permit holders who drive three or less days to campus (21 percent on average for both permit type holders).

4.6.3 VEHICLE AVAILABILITY

Three separate questions on the number of motor vehicles, motorcycles and bicycles available in the household for personal use were included in the survey. As shown in Figure 4.7, most households have at least one motor vehicle but no motorcycle or bicycle. In fact 91 percent of the respondents have at least one motor vehicle that is available for their own personal use in their households. Although only 8 percent of employees stated biking as their primary mode choice (Figure 4.1), 47 percent have access to at least one bicycle for their own personal use in their households (Figure 4.7). Thus, ownership or accessibility of vehicles does not imply vehicle use. Transportation mode choice is influenced by other factors in addition to vehicle ownership or accessibility.

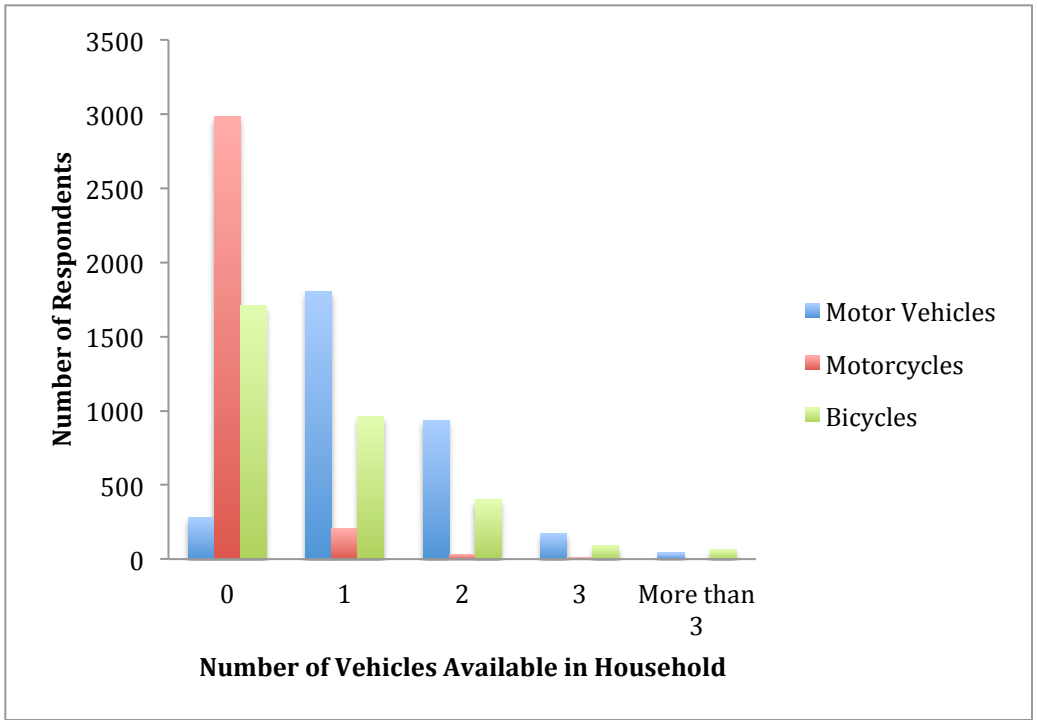

Figure 4.7. Number of vehicles available for personal use in household by vehicle type.

4.7 DISCUSSION

Based on the preliminary data analysis and results presented in this chapter, carpool and biking mode choices do not appear to be affected by income, as there are no substantial differences in the percentages of employees who carpool or bike across all income categories. The walking mode is used by lower and higher income categories, but not the medium income categories. This seems to reflect housing location choices of lower and higher income groups. On the other hand, the number of employees who use the bus is significantly greater for lower income groups than higher income groups, while the distribution of train as a primary mode of transportation is relatively evenly distributed across all income groups up to $180,000. These findings imply that bus subsidies are important to lower income groups, while subsidies for trains, e.g. BART, could benefit every income category.

It has also been shown that driving alone to campus is the most popular choice amongst all University employees and job categories, accounting for 50 percent of all commuting trips to campus. Of those respondents who drive, 70 percent of them park on campus. If these percentages were extrapolated to the campus population of approximately 14,000, it would imply that 7,000 employees drive to campus at least on peak days and 4,900 of them will park on campus. Assuming that 20 percent of the employees who park on campus when they drive to work from home are off campus on a given day of the workweek, 1,400 employees (20 percent of 7,000 employees) will then be working from home per day. This suggests that there would still be 3,500 employees driving to campus daily, requiring at least 3,500 campus parking spaces. This significant parking demand implies that the University can use parking pricing to regulate existing driving patterns and behavior.

Since there are only approximately 5,000 parking spaces on central campus, some of which are used by students, departmental vehicles, contractors, temporary workers, and visitors, there would be a spillover of parking at off-campus locations, such as on-street metered parking spaces, other on-street parking spaces and in public or private off-street parking facilities. Results from the survey showed that 30 percent of drivers parked off campus the last time they drove to campus, which implies a number of 2,100. These alternative off-campus parking locations are likely to remain attractive because of its competitive pricing, as well as abundant supply in areas surrounding the campus. Respondents who use on-street parking, either metered or time limit enforced, tend to stay on campus for one or two hours only. Hence, it is reasonable to say that on-street parking is an alternative for short term parking for UC Berkeley employees, and are more likely to be attractive for employees with more flexible work schedule. Lower income groups have been found to park less on campus than higher income groups. Any changes in campus parking pricing could affect medium income groups the most simply because they are the largest group of campus employees and also the largest group of drivers.

The current parking pricing structure on campus benefits employees who travel to campus five days a week and stay on campus for eight hours or more. This system does not allow much flexibility for employees to select an option that best fits their needs and the prices do not reflect actual demand per day, month or year either. It does not serve employees who only travel to campus a few days a week, who do not stay on campus all day or who do not drive to campus every day, hence do not require parking every day of the workweek. The current parking permit system also does not encourage employees to drive alone less, as once a permit has been purchased at the beginning of the academic year, the cost of parking becomes a fixed cost that has already been paid for before each future trip is made and there is no marginal cost for parking for each additional trip.

The next chapter, Chapter 5, analyzes how parking pricing can influence travel demand and determine how different pricing scenarios will affect transportation mode choice and parking preferences.

CHAPTER 5

EVALUATING PARKING PRICING IMPACT USING DISCRETE CHOICE ANALYSIS

In this chapter, multinomial logit (MNL) models for mode choice and parking choice are presented. The models were estimated using transportation and parking revealed preference (RP) and stated preference (SP) survey data described in detail in previous chapters. The SP data allow for the examination of how UC Berkeley employees would respond to variations in price and incentives not present in the RP data. Both simple, restricted models and models including additional socioeconomic variables are presented in this chapter.

5.1 INTRODUCTION

Parking pricing can be an influential tool in regulating private vehicle use, both in terms of number of trips and vehicle miles traveled (VMT), as well as to better allocate existing parking resources. The marginal cost of driving can be heavily affected by parking pricing, which will ultimately affect the attractiveness of the drive alone mode choice when compared to other transportation modes, such as transit. Since commute travel and its associated parking duration are relatively inflexible compared to non-commute trips, parking pricing can have a significant impact on commute mode choices. However, parking pricing may have a limited effect when there is more than one parking option, e.g. when there are less costly parking alternatives serving as competitors, as seen in areas surrounding the periphery of the UC Berkeley campus.

Most of the employees at UC Berkeley have fixed cost annual or monthly parking permits, purchased at a below market rate, which does not vary with how often an employee parks on campus. If an employee wanted to drive three days a week and use daily permits to park on campus, he or she would pay higher costs than the daily equivalent of a monthly permit. A thorough description of the current daily parking permits can be found in Chapter 4. Changes in parking pricing that bring daily and monthly permit costs into better alignment have been proposed, as have parking permits that are bundled with incentives to drive three or fewer days a week. Understanding how employees are affected by parking pricing and incentives and what factors are most influential in affecting mode choice will provide insights that would be of use in developing more effective transportation and parking pricing policies.

As changes in parking pricing are proposed, it is also important to understand not only the characteristics and choice processes of the employees who use campus parking, but also those who drive but do not park on campus and those who currently commute by other modes. This is because changes in parking pricing and incentives could deter some current campus parkers but could also attract others who are not currently using campus parking.

The models presented in this chapter were designed to address parking price changes, responses to parking options not currently offered and potential responses of all commuters to campus in the survey, not just those who drive and park on campus.

5.2 CURRENT STUDIES

While most travel demand models use RP data, the use of SP data is increasingly common in the building of transportation choice models and travel demand analysis. SP methods were first developed in the field of marketing research in the early 1970s and were applied in transportation studies in the early 1980s. This was mainly due to the development of disaggregated behavioral models, which facilitated the use of SP data for travel demand analysis. SP data have been used to study mode choice (Kroes and Sheldon, 1988; Hensher, 1994), to analyze the impact of transportation policies on travel demand using hypothetical scenarios and also for forecasting (Hensher, 1994; Kroes and Sheldon, 1988; Louviere, 1988).

Parking pricing or parking choices studies in general that have applied the SP approach are fewer in number compared to RP methods, which are mostly used to examine the effect of parking costs and times on mode choice without considering specific spatial location and the different types of parking available (Feeney, 1989). A study by Axhausen and Polak (1991) defined possible types of parking choices and applied a SP approach to examine the choice of parking type in Birmingham City Center, UK and in the city of Karlsruhe, Germany, using disaggregated data on travelers' responses to changes in parking attributes. In their survey, they listed three alternatives, free on-street, metered and illegal parking, each with four attributes, access time, search time, egress time, and parking fee. Both of their logit models (UK and Germany) were found to be realistic models of parking choice and their results were comparable to RP analysis.

Albert and Mahalel's (2006) study on how congestion tolls and parking fees can affect travel behavior used the SP method to analyze the impact of parking pricing. Their study provided an evaluation of attitudes toward congestion tolls and parking fees in Haifa, Israel and found that there was a higher willingness to pay for parking fees than congestion tolls. The study showed that 54 percent of the drivers in the sample would prefer not to pay for parking, while 72 percent of the drivers would prefer to use other options in order to avoid paying a congestion toll. The congestion toll had a higher demand elasticity estimate than the parking fee. One concern about this study is that the elasticities estimated are extremely high (-1.8 for congestion pricing and -1.2 for parking fee), indicating that respondents would react strongly to avoid paying any new charges that will increase total driving costs. It is possible that the authors elicited strategic responses rather than sincere estimates of likely behavior. It also should be noted that the authors did not include income as a variable and therefore could not assess how different social groups might respond to pricing.

5.3 METHODOLOGY

The transportation and parking survey used for collecting RP and SP data for the discrete choice analysis, as well as the choice experiment design and data collection process are described in Chapter 3. This section is mainly focused on the formulation of the choice models used in the evaluation of parking pricing impact on mode and parking choices. The impact of pricing on

these two types of choices was analyzed separately with a different choice model. The transportation mode choice model was estimated using a joint RP-SP data analysis, after analyzing the two types of data separately, while the parking choice model was estimated using SP data that reflect changes in parking pricing.

Both transportation mode and parking choices were estimated using MNL models. The software Python Biogeme (Bierlaire, 2003), a version of Biogeme based on the Python language, was used to estimate all discrete choice models in this dissertation. This software is able to estimate model parameters (β) using maximum likelihood estimation.

5.3.1 DATA SOURCES AND JOINT ANALYSIS

The main difference between RP and SP data is that RP data reflect choice processes based on actual market behavior under real constraints, where individual preferences are revealed through choices made in real world situations, while SP data are elicited from hypothetical choices among alternatives created in an experimental situation (Train, 2009). RP data are generally valid, reliable and suitable for short term forecasting, but they can be inadequate for studying certain choices if, for example, there is little variation in the underlying data (making it impossible to determine how responses are affected by such variation) or if the alternatives of interest are novel or too different from the experiences in the dataset (Louviere et al., 2000). The RP data collected from the survey represent real behavior of UC Berkeley employees, even if they were self-reported by the survey respondents. However, RP data alone is insufficient to analyze the impact of parking pricing because of the lack of variability in actual parking type and prices. This is due to the fact that only two types of parking permit dominate total permit sales, where 73 percent of the survey respondents who drive alone and park on campus use either a Faculty / Staff Annual "F" Permit ($90 per month) or Central Campus Annual "C" Permit ($124 per month). In addition, it is also infeasible to use RP data to estimate the effects of new parking alternatives that provide incentives to those who reduce their parking use because there are no such actual alternatives currently being offered.

SP data are crucial in this dissertation as they were used to examine how transportation mode choice and parking preferences would shift under parking pricing scenarios that do not exist currently. SP data also facilitated the analysis of response to prices that go well beyond those offered to travelers at present. As a result, the price coefficients estimated from SP data are likely to be more robust than those from models estimated from RP data (Swait et al., 1994). On the other hand, because SP data are hypothetical, they might not adequately represent the alternatives as they actually would be presented and experienced if offered, e.g., market and personal constraints might not be accurately accounted for (Louviere et al., 2000). There is also a risk that the survey respondents exaggerated their preferred behaviors because they would not want the University to increase parking prices or to use the survey to determine their willingness to pay for campus parking.

Combining the sources of preference data is a classic way to enhance the strengths and ameliorate the weaknesses of RP and SP data. This approach was first introduced in the late 1980s as an attempt to increase the validity of SP data and to improve the accuracy of parameter estimates (Morikawa, 1989). Combining RP data from actual behavior with SP data from choice

experiments addresses the problem of insufficient variation in explanatory attributes in the data (Louviere et al, 2000). In this case, it can help overcome the low level of variation in the price paid for parking and its location.

In this dissertation, RP and SP data were first used separately for two MNL models to identify factors that were significant in contributing to the modes chosen by the respondents. A joint analysis was then conducted using both data types (RP-SP joint analysis).

5.3.2 MULTINOMIAL LOGIT (MNL) MODEL

The MNL model is a commonly used form of discrete choice analysis. It is obtained by assuming three distinct characteristics of the error components (or the unobserved utility) of the utility function for each alternative. First, the error components are assumed to be extreme-value (or Gumbel) distributed (McFadden, 1974). Second, the error components are identically and independently distributed across alternatives and third, the error components are identically and independently distributed across observations due to its independence from irrelevant alternatives (IIA) property (McFadden, 1974, Train, 2009). The error component can be expressed as ε_{nj}, where n is an individual and j is an alternative in a set of J alternatives. The utility function can be decomposed into, 1) a systematic component of the utility of alternative j, denoted as V_{nj} and known by estimating the relevant parameters, and 2) an unknown random component, ε_{nj}. Hence, the utility (U) function of individual n for alternative j is expressed as,

$$U_{nj} = V_{nj} + \varepsilon_{nj} \tag{5.1}$$

The Gumbel distribution creates a closed-form probabilistic choice model, which allows the calculation of the probability without the use of numerical integration or simulation methods (Koppelman and Sethi, 2006). This assumption reduces the computational burden of MNL models, which explains its popularity.

The outcomes of MNL models are logit choice probabilities of each alternative as a function of the systematic portion of the utility of all the alternatives available in a choice set. The model assumes that each individual chooses an alternative based on the theory of maximum utility, where the maximum likelihood estimation is applied (McFadden, 1974). The general expression for the probability of choosing alternative *i* in a set of *j=1, ...J* alternatives is,

$$P_{ni} = \frac{e^{V_{ni}}}{\sum_j e^{V_{nj}}} \tag{5.2}$$

Since the utility function is assumed to be linear in parameters (β), implying $V_{nj} = \beta X_{nj}$, where β is a row vector of unknown parameters and X_{nj} is a column vector of observed variables associated with alternative j, the logit probabilities can be expressed as,

$$P_{ni} = \frac{e^{\beta X_{ni}}}{\sum_j e^{\beta X_{nj}}} \quad (5.3)$$

5.4 TRANSPORTATION MODE CHOICE MODEL

The transportation and parking survey asked for each respondent's transportation mode choice for seven days of the week, both in the RP and SP sections. Since 4,188 employees responded to the survey, the maximum number of observations for the RP transportation mode choice model is 29,316 (4,188 * 7), resulting in a panel data that represent repeated choices for seven days of the week. As each respondent was shown five SP choice sets, the maximum number of observations for the SP transportation mode choice model is 146,580 (4,188 * 7 * 5). However, because the focus of the discrete choice analysis is to understand commuting preferences in a workweek, i.e. Monday to Friday, data for the weekends (i.e. Saturday and Sunday) were excluded, reducing the maximum number of observations for the RP and SP analyses to 20,940 (4,188 * 5) and 104,700 (4,188 * 5 * 5) respectively. Not all cases had sufficient data that could be used for modeling. Cases that are missing crucial data, such as residential address, which determine travel distance, travel time and travel cost subsequently, or socioeconomic data, such as employment type or income, were removed from the analyses. Hence, the final number of observations used in the MNL models is 12,511 for the RP model and 74,260 for the SP model. These observations also exclude observations with travel distances that are outliers (e.g. employees who reported commuting to Berkeley from a different state). The total number of observations in the RP-SP model is the sum of the observations in the RP and SP models.

5.4.1 MODEL SPECIFICATIONS

ALTERNATIVES AND UTILITY FUNCTIONS

The transportation mode choice model has nine transportation alternatives, including "Working at home" and "Not on campus" (Table 5.1) but eight modal constants, as one alternative (Walk only) was normalized to zero. This means that the "Walk only" alternative was used as a base with a zero constant (Equation 5.11), implying that the other constants would be interpreted as relative to choosing to "Walk only."

The alternative "Other" transportation mode, which was presented in the survey, was not included in all models, as its definition varied across respondents and also because only 0.2 to 1.58 percent of the respondents chose "Other" in the RP section of the survey. A composite alternative was used for transit, which combined bus and train mode choices. The mode with the shortest travel time, hence, highest efficiency was selected when there were multiple transit alternatives. Parking preferences can be found in the two drive alone alternatives, the first is drive alone but park on campus, while the other refers to drive alone but not park on campus. Although other combinations of drive alone and parking alternatives exist in the RP data, only two drive alone alternatives were included in the final mode choice models to be consistent with the SP alternatives, as only two drive alone alternatives were shown in the SP choice set. It is important to note that the SP transportation mode choice model was derived from the parking

choice model, as respondents were asked to choose a parking option first before they were asked to select a transportation mode choice (Figure 3.4).

Table 5.1. Alternatives in Transportation Mode Choice Models

Number	Code	Alternative	
		RP Model	**SP Model**
1	CAR	Drive alone and park on campus	Drive alone and park on campus (using Parking Options provided in SP choice sets)
2	CARNOPK	Drive alone but not park on campus[1]	Drive alone but not park on campus[2]
3	CARPL	Carpool	Carpool
4	MOTRC	Motorcycle	Motorcycle
5	TRANSIT[3]	Transit	Transit
6	BIKE	Bicycle	Bicycle
7	WALK	Walk only	Walk only
8	HOME	Work at home	Work at home
9	NOC	Not on campus	Not on campus

Note. [1]The "Drive alone but not park on campus" alternative in the RP model refers to drive alone to campus but not park on campus. Off campus parking locations include on-street metered parking, public garages, private off-street parking, unmetered on-street parking with time limit enforcement, unmetered on-street parking without time limit enforcement, and on-street residential parking.
[2]In the SP model, the "Drive alone but not park on campus" alternative refers to drive alone to campus but park elsewhere. Respondents who chose to drive alone but not park on campus could have chosen none of the parking options in the SP choice set, i.e. Parking Option E.
[3]The "Transit" alternative in both RP and SP models is a composite alternative that combines train and bus.

The utility of each alternative in the choice set is expressed as follows, where U_{in} is the utility of the *i*th alternative for the *n*th individual.

$$U_{in} = \alpha_i + \beta_i X_{in} + \varepsilon_{in} \quad (5.4)$$

where α_i is the alternative specific constant (ASC), β_i is the vector of unknown parameters, X_{in} represents the vectors of known variables (e.g. travel time, travel cost and socioeconomic variables), while ε_{in} is the unobserved error term.

A simple, restricted model was first estimated with two explanatory variables, namely travel time and travel cost, which were assumed to have a strong impact on the utility functions. These two variables were included in the utility functions for "Drive alone and park on campus," "Drive alone but not park," "Carpool," "Motorcycle," and "Transit." Travel time was the only explanatory variable included in the utility function for "Bicycle," while the utility functions for "Work at home" and "Not on campus" only consisted of their respective alternative specific constants. The parameters used for travel time and travel cost were constrained to be the same, as it was assumed that the impact of time and cost would be equal across all alternatives. In

order words, time and cost will affect each utility (mode choice) the same way. This restricted model (RP data) is specified using the following utility functions (Equations 5.5 to 5.13).

$$U_{CAR} = \alpha_{CAR} + \beta_{TRAVEL\,TIME} CAR\ TRAVEL\ TIME + \beta_{TRAVEL\,COST} CAR\ COST \quad (5.5)$$

$$U_{CARNOPK} = \alpha_{CARNOPK} + \beta_{TRAVEL\,TIME} CAR\ TRAVEL\ TIME + \beta_{TRAVEL\,COST} CARNOPK\ COST \quad (5.6)$$

$$U_{CARPL} = \alpha_{CARPL} + \beta_{TRAVEL\,TIME} CAR\ TRAVEL\ TIME + \beta_{TRAVEL\,COST} CARPL\ COST \quad (5.7)$$

$$U_{MOTRC} = \alpha_{MOTRC} + \beta_{TRAVEL\,TIME} CAR\ TRAVEL\ TIME + \beta_{TRAVEL\,COST} MOTRC\ COST \quad (5.8)$$

$$U_{TRANSIT} = \alpha_{TRANSIT} + \beta_{TRAVEL\,TIME} TRANSIT\ TRAVEL\ TIME + \beta_{TRAVEL\,COST} TRANSIT\ COST \quad (5.9)$$

$$U_{BIKE} = \alpha_{BIKE} + \beta_{TRAVEL\,TIME} BIKE\ TRAVEL\ TIME \quad (5.10)$$

$$U_{WALK} = \alpha_{WALK} + \beta_{TRAVEL\,TIME} WALK\ TRAVEL\ TIME \text{ (normalized to zero)} \quad (5.11)$$

$$U_{HOME} = \alpha_{HOME} \quad (5.12)$$

$$U_{NOC} = \alpha_{NOC} \quad (5.13)$$

A restricted model was also estimated using the SP data. The only difference between the RP and SP mode choice model is the addition of an inertia dummy in all of the SP alternatives. The endogenous choice variable from the RP data was incorporated as an exogenous variable in the SP utility functions in order to represent inertia, which suggests that travel behavior may be habitual (Cantillo et al., 2007). Inertia also implies the presence of state dependence (Hensher, 1994), i.e. the dependence of SP on RP. It is a common practice to include inertia dummies in models derived from SP surveys or RP-SP surveys, in order to prevent misspecified models and biased results (Kitamura, 1990; Bradley and Daly, 1997).

The SP restricted model is specified with the following utility functions (Equations 5.14 to 5.22). The "Walk only" alternative was normalized to zero (Equation 5.20), just like in the RP model, which means that the "Walk only" alternative was used as a base with a zero constant, implying that the other constants would be interpreted as relative to choosing to "Walk only."

$$U_{CAR\_SP} = \alpha_{CAR\_SP} + \beta_{TRAVEL\,TIME} CAR\ TRAVEL\ TIME + \beta_{TRAVEL\,COST} CAR\ COST + \beta_{INERTIA}(RP\ CHOICE = CAR) \quad (5.14)$$

$$U_{CARNOPK\_SP} = \alpha_{CARNOPK\_SP} + \beta_{TRAVEL\,TIME} CAR\ TRAVEL\ TIME + \beta_{TRAVEL\,COST} CARNOPK\ COST + \beta_{INERTIA}(RP\ CHOICE = CARNOPK) \quad (5.15)$$

$$U_{CARPL\_SP} = \alpha_{CARPL\_SP} + \beta_{TRAVEL\,TIME} CAR\,TRAVEL\,TIME + \beta_{TRAVEL\,COST} CARPL\,COST + \beta_{INERTIA}(RP\,CHOICE = CARPL) \quad (5.16)$$

$$U_{MOTRC\_SP} = \alpha_{MOTRC\_SP} + \beta_{TRAVEL\,TIME} CAR\,TRAVEL\,TIME + \beta_{TRAVEL\,COST} MOTRC\,COST + \beta_{INERTIA}(RP\,CHOICE = MOTRC) \quad (5.17)$$

$$U_{TRANSIT\_SP} = \alpha_{TRANSIT\_SP} + \beta_{TRAVEL\,TIME} TRANSIT\,TRAVEL\,TIME + \beta_{TRAVEL\,COST} TRANSIT\,COST + \beta_{INERTIA}(RP\,CHOICE = TRANSIT) \quad (5.18)$$

$$U_{BIKE\_SP} = \alpha_{BIKE\_SP} + \beta_{TRAVEL\,TIME} BIKE\,TRAVEL\,TIME + \beta_{INERTIA}(RP\,CHOICE = BIKE) \quad (5.19)$$

$$U_{WALK\_SP} = \alpha_{WALK\_SP} + \beta_{TRAVEL\,TIME} WALK\,TRAVEL\,TIME + \beta_{INERTIA}(RP\,CHOICE = WALK) \text{ (normalized to zero)} \quad (5.20)$$

$$U_{HOME\_SP} = \alpha_{HOME\_SP} + \beta_{INERTIA}(RP\,CHOICE = HOME) \quad (5.21)$$

$$U_{NOC\_SP} = \alpha_{NOC\_SP} + \beta_{INERTIA}(RP\,CHOICE = NOC) \quad (5.22)$$

A third model that reflects the RP-SP joint analysis was also estimated using both RP and SP data, which were stacked together as an input to the MNL estimation program. Separate constants were estimated and different scale parameters were specified for the SP and RP models. It is conventional to normalize the RP scale parameter to one, which implies that the SP scale parameter is a relative scale with respect to the RP scale parameter (Louviere et al., 2000). The coefficients in the RP-SP model were divided by the SP scale parameter for the SP observations. The SP scale parameter is denoted as μ. All SP utility functions in the RP-SP joint analysis also included an inertia dummy.

Additional variables were then added to the mode choice models to further explain transportation behavior, after the restricted models were estimated. A model with a full set of variables was first estimated to identify insignificant parameters across all alternatives, which were then excluded in the final model. The parameters used for socioeconomic variables that reflect individual characteristics were not constrained across all utility functions. This is because individual characteristics were assumed to have a different impact on each alternative. For example, age will have a greater impact on the utility for bicycle than drive alone to campus and older employees are more likely to walk than bicycle to campus. Another example is that gender will affect the utility for motorcycle more than drive alone, as male employees are more likely to ride motorcycles to campus than female employees.

The following utility functions, Equations 23 to 31, were included in the final RP mode choice model, with socioeconomic variables such as income (INC), faculty dummy (faculty or staff affiliation with UC Berkeley) (FAC), number of dependents (DEP), gender (GEN), and age (AGE). These variables were retained in the final model because of their significance across most alternatives. The faculty dummy, number of dependents and gender variables are in fact

significant across all alternatives. Retaining income, University affiliation, i.e. faculty or staff, number of dependents, gender, and age variables will help understand how travel preferences vary across different social groups. Again, the "Walk only" alternative was normalized to zero and used as a base with a zero constant (Equation 5.29).

The final SP and RP-SP model choice models were also estimated using identical utility functions, with the addition of an inertia dummy in the SP analysis and the use of a SP scale parameter in the RP-SP joint analysis.

$$U_{CAR} = \alpha_{CAR} + \beta_{TRAVEL\,TIME} CAR\ TRAVEL\ TIME + \beta_{TRAVEL\,COST} CAR\ COST + \beta_{INC\_CAR} INC + \beta_{FAC\_CAR} FAC + \beta_{DEP\_CAR} DEP + \beta_{GEN\_CAR} GEN + \beta_{AGE\_CAR} AGE \quad (5.23)$$

$$U_{CARNOPK} = \alpha_{CARNOPK} + \beta_{TRAVEL\,TIME} CAR\ TRAVEL\ TIME + \beta_{TRAVEL\,COST} CARNOPK\ COST + \beta_{INC\_CARNOPK} INC + \beta_{FAC\_CARNOPK} FAC + \beta_{DEP\_CARNOPK} DEP + \beta_{GEN\_CARNOPK} GEN + \beta_{AGE\_CARNOPK} AGE \quad (5.24)$$

$$U_{CARPL} = \alpha_{CARPL} + \beta_{TRAVEL\,TIME} CAR\ TRAVEL\ TIME + \beta_{TRAVEL\,COST} CARPL\ COST + \beta_{INC\_CARPL} INC + \beta_{FAC\_CARPL} FAC + \beta_{DEP\_CARPL} DEP + \beta_{GEN\_CARPL} GEN + \beta_{AGE\_CARPL} AGE \quad (5.25)$$

$$U_{MOTRC} = \alpha_{MOTRC} + \beta_{TRAVEL\,TIME} CAR\ TRAVEL\ TIME + \beta_{TRAVEL\,COST} MOTRC\ COST + \beta_{INC\_MOTRC} INC + \beta_{FAC\_MOTRC} FAC + \beta_{DEP\_MOTRC} DEP + \beta_{GEN\_MOTRC} GEN + \beta_{AGE\_MOTRC} AGE \quad (5.26)$$

$$U_{TRANSIT} = \alpha_{TRANSIT} + \beta_{TRAVEL\,TIME} TRANSIT\ TRAVEL\ TIME + \beta_{TRAVEL\,COST} TRANSIT\ COST + \beta_{INC\_TRANSIT} INC + \beta_{FAC\_TRANSIT} FAC + \beta_{DEP\_TRANSIT} DEP + \beta_{GEN\_TRANSIT} GEN + \beta_{AGE\_TRANSIT} AGE \quad (5.27)$$

$$U_{BIKE} = \alpha_{BIKE} + \beta_{TRAVEL\,TIME} BIKE\ TRAVEL\ TIME + \beta_{INC\_BIKE} INC + \beta_{FAC\_BIKE} FAC + \beta_{DEP\_BIKE} DEP + \beta_{GEN\_BIKE} GEN + \beta_{AGE\_BIKE} AGE \quad (5.28)$$

$$U_{WALK} = \alpha_{WALK} + \beta_{TRAVEL\,TIME} WALK\ TRAVEL\ TIME \text{ (normalized to zero)} \quad (5.29)$$

$$U_{HOME} = \alpha_{HOME} + \beta_{INC\_HOME} INC + \beta_{FAC\_HOME} FAC + \beta_{DEP\_HOME} DEP + \beta_{GEN\_HOME} GEN + \beta_{AGE\_HOME} AGE \quad (5.30)$$

$$U_{NOC} = \alpha_{NOC} + \beta_{INC\_NOC} INC + \beta_{FAC\_NOC} FAC + \beta_{DEP\_NOC} DEP + \beta_{GEN\_NOC} GEN + \beta_{AGE\_NOC} AGE \quad (5.31)$$

Travel Time, Travel Cost and Parking Cost Estimations

Google Maps Application Programming Interface (API) Web Services were used to estimate travel time for driving, biking and walking, first by geocoding the street address (intersection), city and zip code provided by the survey respondents. Second, the destination of each respondent was geocoded using the building name or street address (depending on what was provided) of his or her primary workplace on campus. Each respondent has a unique origin and destination pair that is then converted to a pair of latitude and longitude coordinates. These coordinates were then used to estimate travel distance and travel time for driving, biking and walking using Google Directions API. Transit travel time was estimated by zip code, also using Google Maps but not with Google Directions API because each origin has to correspond with a feasible transit service, e.g. a BART station or AC Transit bus stop, so a manual check was necessary for each origin and destination pair. Walking time from each respondent's parking location to his or her primary work place (building) on campus was also estimated using Google Maps API after each origin and destination pair has been geocoded. Carpooling and motorcycle alternatives were assumed to have the same travel time as driving alone.

Travel cost was estimated differently depending on the transportation alternative. The cost of driving alone (CAR) was estimated using Equation 5.32, where the cost of vehicle operation (gasoline and miscellaneous) was assumed to be \$0.20 per mile, which is the approximate average variable cost of vehicle operation (fuel, oil, tires etc.) in California. All travel and parking costs were scaled to a daily cost (per trip) in the transportation mode choice models.

$$CAR\ Travel\ Cost = (0.2 * CAR\ Travel\ Distance) + CAR\ Parking\ Cost \quad (5.32)$$

where $CAR\ Parking\ Cost$ is a function of UC Berkeley campus parking permit type for respondents who have reported holding a parking permit in the RP model.

Parking cost for drive alone and park on campus in the RP analysis was estimated based on the reported campus parking permit type in the survey. The prices of all campus parking permits are shown in Table 3.1. Prices of campus parking permits range from \$38 (Emeritus Permit) to \$124 for a Central Campus Annual "C" Permit. A daily average cost of each of the reported campus parking permit, with the assumption of 20 working days a month, was used in the model. For example, if a survey respondent reported holding a Faculty / Staff Annual "F" permit, which costs \$90 per month, the daily parking cost of this respondent would thus be \$4.50. For respondents who did not report drive alone and park on campus in the survey, their daily parking rate for on campus parking was assumed to be \$4.50, as the Faculty / Staff Annual "F" permit is the most popular campus parking permit sold and is available to all employees.

On the other hand, all parking costs in the SP analysis were predefined values from the SP choice sets. Again, a daily parking cost was used for the cost estimation for consistency across all alternatives. The SP choice sets included parking options that were priced by month and day, and the monthly cost values were converted to a daily rate for respondents who had chosen to drive and park using the parking options provided. A per day rate for the monthly parking options was calculated by assuming 20 (Parking Option A), 16 (Parking Option B, restricted to

parking four days a week), or 12 (Parking Option B, restricted to parking three days a week) working days per month, depending on the type of parking permit presented and chosen. If a respondent did not choose to drive and park on campus, i.e. did not choose Parking Option A, B, or C, a daily parking rate of $9 was assumed for the cost of parking on campus. This is the average cost of the daily parking option (Parking Option C) presented in the SP choice sets.

The travel cost for driving alone to campus but not park on campus (CARNOPK) differs from the cost of driving alone and park on campus by the assumptions made for parking cost.

$$CARNOPK\ Travel\ Cost = (0.2 * CAR\ Travel\ Distance) + CARNOPK\ Parking\ Cost \quad (5.33)$$

The parking cost in this case is not a function of campus permit type, but off-campus parking locations instead, which determine the cost of off-campus parking. Reported off-campus parking locations in the survey include public off-street parking garages ($9 per day), metered on-street parking ($1.67 per hour on average in the City of Berkeley, $1.67 * 8 average working hours = $13.36 per day) and unmetered on-street parking with and without time limit enforcement ($0). In the RP model, parking cost was estimated using the reported responses on off campus parking location for respondents who chose to drive and park off campus. For respondents who did not choose to drive and park off campus, their cost of off-campus parking was assumed to be $9 per day, which is the average parking cost at public garages.

In the SP model, a parking cost of $9 per day was assumed for respondents who chose to drive alone to campus but park elsewhere, not using any of the parking options presented in the SP choice set. This is the daily cost of off-campus parking that most employees have reported paying.

The cost of carpooling (CARPL) was estimated to be half of the cost of driving alone. However, since the cost of a current campus carpool permit has to be purchased by each carpooler, the cost of parking for carpoolers is lower than the cost of parking for solo drivers but not necessarily by 50 percent. Hence, the travel cost for carpoolers was calculated by dividing the cost of driving alone by two but with a separate parking cost for carpool users. The cost of a carpool permit reflects the actual cost of a campus carpool parking permit in the RP model, which is $44 for a Central Campus Carpool Permit and $29 for a Faculty/Staff Carpool Permit per month. In the SP model, the cost of parking for carpool users was assumed to be half of the cost of parking shown in the SP choice sets.

$$CARPL\ Travel\ Cost = \left(\frac{0.2 * CAR\ Travel\ Distance}{2}\right) + CARPL\ Parking\ Cost \quad (5.34)$$

The travel cost of motorcycles was assumed to be the same as driving alone but with a different parking cost (Equation 5.35). The parking cost for motorcycles reflects the actual campus motorcycle permit, which is $24 per month. The same assumption was made in both RP and SP models.

$$MOTRC\ Travel\ Cost = (0.2 * CAR\ Travel\ Distance) + MOTRC\ Parking\ Cost \quad (5.35)$$

Transit cost was estimated by zip code using Google Map or 511.org depending on the availability of information. Although only AC Transit and BART offer direct services to the UC Berkeley campus, certain residential locations require the use of a combination of other transit agencies in the San Francisco Bay Area, such as SF Muni, Contra Costa County Connection, Caltrain, VTA, Amtrak, Golden Gate Transit, SamsTrans, and TriDelta Transit, Altamont Commuter Express.

5.4.2 MODEL ESTIMATION RESULTS

Table 5.2 presents the results of the RP, SP and RP-SP restricted models. In the RP model, transit has the highest constant, which suggests that transit is the most preferred mode choice, followed by drive alone and park on campus. This shows that transit is still a popular mode choice at UC Berkeley, which reflects feasible transit services and employees' high preference to use transit. Drive alone is another popular mode choice. In the RP data presented in Chapter 4, approximately a quarter of survey respondents currently use transit to commute to work, while almost half of all respondents drive alone to work (Figures 4.1 and 4.2). Both travel time and cost variables are positive and highly significant, which implies that the longer the travel time and the higher the travel cost, the less attractive the alternatives will be.

The inertia dummy has a positive sign and is highly significant at 6.77. This suggests that there is state dependence in the SP model and RP-SP joint analysis, i.e. the respondents were selecting SP choices based on their RP choices.

A likelihood ratio test was done to determine the validity of the SP model. The restricted RP-SP model has 20 parameters and a log-likelihood of -106,851 (Table 5.2). The unrestricted model, which is the RP and SP models separately estimated, has a log-likelihood of -22,545 (RP) + (-84,303) (SP) = -106,848. The degrees of freedom is 10 (RP) + 11 (SP) – 20 (RP-SP) = 1. Hence, the test statistic is, -2 * (-106,851 – (-106,848)) = 5.37. The Chi-Squared critical value with a one degree of freedom is 6.63 for p = 0.01. Since 5.37 is less than 6.63, the null hypothesis that the RP parameters and SP parameters are the same is not rejected. This implies that the SP parameters are valid and robust estimations of travel and parking behavior.

Table 5.2. Multinomial Logit (MNL) Model: Joint Estimation of SP and RP Transportation Mode Choices (Restricted Model)

	RP			SP			RP+SP		
Explanatory Variables	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**
Drive alone park on campus constant (RP)	0.286	3.75	0.00				0.358	5.73	0.00
Drive alone park off campus constant (RP)	-0.562	-5.62	0.00				-0.470	-6.12	0.00
Carpool constant (RP)	-1.570	-23.57	0.00				-1.550	-23.39	0.00
Motorcycle constant (RP)	-3.120	-32.13	0.00				-3.080	-32.20	0.00
Transit constant (RP)	0.551	11.81	0.00				0.577	13.25	0.00
Bicycle constant (RP)	-0.640	-12.53	0.00				-0.634	-12.40	0.00
Walk only constant (RP)	-	-	-						
Work at home constant (RP)	-2.990	-31.75	0.00				-2.980	-31.44	0.00
Not on campus constant (RP)	-1.930	-22.79	0.00				-1.920	-22.47	0.00
Drive alone park on campus constant (SP)				1.140	30.94	0.00	2.630	15.50	0.00
Drive alone park off campus constant (SP)				-0.977	-21.77	0.00	-2.470	-17.31	0.00
Carpool constant (SP)				-0.526	-16.91	0.00	-1.320	-17.62	0.00
Motorcycle constant (SP)				-1.750	-46.44	0.00	-4.240	-20.65	0.00
Transit constant (SP)				0.724	34.54	0.00	1.700	16.14	0.00
Bicycle constant (SP)				-0.052	-2.46	0.01	-0.128	-2.62	0.01
Walk only constant (SP)				-	-	-	-	-	-

	RP			SP			RP+SP		
Explanatory Variables	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**
Work at home constant (SP)				-1.540	-39.82	0.00	-3.700	-22.32	0.00
Not on campus constant (SP)				-1.360	-38.86	0.00	-3.270	-22.68	0.00
Travel cost ($/trip)	-0.063	-7.61	0.00	-0.034	-12.19	0.00	-0.072	-12.19	0.00
Travel time (min)	-0.019	-27.94	0.00	-0.008	-25.05	0.00	-0.018	-27.38	0.00
Inertia dummy				2.820	233.08	0.00	6.770	19.29	0.00
Scale (μ)							0.417	19.56	0.00
Summary Statistics									
Number of observations	12,496			74,059			86,555		
Log-Likelihood (0)	-27,457			-162,725			-190,181		
Log-Likelihood (Model)	-22,545			-84,303			-106,851		
Likelihood ratio test	9,822			156,843			166,660		
Rho square	0.03			0.23			0.20		

After estimating the restricted models, five additional explanatory variables were added to provide a better understanding of travel behavior. A likelihood ratio test was done to determine if the additional variables included in the final RP and SP models contributed further explanatory power compared to the restricted models. As shown in Table 5.2, the restricted RP mode choice model only has two explanatory variables, i.e. travel cost and travel time, 10 parameters and a log-likelihood of -22,545. In the final RP model, the number of parameters has increased to 50 and the log-likelihood is -21,671. The likelihood ratio test statistic is therefore, -2 * (-22,545 – (-21,671) = 1,748. The degrees of freedom is 50 – 10 = 40, which gives a Chi-Squared critical value of 64 for p = 0.01. Since 1,748 is greater than 64, the null hypothesis that the additional variables do not contribute to the model is rejected with 99 percent confidence. Hence, it is important to include the additional variables in the final model to better understand travel behavior.

The same likelihood ratio test was done for the SP restricted and SP full models, and the test result shows that the likelihood ratio test statistic is 1,690, which is greater than the Chi-Squared critical value of 40. Therefore, the null hypothesis that additional variables do not contribute to the model is also rejected with 99 percent confidence for the SP model.

The model estimation results show that transit has the highest constant in the RP model, as well as in the SP and RP-SP models. Non-motorized transportation modes, i.e. walk and bicycle, have the second highest utility in the RP model. This shows that employees prefer to use transit than to walk or bicycle to campus. However, in the SP model, the "drive alone and park on campus" alternative has the second highest constant, followed by non-motorized transportation modes. For those who do drive, drive alone and park on campus is more attractive than drive alone but park off campus in all three models. More employees prefer to park on campus than off campus. This is supported by the underlying data where 70 percent of employees who drive to campus park on campus. This could be an income driven preference, as the higher the income, the more likely employees will drive and park on campus (Table 5.3). Travel time and cost variables are significant and negative in all three models, implying that respondents prefer alternatives with lower travel cost and time.

Socioeconomic variables included in the final model are, age, number of dependents, faculty dummy, gender, and total annual household income. The parameters for age are highly significant for drive alone and park on campus, drive alone and park off campus and bicycle across all three models. The older the age, the higher the preference to drive alone, regardless of where they choose to park, compared to walking to campus. On the other hand, the older the age, the less likely employees would bicycle to campus. Since all other age parameters are positive in alternatives other than bicycle, older employees will bicycle less than walk to campus but would choose all the other alternatives over walking to campus.

The number of dependents variable is highly significant and positive across all three models for five alternatives, with the highest values for the two drive alone alternatives. This means that employees with more dependents are most likely to drive alone but not park on campus, followed by drive alone but park on campus. Other alternatives that have significant number of dependents parameters include transit, work from home and not on campus, which show that the

greater the number of dependents in a household, the higher the preference to use transit, work from home or not be on campus more than to walk to campus.

Faculty members use motorcycle, bicycle, work at home, and are more likely to not be on campus when compared to staff members. Similarly, male employees also tend to find motorcycle and bicycle mode choices more attractive than female employees. Staff members tend to favor the two drive alone alternatives, carpool, and transit more compared to faculty members, as suggested by the negative parameter estimates for each of the relevant faculty dummy variable. Gender, where male = 1 in the dummy variable, also has negative parameter estimates in the two drive alone alternatives, carpool and transit, implying that female respondents drive alone, carpool and use transit more than male respondents do.

Annual household income is insignificant for drive alone but not park on campus, motorcycle and transit, which means that there are other reasons for these mode choice decisions. The fact that drive alone but not park on campus is not affected by income shows that employees choose to park off campus regardless of income and could make such a decision based on a higher preference to use off-campus parking locations. Transit use is not affected by income too, which signifies that it is a mode choice that appeals to different income groups.

Income is significant and has a positive sign for all other alternatives, including drive alone and park on campus, carpool, bicycle, work at home, and not being on campus. Hence, employees with higher household income tend to drive and park on campus, carpool and bicycle more than walk to campus.

Another likelihood ratio test was done to determine the validity of the final SP model. The restricted RP-SP model has 60 parameters and a log-likelihood of -105,361 (Table 5.3). The unrestricted model, which is the RP and SP models separately estimated, has a log-likelihood of -21,671 (RP) + (-83,458) (SP) = 61,787. The degrees of freedom is 50 (RP) + 51 (SP) – 60 (RP-SP) = 41. Hence, the test statistic is, -2 * (-105,361 – (-61,787)) = 463. The Chi-Squared critical value with 41 degrees of freedom is 65 for p = 0.01. Since 463 is greater than 65, the null hypothesis that the RP parameters and SP parameters are the same is rejected. This shows that the final SP model is not as statistically robust as the SP restricted model. Hence, parameters estimated in the SP model were not used in the estimation of price demand elasticity in Section 5.4.4 and in the parking price forecast described in Section 5.6.

Table 5.3. Multinomial Logit (MNL) Model: Joint Estimation of SP and RP Transportation Mode Choices

	RP			SP			RP + SP		
Explanatory Variables	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**
Drive alone park on campus constant (RP)	-1.620	-10.52	0.00				-1.280	-10.19	0.00
Drive alone park off campus constant (RP)	-2.230	-11.51	0.00				-1.730	-11.12	0.00
Carpool constant (RP)	-2.830	-15.33	0.00				-2.260	-15.57	0.00
Motorcycle constant (RP)	-4.320	-13.53	0.00				-4.230	-18.30	0.00
Transit constant (RP)	0.061	0.44	0.66				0.368	3.40	0.00
Bicycle constant (RP)	-1.420	-8.72	0.00				-0.693	-5.59	0.00
Walk only constant (RP)	-	-	-				-	-	-
Work at home constant (RP)	-4.620	-17.90	0.00				-4.360	-21.33	0.00
Not on campus constant (RP)	-4.070	-19.16	0.00				-3.360	-18.76	0.00
Drive alone park on campus constant (SP)				0.543	7.36	0.00	0.834	5.94	0.00
Drive alone park off campus constant (SP)				-1.320	-12.45	0.00	-3.610	-19.10	0.00
Carpool constant (SP)				-0.570	-6.88	0.00	-2.000	-13.28	0.00
Motorcycle constant (SP)				-2.150	-18.23	0.00	-5.180	-19.91	0.00
Transit constant (SP)				0.779	11.72	0.00	1.400	11.71	0.00
Bicycle constant (SP)				0.363	5.21	0.00	-0.124	-1.01	0.31

	RP			SP			RP + SP		
Explanatory Variables	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**
Walk only constant (SP)				-	-	-	-	-	-
Work at home constant (SP)				-2.060	-18.41	0.00	-5.000	-21.68	0.00
Not on campus constant (SP)				-1.640	-16.50	0.00	-4.670	-22.28	0.00
Age - Drive alone park on campus	0.198	6.99	0.00	0.086	6.18	0.00	0.203	9.53	0.00
Age - Drive alone park off campus	0.286	8.38	0.00	-0.019	-0.96	0.34	0.172	6.18	0.00
Age - Carpool	0.056	1.50	0.13	-0.034	-2.08	0.04	0.003	0.12	0.91
Age - Motorcycle	0.120	2.01	0.04	0.029	1.40	0.16	0.117	3.11	0.00
Age - Transit	0.079	2.77	0.01	-0.039	-2.78	0.01	0.009	0.43	0.67
Age - Bicycle	-0.111	-3.34	0.00	-0.241	-15.93	0.00	-0.305	-12.42	0.00
Age - Work at home	0.092	1.84	0.07	0.019	0.91	0.36	0.080	2.25	0.02
Age - Not on campus	0.251	6.36	0.00	-0.021	-1.09	0.27	0.136	4.52	0.00
Dependents - Drive alone park on campus	0.522	8.58	0.00	0.145	5.54	0.00	0.422	10.17	0.00
Dependents - Drive alone park off campus	0.594	9.08	0.00	0.279	8.78	0.00	0.565	12.47	0.00
Dependents - Carpool	0.486	6.80	0.00	0.021	0.74	0.46	0.274	5.58	0.00
Dependents - Motorcycle	0.356	3.58	0.00	0.038	0.97	0.33	0.213	3.20	0.00
Dependents - Transit	0.310	4.97	0.00	0.081	3.06	0.00	0.239	5.73	0.00
Dependents - Bicycle	0.437	6.43	0.00	0.005	0.18	0.86	0.233	5.01	0.00
Dependents - Work at home	0.333	3.92	0.00	0.131	3.76	0.00	0.310	5.50	0.00
Dependents - Not on campus	0.291	4.06	0.00	0.113	3.63	0.00	0.253	5.19	0.00
Faculty dummy - Drive alone park on campus	-0.118	-1.20	0.23	0.072	1.49	0.14	-0.008	-0.11	0.91
Faculty dummy - Drive alone park off campus	-0.332	-2.80	0.01	-0.137	-1.83	0.07	-0.305	-3.16	0.00
Faculty dummy - Carpool	-0.819	-5.39	0.00	0.035	0.58	0.56	-0.384	-3.91	0.00
Faculty dummy - Motorcycle	0.181	0.76	0.45	-0.309	-3.40	0.00	-0.344	-2.03	0.04
Faculty dummy - Transit	-0.772	-7.32	0.00	-0.246	-4.84	0.00	-0.682	-8.60	0.00
Faculty dummy - Bicycle	0.455	3.98	0.00	0.490	9.34	0.00	0.753	8.96	0.00
Faculty dummy - Work at home	1.200	7.70	0.00	0.640	9.37	0.00	1.300	11.62	0.00
Faculty dummy - Not on campus	0.819	6.74	0.00	0.228	3.66	0.00	0.732	7.74	0.00
Gender - Drive alone park on campus	-0.630	-8.10	0.00	-0.070	-1.82	0.07	-0.423	-7.05	0.00
Gender - Drive alone park off campus	-0.624	-6.81	0.00	-0.094	-1.68	0.09	-0.466	-6.31	0.00

	RP			SP			RP + SP		
Explanatory Variables	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**
Gender - Carpool	-0.480	-4.71	0.00	-0.200	-4.35	0.00	-0.470	-6.33	0.00
Gender - Motorcycle	0.945	5.19	0.00	0.531	8.20	0.00	1.060	9.11	0.00
Gender - Transit	-0.143	-1.85	0.06	-0.038	-0.97	0.33	-0.113	-1.93	0.05
Gender - Bicycle	0.516	5.54	0.00	0.497	12.13	0.00	0.791	11.83	0.00
Gender - Work at home	-0.608	-4.46	0.00	-0.306	-4.93	0.00	-0.664	-6.63	0.00
Gender - Not on campus	-0.514	-5.00	0.00	-0.206	-3.96	0.00	-0.473	-6.03	0.00
Income ($) - Drive alone park on campus	0.145	6.95	0.00	0.013	1.21	0.23	0.093	5.78	0.00
Income ($) - Drive alone park off campus	-0.008	-0.31	0.75	0.016	1.06	0.29	-0.001	-0.07	0.95
Income ($) - Carpool	0.144	5.65	0.00	0.055	4.47	0.00	0.133	7.06	0.00
Income ($) - Motorcycle	-0.081	-1.86	0.06	0.010	0.59	0.55	-0.022	-0.80	0.42
Income ($) - Transit	-0.009	-0.43	0.67	0.011	0.98	0.33	0.004	0.25	0.81
Income ($) - Bicycle	0.047	1.92	0.06	0.041	3.61	0.00	0.069	3.91	0.00
Income ($) - Work at home	0.145	4.34	0.00	0.038	2.63	0.01	0.116	4.93	0.00
Income ($) - Not on campus	0.145	5.48	0.00	0.048	3.65	0.00	0.127	6.34	0.00
Travel cost ($/trip)	-0.072	-8.62	0.00	-0.037	-13.12	0.00	-0.078	-13.80	0.00
Travel time (min)	-0.019	-27.07	0.00	-0.007	-24.44	0.00	-0.018	-29.29	0.00
Inertia dummy				2.780	226.90	0.00	6.320	26.92	0.00
Scale (μ)							0.437	27.61	0.00
Summary Statistics									
Number of observations	12,496			74,059			86,555		
Log-Likelihood (0)	-30,030			-162,724			-190,181		
Log-Likelihood (Model)	-21,671			-83,458			-105,361		
Likelihood ratio test	16,716			158,532			169,640		
Rho square	0.08			0.24			0.20		

5.4.3 VALUE OF TIME

The parameters estimated from the transportation mode choice model were used to calculate the values of travel time and walking time from parking location to the final destination on campus. The value of travel time depends on the utility that an individual attaches to time spent in a particular mode and the opportunity cost of travel time (Oort, 1969). A high value of time can be the result of a high opportunity cost of time or a high level of disutility of time spent on a transportation mode (Small and Winston, 1999). The value of time is also the marginal rate of substitution, which expresses the willingness to pay for a specific transportation mode and the trade-off between time and cost while still maintaining the same level of utility. If the utility is linear in parameters, which is the case in this analysis as shown in Equation 5.5 for example, the marginal rate of substitution of time for cost ($MRS_{Time\text{-}Cost}$) can be estimated using Equation 5.36.

$$\mathrm{MRS}_{Time-Cost} = \frac{\frac{\partial \mathrm{U}}{\partial Travel\,Time_{TRANSIT}}}{\frac{\partial U}{\partial Cost_{TRANSIT}}} = \frac{\beta_{Travel\,Time}}{\beta_{Cost}} \tag{5.36}$$

where U is the utility function and β represents the parameters.

The results shown in Tables 5.2 and 5.3 were estimated under the assumption that travel cost is linear. However, different income groups can have different sensitivity levels to travel cost. In order to estimate how travel cost and hence, value of time, would differ across income, the RP, SP and RP-SP joint models (final model, not restricted model) were estimated a second time with the addition of three cost interaction variables, i.e. Travel Cost * Low Income (-0.138), Travel Cost * Medium Income (-0.124) and Travel Cost * High Income (-0.123). The full model estimation results are shown in Appendix I. Total annual household income was divided into three categories. Table 5.4 shows the value of time estimates using parameters derived from the RP, SP and RP-SP choice models.

Table 5.4. Value of Time (VOT) Estimates

	RP		**SP**		**RP+SP**	
	VOT ($/min)	VOT ($/hr)	VOT ($/min)	VOT ($/hr)	VOT ($/min)	VOT ($/hr)
Full Sample (Restricted Model)	0.29	17.66	0.22	13.21	0.26	15.34
Full Sample (Final Model)	0.27	16.17	0.20	11.95	0.23	13.76
Low Income: less than $90,000	0.24	14.48	0.18	10.71	0.21	12.58
Medium Income: $90,000 - $119,999	0.30	18.07	0.20	12.25	0.25	14.85
High Income: greater than $119,999	0.29	17.55	0.22	13.35	0.24	14.65

The value of travel time from the RP-SP joint analysis is $14 per hour in the final model with additional explanatory variables in addition to travel time and travel cost (Table 5.4), which is similar to previous studies (Small and Yan, 2001; Smith, 1991). The value of travel time is lower in the SP model ($12 per hour) than in the RP model ($16 per hour), which suggests that

the respondents' actual values are higher than those reported in the SP choice sets. However, since inertia is expected to exist in travel behavior, the results reflect state dependence. Without the addition of the inertia dummy in the specification of the MNL models, the SP value of time will be significantly higher. Survey respondents may be willing to pay less to travel for less time than they think they would or are willing to acknowledge in a survey.

The value of time estimations across three categories of income all reflect a similar trend, where lower income employees have the lowest value of time, while medium and high income groups have similar value of time estimates. However, in the RP model and RP-SP joint analysis, the value of time estimates for the medium income categories are slightly greater than those in the high income categories. Employees with medium income may have jobs that are less flexible than higher income groups and thus, would be willing to pay slightly more to have a shorter commute, in order to arrive on campus by a certain time.

The average annual salary at UC Berkeley is approximately $65,000 (UC Berkeley, 2014b) or $34 per hour, assuming there are 40 working hours per week. The value of time for the full sample (final model) is therefore 47 percent of the wage rate. If compared to the RP-SP value of time estimate, this percentage decreases to 40 percent.

Since the difference between the value of time estimates in the RP and SP models is relatively small (approximately 30 percent), the SP parameters, as well as the parking choice model, described in Section 5.5, which uses the SP parameters are considered valid and plausible.

5.4.4 PRICE ELASTICITY ESTIMATES

Demand elasticity is defined as the percentage change in the use of a transportation service resulting from a one percent change in an attribute such as price or travel time (Small and Winston, 1999). In this dissertation, the outputs of the choice models were used to measure the changes in driving demand resulting from changes in travel cost, which includes parking pricing. The value of demand elasticity depends on which point it is at along the demand curve and this point elasticity of demand (E) can be expressed as,

$$E = (\partial Q/\partial P)*(P/Q) \tag{5.37}$$

where Q refers to the quantity demanded and P is the price or any other variable. ∂Q is the change in the quantity demanded and ∂P is the change in price.

The disaggregate elasticity, which represents the responsiveness of an individual's choice probability to a change in the value of an attribute in a logit model can be calculated using Equation 5.38.

$$E_{x_{ink}}^{p_n(i)} = \frac{\partial P_n(i)}{\partial x_{ink}} * \frac{x_{ink}}{P_n(i)} = \frac{\partial lnP_n(i)}{\partial lnx_{ink}} = [1 - P_n(i)]x_{ink}\beta_k \tag{5.38}$$

where, $P_n(i)$ denotes the probability of respondent *n* choosing alternative *i*, x_{ink} is the attribute associated with alternative *i* that decision maker *n* chose with *k* unknown parameters, while β_k represents the parameter for the attribute, which can be derived from the choice model (Domencich and McFadden, 1975; Ben-Akiva and Lerman, 1985).

Since it is also important to know the responsiveness of the sample as a whole instead of just an individual, aggregate elasticities can be used to capture expected changes in choices due to a one percent change in a given variable, which in this case is travel cost. The aggregate elasticity formula for the logit model is as follows (Domencich and McFadden, 1975; Ben-Akiva and Lerman, 1985),

$$E_{x_{ik}}^{\bar{P}(i)} = \frac{\sum_{n=1}^{N} P_n(i)\, E_{x_{ink}}^{p_n(i)}}{\sum_{n=1}^{N} P_n(i)} \tag{5.39}$$

where $\bar{P}(i)$ is the expected share of the sample choosing alternative i, $E_{x_{ink}}^{p_n(i)}$ is the disaggregate elasticity from Equation 5.38, and *N* is the number of observations in the sample.

Equation 5.39 is also the weighted average of the individual elasticities using the choice probabilities as weights. The elasticity estimates of drive alone and park on campus, drive alone but park off campus, carpool, and transit with respect to travel cost were estimated using Equations 5.38 and 5.39. The aggregate values are presented in Table 5.5. As previously described, travel cost is defined as the sum of cost of operation (e.g. fuel, tire) and parking cost for drive alone and carpool. The price elasticity estimates for the overall results of this study using the full sample (final model) were calculated using the parameter for travel cost ($\beta_{Travel\ Cost}$), which is -0.072, as derived from the RP final model (Table 5.3), while elasticities by income were calculated using the parameter estimates of Travel Cost * Low Income (-0.138), Travel Cost * Medium Income (-0.124) and Travel Cost * High Income (-0.123), also from a RP model but with interaction variables. The full model estimation results with the interaction variables are shown in Appendix I.

Table 5.5. RP Price Elasticity Estimates of Drive Alone and Carpool Mode Choices

	Drive Alone and Park on Campus	Drive Alone but Park off Campus	Carpool
Full Sample	-0.45	-0.70	-0.30
Low Income: less than $90,000	-0.50	-0.77	-0.33
Medium Income: $90,000 - $119,999	-0.40	-0.62	-0.27
High Income: greater than $119,999	-0.41	-0.64	-0.27

The results show that as income increases, price elasticities decrease in general, which reflects the income effect. However, when total household income is greater than $119,999 (38 percent of survey respondents, excluding respondents who preferred not to answer the income question),

price elasticity increases slightly or remains the same as seen for carpool. The higher income category of $119,999 and above is the group that is least price sensitive.

Respondents who park on campus are less sensitive to changes in travel cost (including parking cost) than those who park off campus across all income categories. This suggests that changes in off campus parking pricing can have a greater impact than changes in on campus parking pricing. However, the percentage of drive alone but park off campus respondents is much lower than drive alone but park on campus respondents. Hence, on campus parking pricing can still be an effective tool in regulating driving and parking demand. The elasticity estimates for carpool are the lowest amongst the three alternatives, suggesting that carpool riders are least affected by changes in parking pricing, as their cost burden was assumed to be at least 50 percent less than solo drivers. Carpool elasticities show a similar trend as the other two drive alone alternatives, where elasticity decreases when income increases.

5.5 SP PARKING CHOICE ANALYSIS

The parking choice analysis was based on the SP data collected from the transportation and parking survey. Each respondent was provided with five different choice sets in the SP section of the survey. Hence, the sample size for the parking choice model has a maximum number of 20,940 observations (4,188 * 5), resulting in a panel data that represent repeated choices. Not all respondents completed all five SP choice set questions and some did not respond to any of the choice sets. In addition, responses that were missing certain key variables, such as income, were also removed from the final analysis. As a result, the final number of observations in the SP parking choice model is 13,376. Respondents who did not complete all five choice sets were also included, as long as responses for each full choice set were provided. A full choice set consisted of a parking choice question, followed by a transportation mode choice question. This section describes the analysis of parking choice.

5.5.1 MODEL SPECIFICATION

ALTERNATIVES AND UTILITY FUNCTIONS

There are five alternatives in the SP parking choice model as shown in Table 5.6. Each parking alternative is associated with its own set of attributes, apart from Parking Option E, which does not have any predetermined attributes presented in the choice set.

Table 5.6. Alternatives in Parking Choice Model

Number	Code	SP Model Alternative
1	PA	Parking Option A (Monthly Parking Permit Option)
2	PB	Parking Option B (Restricted Monthly Parking Permit Option)
3	PC	Parking Option C (Daily Parking Permit Option)
4	PD	Parking Option D (Hourly Parking Option)
5	PE	Parking Option E (None of the Parking Options)

The parking choice model has five parking alternatives, including one that refers to none of the parking options, which could mean drive alone to campus but park elsewhere or not drive to campus at all. There are four constants in the model, as one alternative, Parking Option D, was normalized to zero (Equation 5.43), which means Parking Option D, the hourly parking option has a zero constant and is the base that all the other alternatives would be compared to.

Similar to the mode choice models presented in previous sections, a simple, restricted model was first estimated with only two explanatory variables, namely parking cost and walking time from parking location to primary workplace (destination) on campus. These two variables were assumed to have a strong impact on the utility of parking options and were included in all utility functions, apart from Parking Option E's. Parking Option E is an alternative where its parking cost and walking time were undefined in the SP choice set. The parameters used for parking cost and walking time were constrained to be the same, as the effects of time and cost are likely to be equal across all alternatives. In order words, walking time and parking cost will affect each utility (parking choice) the same way. This restricted model uses SP data and is specified using the following utility functions (Equation 40 to 44).

$$U_{PA} = \alpha_{PA} + \beta_{Cost} PA\ Cost + \beta_{WKTM} PA\ WKTM \quad (5.40)$$

$$U_{PB} = \alpha_{PB} + \beta_{Cost} PB\ Cost + \beta_{WKTM} PB\ WKTM \quad (5.41)$$

$$U_{PC} = \alpha_{PC} + \beta_{Cost} PC\ Cost + \beta_{WKTM} PC\ WKTM \quad (5.42)$$

$$U_{PD} = \alpha_{PD} + \beta_{Cost} PD\ Cost + \beta_{WKTM} PD\ WKTM \text{ (normalized to zero)} \quad (5.43)$$

$$U_{PE} = \alpha_{PE} \quad (5.44)$$

where α is the ASC, β_{Cost} is the parameter for the cost of parking (COST) and β_{WKTM} is the parameter for walking time (WKTM). In this parking choice model, both parking cost and walking time are constrained across all alternatives, i.e. there is only one cost parameter and one walking time parameter for Parking Options A, B, C, and D. The utility function of Parking Option E does not contain any cost or walking time parameters and variables.

Additional explanatory variables were added to the restricted parking choice model to further explain parking behavior. A model with the full set of variables was first estimated in order to identify insignificant variables, which were subsequently removed from the final model. Parameters used for socioeconomic variables that reflect individual characteristics are not constrained across all utility functions. This is because individual characteristics were assumed to have a different impact on each alternative.

The following utility functions, which consist of significant attributes and important socioeconomic variables, such as parking fee refund for days not parked (REF), free transit pass (PASS), free transit pass that includes BART (BART), number of days on campus (DAYS_CAM), number of hours on campus (TIME), faculty dummy (FAC), changes in summer schedule (SUMSCH), availability of second office (SECOFF), off campus trips (OFFCAM),

arrival time (ARTM), departure time (DPTM), age (AGE), and income (INC), were included in the final parking choice model. Although not all the parameters for each of these individual characteristic variables are significant across all alternatives, they were not removed from the final model in order to provide better understanding of parking behavior. Especially since most of the variables included reflect scheduling characteristics that have not been studied previously. Parking Option D was again normalized to zero (Equation 5.48), which means it has a zero constant and is the base that all the other alternatives would be compared to.

$$U_{PA} = \alpha_{PA} + \beta_{Cost} PA\ Cost + \beta_{WKTM} PA\ WKTM + \beta_{REF} REF + \beta_{PASS\_PA} PASS\_PA + \beta_{BART} BART + \beta_{DAYS\_CAM\_PA} DAYS\_CAM + \beta_{TIME\_PA} TIME + \beta_{FAC\_PA} FAC + \beta_{SUMSCH\_PA} SUMSCH + \beta_{SECOFF\_PA} SECOFF + \beta_{OFFCAM\_PA} OFFCAM + \beta_{ARTM\_PA} ARTM + \beta_{DPTM\_PA} DPTM + \beta_{AGE\_PA} AGE + \beta_{INC\_PA} INC \quad (5.45)$$

$$U_{PB} = \alpha_{PB} + \beta_{Cost} PB\ Cost + \beta_{WKTM} PB\ WKTM + \beta_{PASS\_PB} PASS\_PB + \beta_{BART} BART + \beta_{DAYS\_CAM\_PB} DAYS\_CAM + \beta_{TIME\_PB} TIME + \beta_{FAC\_PB} FAC + \beta_{SUMSCH\_PB} SUMSCH + \beta_{SECOFF\_PB} SECOFF + \beta_{OFFCAM\_PB} OFFCAM + \beta_{ARTM\_PB} ARTM + \beta_{DPTM\_PB} DPTM + \beta_{AGE\_PB} AGE + \beta_{INC\_PB} INC \quad (5.46)$$

$$U_{PC} = \alpha_{PC} + \beta_{Cost} PC\ Cost + \beta_{WKTM} PC\ WKTM + \beta_{DAYS\_CAM\_PC} DAYS\_CAM + \beta_{TIME\_PC} TIME + \beta_{FAC\_PC} FAC + \beta_{SUMSCH\_PC} SUMSCH + \beta_{SECOFF\_PC} SECOFF + \beta_{OFFCAM\_PC} OFFCAM + \beta_{ARTM\_PC} ARTM + \beta_{DPTM\_PC} DPTM + \beta_{AGE\_PC} AGE + \beta_{INC\_PC} INC \quad (5.47)$$

$$U_{PD} = \alpha_{PD} + \beta_{Cost} PD\ Cost + \beta_{WKTM} PD\ WKTM \text{ (normalized to zero)} \quad (5.48)$$

$$U_{PE} = \alpha_{PE} + \beta_{DAYS\_CAM\_PE} DAYS\_CAM + \beta_{TIME\_PE} TIME + \beta_{FAC\_PE} FAC + \beta_{SUMSCH\_PE} SUMSCH + \beta_{SECOFF\_PE} SECOFF + \beta_{OFFCAM\_PE} OFFCAM + \beta_{ARTM\_PE} ARTM + \beta_{DPTM\_PE} DPTM + \beta_{AGE\_PE} AGE + \beta_{INC\_PE} INC \quad (5.49)$$

COST OF PARKING OPTION

Although the costs of Parking Options A, B, C, and D were presented as monthly, daily and hourly costs in the SP part of the survey, i.e. in the SP choice set, all of them were converted to a daily parking cost in the parking choice model. It was assumed that there were 20 working days in a month and eight working hours in a day. Hence, the cost of Parking Option A was divided by 20, the cost of Parking Option B was divided by 12 (3 parking days per week * 4 weeks per month) or 16 (4 parking days per week * 4 weeks per month) depending on the question presented in the survey and the cost of Parking Option D was multiplied by eight.

5.5.2 MODEL ESTIMATION RESULTS

As described in the previous section, parking cost for each parking option was scaled to a uniform per day rate, unlike what was presented in the actual survey. In addition, the constant for Parking Option D was normalized to zero, implying that the other constants would be

interpreted as relative to choosing to drive and park using one of the given parking options. Table 5.7 shows the restricted MNL parking choice model estimation results with only two explanatory variables, i.e. parking cost and walking time. In this simple model, the constant for Parking Option A is the highest, which means that a conventional, unlimited monthly parking permit is the most popular choice amongst all alternatives and UC Berkeley employees may not be willing to switch to other types of parking options so easily. Both parking cost and walking time parameters are highly significant and negative. Hence, survey respondents prefer parking options that are lower in cost and require shorter walking time.

Table 5.7. Parking Choice Model Estimation Results (Restricted Model)

Explanatory Variables	Parameter Estimates	T-test	P-value
Alternative specific constants			
Parking Option A – Unlimited monthly parking permit	0.693	17.49	0.00
Parking Option B – Restricted monthly parking permit	0.476	11.52	0.00
Parking Option C – Daily parking permit	0.502	12.11	0.00
Parking Option D – Hourly parking option	-	-	-
Parking Option E – None of the given parking options	-0.323	-5.26	0.00
Attributes in choice set			
Parking cost ($/day)	-0.185	-35.87	0.00
Walking time (min)	-0.045	-21.67	0.00
Summary Statistics			
Number of observations	13,376		
Log-Likelihood (O)	-21,528		
Log-Likelihood (Model)	-18,378		
Likelihood ratio test	6,300		
Rho square	0.021		

The parameters for parking cost and walking time (-0.185 and -0.045 respectively) estimated in the restricted model (Table 5.7) were used as starting values in the final model to estimate a new set of parameters. Prior to the estimation of the final model, a model with a full set of explanatory variables was tested and variables that were insignificant across all alternatives, such as the number of household members, were removed from the final model. Variables that did not contribute to further understanding of parking behavior were also removed. These variables include gender, which was only significant for Parking Option E, i.e. more male respondents chose Parking Option E, which is the choice for none of the parking options presented. In addition, an attribute in the SP choice set, the "Restricted Parking" dummy, which was created to differentiate a three-day per week parking permit from a four-day per week parking permit, was also found to be insignificant and excluded in the final model. It could be insignificant because a restricted monthly parking permit creates the same level of utility regardless of whether it allows parking three days a week or four days a week.

The parameters of individual characteristics of the respondents were not constrained and specified to differ according to the utility function in the final model. These parameters include both "scheduling" and "socioeconomic" characteristics of respondents, as presented in Table 5.8.

A likelihood ratio test was conducted to determine if the additional variables added to the final model contributed further explanatory power. As previously described, the restricted parking choice model (Table 5.7) only has two explanatory variables, i.e. parking cost and walking time, six parameters and a log-likelihood of -18,378. The final model has 50 parameters and a log-likelihood of -17,722 (Table 5.8). The likelihood ratio test statistic is therefore, -2 * (-18,378 – (-17,722)) = 1,312. The degrees of freedom is 50 – 6 = 44, which gives a Chi-Squared value of 69 for p = 0.01. Since 1,312 is greater than 69, the null hypothesis that the additional variables does not contribute to the model is rejected with 99 percent confidence. Hence, it is important to include the additional variables in the final parking choice model to better understand parking behavior.

Table 5.8. Parking Choice Model Estimation Results

Explanatory Variables	Parameter Estimates	T-test	P-value
Alternative specific constants			
Parking Option A – Unlimited monthly parking permit	-4.810	-13.49	0.00
Parking Option B – Restricted monthly parking permit	-0.953	-3.15	0.00
Parking Option C – Daily parking permit	-0.477	-1.64	0.10
Parking Option D – Hourly parking option	-	-	-
Parking Option E – None of the given parking options	-1.560	-5.73	0.00
Attributes in choice set			
Parking cost ($/day)	-0.188	-35.95	0.00
Parking fee refund in Parking Option A ($)	0.091	3.33	0.00
Free transit pass in Parking Option A (yes = 1, no = 0)	0.277	6.28	0.00
Free transit pass in Parking Option B (yes = 1, no = 0)	0.469	9.48	0.00
Walking time (min)	-0.046	-21.77	0.00
BART pass dummy in Parking Options A and B (yes = 1, no = 0)	0.138	3.66	0.00
Scheduling characteristics of respondents			
Arrival time - Unlimited monthly parking permit	0.308	2.33	0.02
Arrival time - Restricted monthly parking permit	0.269	2.13	0.03
Arrival time - Daily parking permit	0.120	0.85	0.39
Arrival time - None of the given parking options	0.210	1.73	0.08
Departure time - Unlimited monthly parking permit	-0.375	-2.83	0.00
Departure time - Restricted monthly parking permit	-0.335	-2.63	0.01
Departure time - Daily parking permit	-0.101	-0.71	0.48
Departure time - None of the given parking options	-0.246	-2.02	0.04
Hours on campus (hours / day) - Unlimited monthly parking permit	0.499	3.61	0.00
Hours on campus (hours / day) - Restricted monthly parking permit	0.424	3.20	0.00
Hours on campus (hours / day) - Daily parking permit	0.195	1.33	0.18
Hours on campus (hours / day) - None of the given parking options	0.323	2.55	0.01

Explanatory Variables	Parameter Estimates	T-test	P-value
Days on campus (days / 5-day workweek) - Unlimited monthly parking permit	0.790	14.93	0.00
Days on campus (days / 5-day workweek) - Restricted monthly parking permit	0.161	4.47	0.00
Days on campus (days / 5-day workweek) - Daily parking permit	0.010	0.29	0.77
Days on campus (days / 5-day workweek) - None of the given parking options	0.225	6.50	0.00
Off-campus trips (yes = 1, no = 0) - Unlimited monthly parking permit	-0.263	-2.64	0.01
Off-campus trips (yes = 1, no = 0) - Restricted monthly parking permit	-0.027	-0.26	0.79
Off-campus trips (yes = 1, no = 0) - Daily parking permit	0.014	0.14	0.89
Off-campus trips (yes = 1, no = 0) - None of the given parking options	0.198	2.17	0.03
Availability of second office (yes = 1, no = 0) - Unlimited monthly parking permit	-0.272	-2.58	0.01
Availability of second office (yes = 1, no = 0) - Restricted monthly parking permit	-0.243	-2.23	0.03
Availability of second office (yes = 1, no = 0) - Daily parking permit	-0.331	-3.02	0.00
Availability of second office (yes = 1, no = 0) - None of the given parking options	-0.490	-5.06	0.00
Changes in summer schedule (yes = 1, no = 0) - Unlimited monthly parking permit	-0.248	-2.39	0.02
Changes in summer schedule (yes = 1, no = 0) - Restricted monthly parking permit	-0.185	-1.73	0.08
Changes in summer schedule (yes = 1, no = 0) - Daily parking permit	-0.377	-3.57	0.00
Changes in summer schedule (yes = 1, no = 0) - None of the given parking options	-0.555	-5.81	0.00
Socioeconomic characteristics of respondents			
Age - Unlimited monthly parking permit	0.074	2.40	0.02
Age - Restricted monthly parking permit	-0.042	-1.32	0.19
Age - Daily parking permit	-0.011	-0.36	0.72
Age - None of the given parking options	0.017	0.59	0.55
Faculty dummy (faculty = 1, staff = 0) - Unlimited monthly parking permit	-0.331	-2.85	0.00
Faculty dummy (faculty = 1, staff = 0) - Restricted monthly parking permit	-0.407	-3.32	0.00
Faculty dummy (faculty = 1, staff = 0) - Daily parking permit	-0.099	-0.85	0.40
Faculty dummy (faculty = 1, staff = 0) - None of the given parking options	-0.089	-0.84	0.40
Total annual household income ($) - Unlimited monthly parking permit	0.144	6.97	0.00
Total annual household income ($) - Restricted monthly parking permit	0.062	2.83	0.00
Total annual household income ($) - Daily parking permit	0.080	3.70	0.00

Explanatory Variables	Parameter Estimates	T-test	P-value
Total annual household income ($) - None of the given parking options	-0.046	-2.29	0.02
Summary Statistics			
Number of observations	13,376		
Log-Likelihood (O)	-19,578		
Log-Likelihood (Model)	-17,722		
Likelihood ratio test	3,711		
Rho square	0.009		

Results from the final parking choice model show that Parking Option D, the hourly parking cost option, has the highest utility, which means it is the most preferred alternative when other explanatory variables other than parking cost and walking time were added into the model. The parameters for parking cost and walking time remain highly significant in this final model and both have negative signs, which imply that utility increases when cost and walking time decrease. This means that charging more for parking near an individual's destination would be a reasonable policy option.

Attributes associated to different parking options are all significant, apart from the "Restricted Parking" dummy variable, as described previously. Parking fee refund and the availability of a free transit pass have positive parameters and are significant variables that can influence the utilities of both monthly parking options (Parking Options A and B). In other words, when incentives in the form of a parking fee refund for days not parked or a free transit pass are bundled together with changes in parking pricing, they make the parking options more attractive. Whether or not a transit pass includes BART is important too. The BART pass dummy variable is significant and makes the two monthly parking options more attractive than without.

As for scheduling characteristics of the survey respondents, they are represented by seven different types of explanatory variables with varying levels of significance across parking alternatives (Table 5.8). The only variable in this category that is significant for all four alternatives is the availability of a second office. The utilities of all four parking alternatives are higher when respondents do not have a second office on or off campus. Arrival time is significant for the monthly parking options, where the later the arrival time, the more likely an employee will choose to park on campus and pay for monthly parking permits compared to an hourly parking option. Departure time is also significant for the two monthly parking options, but it has a negative sign, which implies that the later the departure time, the less likely respondents will choose to park on campus using monthly parking permits compared to the hourly parking option.

The difference between arrival and departure time is the time spent on campus per day, i.e. the number of hours on campus. This variable is significant for the monthly parking permits and not choosing any of the presented parking options, where the greater the number of hours spent on campus, the more likely respondents will choose to use the monthly parking permits than a daily parking permit. Similarly, the number of days on campus variable is significant for the monthly parking permits and not choosing to park using any of the options, where the more frequently the respondents are on campus per week, the more likely they will choose the monthly parking permits and not park using any of the options with respect to an hourly parking option. The hourly parking option becomes unattractive once frequent parking is required.

There are three significant and important socioeconomic variables included in the full model. First, age is significant only for the unlimited monthly parking option. Older respondents are more likely to choose the unlimited monthly parking options than the hourly parking option. They would prefer the convenience of paying for a monthly permit rather than paying on an hourly basis. Their work schedule may also require them to spend more time on campus, which will make paying by the hour less efficient. The faculty dummy variable has a negative sign and

is significant for both monthly parking options. Hence, staff members will tend to choose the unlimited monthly parking option and daily parking option over the hourly parking option.

Total annual household income is significant across all four alternatives. The higher the income, the more likely the monthly and daily parking options will be preferred over the hourly parking option. Also, the lower the income, the more likely the employee will not choose to drive alone to campus or drive alone but not park using any of the given parking options, compared to the hourly parking option. It is important to note that Parking Option E does not necessary only imply parking at off-campus locations, it can also represent choices of respondents who choose other travel modes.

5.5.3 VALUE OF WALKING TIME

The value of walking time was calculated for each parking option using the parking cost and walking time parameters estimated from the parking choice models. Similar to Equation 5.36, the marginal rate of substitution of walking time from parking location to the primary workplace building on campus ($MRS_{\text{Walking Time-Cost}}$) of a linear utility function (e.g. Equation 5.40) can be expressed as the following.

$$\text{MRS}_{Walking\ Time-Cost} = \frac{\frac{\partial U}{\partial Walking\ Time_{PB}}}{\frac{\partial U}{\partial Cost_{PB}}} = \frac{\beta_{Walking\ Time}}{\beta_{Parking\ Cost}} \tag{5.50}$$

The value of walking time for the full sample was estimated using the parameters for walking time and parking cost derived in the parking choice models (Tables 5.7 and 5.8). Another identical model (final model, not restricted model) with three non-linear travel cost variables (interacted with income) was estimated to calculate the value of walking time by income, i.e. Parking Cost * Low Income (-0.206), Parking Cost * Medium Income (-0.179) and Parking Cost * High Income (-0.173). The full model estimation results are shown in Appendix I. All estimated values of walking time are presented in Table 5.9.

Table 5.9. Value of Walking Time Estimates

	Value of Walking Time ($/min)	Value of Walking Time ($/hr)
Full Sample (Restricted Model)	0.25	14.87
Full Sample (Final Model)	0.25	14.71
Low Income: less than $90,000	0.22	13.43
Medium Income: $90,000 - $119,000	0.26	15.45
High Income: greater than $119,000	0.27	15.99

The value of walking time for the full sample is $0.25 per minute, which suggests that respondents are willing to spend $0.25 more to save a minute less of walking time. In other words, they are willing to pay $0.25 more to park a minute closer to where they work on campus. This suggests that a 10 minute walk is worth $2.50 a day, or for a 20 day month, $50. On the

other hand, a walk of an additional two minutes would be worth only $10 per month and a one minute difference (as might result from parking up a flight of stairs or at a far end of a parking garage) would be worth only $5 per month or less.

When compared to the hourly wage rate at UC Berkeley (2014b), the value of walking time for the full sample is 44 percent of the average wage, which is three percent less than the RP value of travel time.

The value of walking time varies across income groups and reflects the income effect. Table 5.9 shows that the higher the income, the greater the value of walking time. However, the differences in the estimates are relatively small for the income categories used in this analysis. Thus, the value of walking time for employees with an annual household income of $90,000 or more is very similar.

5.5.4 PRICE ELASTICITY OF PARKING DEMAND

Using the same method described in Section 6.4 (Equations 5.12 and 5.13), the aggregate elasticity estimates of Parking Options A, B, C, and D, with respect to parking cost, were calculated and presented in Table 5.10. Elasticity for Parking Option E was not estimated because this alternative is not associated with any parking cost.

The price elasticity estimate for the overall results of this study using the full sample (final model) was calculated using the parameter for parking cost ($\beta_{Parking\ Cost}$), which is -0.188, as derived from the SP parking choice model (Table 5.8), while elasticities by income were calculated using the parameter estimates of Parking Cost * Low Income (-0.206), Parking Cost * Medium Income (-0.179) and Parking Cost * High Income (-0.173) from another SP model with the interaction variables (Appendix I).

Table 5.10. Price Elasticity Estimates of Parking Options

	Unlimited Monthly Parking	Restricted Monthly Parking	Hourly Parking	Daily Parking
Full Sample	-0.97	-1.10	-1.19	-1.22
Low Income: less than $90,000	-1.06	-1.21	-1.30	-1.34
Medium Income: $90,000 - $119,999	-0.92	-1.05	-1.13	-1.16
High Income: greater than $119,999	-0.89	-1.02	-1.09	-1.12

Parking Option A, a monthly parking permit, has the lowest price elasticity among all four parking options. Parking Option B, which is also a monthly parking permit but with a restriction on the number of days parked per week, has the second lowest elasticity estimate (Table 5.10). Parking Options C and D have higher elasticities compared to Parking Options A and B, suggesting that the survey respondents are more sensitive to changes in parking pricing for more flexible parking options. Parking Options C and D offer daily and hourly parking options respectively. These are shorter term decisions compared to Parking Options A and B, which

require at least a one month commitment. Hence, their demand would fluctuate much more in the short term compared to Parking Options A and B.

The elasticity estimates for all four parking options show the same trend across three income categories, lowest for the monthly parking permit (Parking Option A) and highest for the hourly parking option (Parking Option D). Respondents with less than $90,000 annual household income have the highest elasticity estimates for all four parking options. This is an income group whose parking behavior will be most affected by changes in parking pricing and are most likely to switch to off campus parking locations with lower parking prices. However, since the elasticity estimate for the monthly parking option of this income group is still the lowest compared to other parking options, those who do not have flexible work schedules may continue to park on campus. According to the income data collected, 46 percent of the survey respondents fall under this group.

5.6 PARKING PRICING FORECASTS

One of the properties of discrete choice models is the ability to forecast behavior in the future or to test certain future scenarios. UC Berkeley campus parking prices are expected to increase over time and can have significant impact on transportation mode and parking location choices. This section evaluates the impact of future changes in parking pricing using the model estimation results shown in Table 5.3 for mode choice.

RP parameters estimates were used to forecast transportation mode choice in six different scenarios, as shown in Table 5.11. The baseline for the scenarios reflects actual travel and parking prices used in the RP analysis. On-campus parking prices can range from $2.25 to $16 per day depending on the type of campus parking permit purchased, while off-campus parking prices depends on parking location and were assumed to range from zero to $13.36 per day. Carpool parking prices also depends on the University affiliation of the employee, which determine the type of carpool parking permit purchased. Transit fare has a wide rage starting from $1.85 to as high as $36 per trip depending on the residential location of the employee and the transit services chosen to travel to campus. In Scenarios 1, 2 and 3, transit fare would be fully subsidized by the University, while in Scenarios 4, 5 and 6, transit fare is the same as in the Baseline.

Table 5.11. Parking Pricing Scenarios

Scenario	On-Campus Parking ($ per day)	Off-Campus Parking ($ per day)	Carpool Campus Parking ($ per day)	Transit Fare ($ per trip)
Baseline (Current Prices)	2.25 – 16.00	0 - 13.36	1.45 - 2.20	1.85 – 36.00
1	9.00	8.00	4.50	0.00
2	16.00	8.00	8.00	0.00
3	20.00	8.00	10.00	0.00
4	9.00	8.00	4.50	1.85 – 36.00
5	16.00	8.00	8.00	1.85 – 36.00
6	20.00	8.00	10.00	1.85 – 36.00

Using the estimation results shown in Table 5.3, the probability of each alternative for each individual was first estimated by calculating the utility of each alternative (Equations 5.3 and 5.4). The aggregate demand was then calculated by multiplying each probability with its weight. In this case, since the sample was selected based on exogenous factors, i.e. faculty and staff of the UC Berkeley campus, the weight was assumed to be the inverse of the sampling probability (Train, 2009). Hence, the weight for RP data is approximately 4.80 (12,000/(12,496/5)), where 12,000 is the estimated total number of faculty and staff at UC Berkeley and 12,496 is the number of observations in the RP model. These numbers had to be further divided by five because the final models included five RP mode choice responses (one for each day of the week) per individual. The mode share was then calculated using the estimated weighted probability values derived from the utility values. Only RP data were used in this forecasting exercise.

The calculations for the parking pricing scenarios were made after replacing the parking cost components for drive alone and park on campus, drive alone but park off campus and carpool, as well as changing the travel cost for transit. The new parking prices are no longer a reflection of actual parking permit type as specified in the RP mode choice models described earlier in Section 5.4. It was assumed that there is only one type of parking permit available for all on-campus parking spaces. Hence, regardless of whether an employee currently holds a current campus parking permit or not, the same on-campus parking price applies. All off-campus parking spaces also have the same parking price in each scenario. Taking account the new parking prices shown in Table 5.11, probabilities for the nine alternatives were calculated again and the changes in mode share are shown in Figure 5.1.

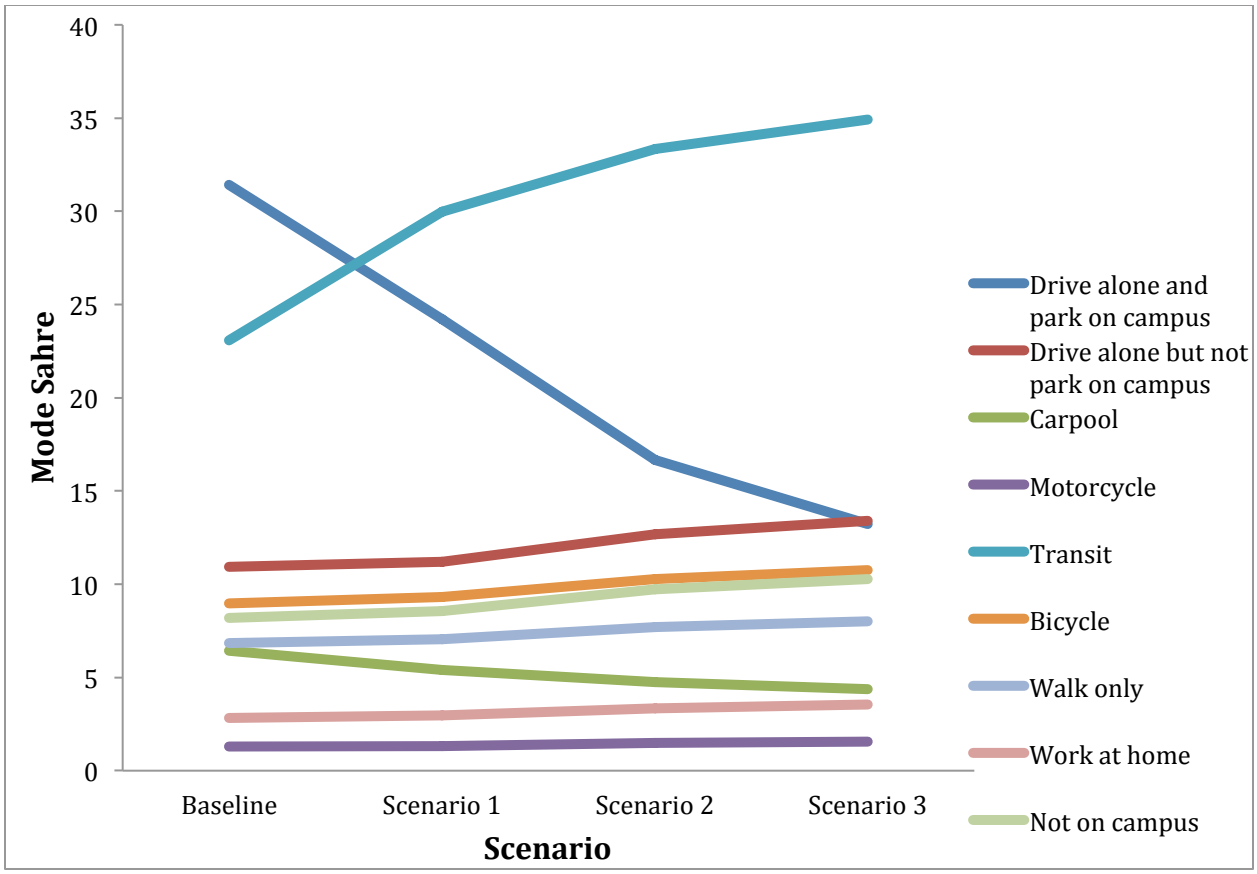

Figure 5.1. Mode share forecasts under parking pricing Scenarios 1, 2 and 3.

As shown in Figure 5.1, the mode share for drive alone and park on campus (CAR) will decrease significantly in all scenarios as on-campus parking prices increase. This will lead to an increase in drive alone but park off campus (CARNOPK) (up to 18 percent) and an even greater increase in transit share (up to 34 percent) in Scenario 3, where transit is fully subsidized. Carpool (CARPL) share will decrease by up to 48 percent if no further subsidies, apart from a 50 percent discount off regular campus parking were given. On the other hand, bicycle (BIKE) and walk only (WALK) mode shares will increase by up to 17 and 14 percent respectively as parking pricing changes over time. Changes in non-motorized mode use are not as great as transit use. This could be due to the fact that University employees do not consider bicycling or walking as feasible transportation alternatives. Some live too far away from the campus to bicycle or walk, others live in residential areas that are infeasible to bicycle or walk, e.g. in hilly or steep neighborhoods. There could also be personal reasons to not bicycle or walk to campus, such as health conditions, perceptions on bicycle safety and preferences to use other modes. Transit on the other hand, may have longer travel time but is more feasible for most employees, since most of them live in residential locations with transit accessibility.

When transit fare is not subsidized but remain the same as in the Baseline, which reflects current transit travel costs, the parking pricing forecasts show a slightly different trend in mode share. Figure 5.2 shows the changes in mode shares in Scenarios 4, 5 and 6. Transit use will increase by up to 23 percent in Scenario 6, which is 11 percent lower than the transit mode share in

Scenario 3. On the other hand, bicycle and walk mode shares are higher when transit fare is not subsidized. The increases in bicycling and walking in Scenarios 4, 5 and 6 are approximately four percent higher than in Scenarios 1, 2 and 3, where transit fare is fully subsidized. Similarly, more employees will drive and carpool in Scenarios 4, 5 and 6 than in the first three scenarios.

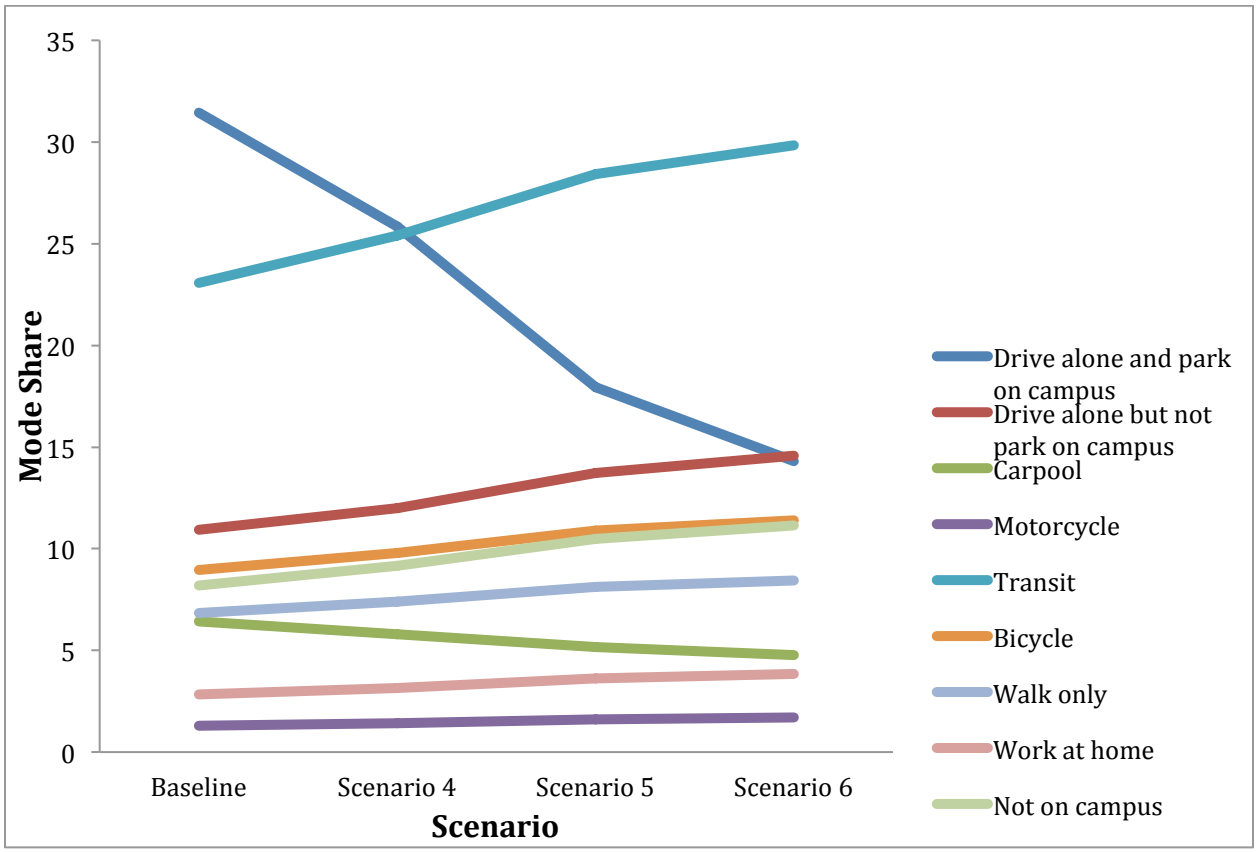

Figure 5.2. Mode share forecasts under parking pricing Scenarios 4, 5 and 6.

Raising daily on-campus parking prices will certainly decrease driving and lead to an increase in other mode shares. When transit fare is fully subsidized, there will be further decreases in drive alone share (up to approximately 18 percent) compared to when transit is not subsidized. Figure 5.3 shows the percentage changes in mode shares across all six scenarios from the Baseline. Scenario 3 shows the highest decline in drive alone and park on campus compared to all other scenarios, and at the same time illustrating the highest transit mode share of almost 34 percent. Drive alone but park off campus is the highest in Scenario 6, where on-campus parking pricing is high and transit is not fully subsidized. Similarly, work at home (HOME) and not on campus (NOC) alternatives are also the highest in Scenario 6. However, these two choices cannot be made just based on the parameter estimates alone. There are numerous other non-cost related factors that would determine the changes in the frequencies of working at home and not being on campus.

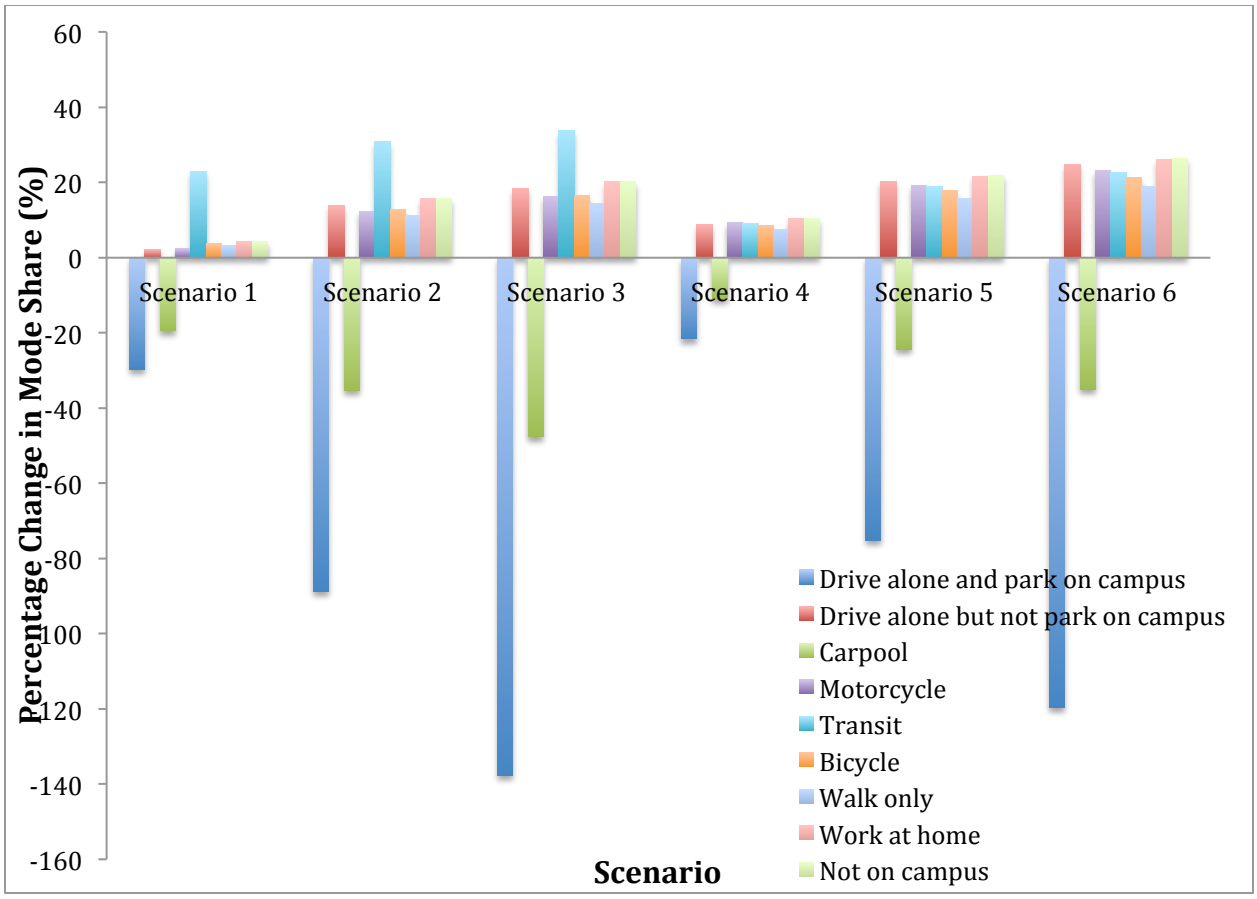

Figure 5.3. Percentage changes in mode share in parking pricing Scenarios 1, 2, 3, 4, 5, and 6.

5.7 DISCUSSION

Changes in parking pricing, in terms of cost and payment type, i.e. monthly, daily or hourly, have been incorporated in the SP component of the transportation and parking survey. Therefore, the SP model estimation results reflect transportation and parking behavior within the context of different parking pricing compared to current parking policies.

The results from the RP, SP and RP-SP transportation mode choice models all point to the same conclusion that transit is still the most preferred alternative, while parking on campus using the conventional monthly parking permit is the most preferred parking option for those who choose to drive. However, the flexible hourly parking option can be attractive too, when other explanatory variables are considered. Staff members are more likely to drive and park on campus, whereas faculty members are most likely to not use a monthly parking option but to either choose a more flexible parking option that offers paying by day or hour, or to park off campus. Hence, faculty members are less sensitive to changes in parking pricing due to their relatively higher average income than staff members and also because they are already less likely to drive and park on campus.

One of the fundamental differences between drive alone and using transit is that travel time for transit can be twice as long or beyond compared to driving for most employees in the San Francisco Bay Area. In order to save time, employees are willing to pay for driving and parking. In addition, in many cases, the cost of transit is equivalent to the costs of driving and parking. Hence, unless there were very strong incentives to use transit, if transit services were considerably more attractive than driving, or if there were personal reasons to not drive, employees will most likely choose options that offer them the highest travel cost and time savings.

Although a free BART pass is attractive to employees, as indicated in the mode choice estimation results, it is only attractive to employees who live in certain residential locations. Since approximately 31 percent of the survey respondents live in Berkeley and 21 percent live in Oakland, BART may not be the most efficient way to travel to campus for possibly half of the employees. A BART incentive may only be attractive to certain user groups but insufficient to substantially increase its mode choice. Existing transit users will appreciate additional transit incentives, but current drivers would not shift to transit by providing free transit passes alone. There must be other complementary policies that would need to increase the attractiveness of transit before a shift in mode choice could take place. Some of these policies, such as improving transit services, are beyond the control of University's officials.

Carpool is a transportation mode choice that relies heavily on another individual's schedules and residential location, carpooling tend to be more habitual and restricted than other modes. Hence, it is less likely for current non-carpoolers to switch to carpooling based on the parking cost and walking time attributes provided in the SP choice sets.

The later the arrival time, the more likely an employee will choose to drive and park on campus. This implies that on-campus parking is available at various times of the day and not just in the early mornings. In addition, this also suggests that off-campus parking may be more in demand than on-campus parking and will not be available after a certain time. Off-street garages often charge higher rates after 9:00AM, which will then make campus parking more attractive for employees who arrive later in the morning.

Off-campus parking locations serve as competitors to campus parking. The provision of more flexible parking payment options (e.g. monthly, daily and hourly) will thus enhance its flexibility and shift drivers who park off campus to on-campus parking locations instead. Free parking options available in the residential neighborhoods surrounding the campus are not necessarily desirable if walking time is longer than on-campus alternatives. Walking time from parking location to primary workplace on campus is highly significant in determining the type of parking option chosen. Parking spaces that require less walking time are certainly more attractive than those that are located further away.

The value of travel time is estimated to be $16 per hour (RP), while the value of walking time from parking location to workplace is slightly lower at $15 per hour, implying that employees are willing to spend $0.25 to park a minute closer to their primary workplace on campus. Walking distance is a significant factor in influencing parking choice and should be considered for future parking policies. Parking pricing may not have a considerable effect on mode choice

if the value of travel time remains high and if alternative transportation modes do not provide any substantial travel time savings. However, if parking prices were raised to a significantly higher rate, such as $9 per day and transit could be fully subsidized, drive alone and park on campus can decrease considerably by almost 30 percent from the present mode share, while at the same time increasing transit mode share by 23 percent. Parking pricing can still be an influential tool in managing transportation demand and mode share depending on the level of prices imposed, even without a substantial transit subsidy. Without a full transit subsidy, the difference in the decrease of drive alone and park on campus mode share is 13 percent on average. Regardless of how much parking pricing changes in the future, lower income groups will be most affected compared to medium or high income groups, as they are more price sensitive and have higher price demand elasticity estimates. It is likely that they will then switch to less costly off-campus parking alternatives, when on-campus parking pricing increases.

CHAPTER 6

FACTORS AFFECTING MODE CHOICE AND PRICING IMPACT: JOB CHARACTERISTICS AND WORK SCHEDULE FLEXIBILITY

This chapter examines in greater detail two issues that may affect commuter mode choice and responsiveness to parking pricing, namely job characteristics and work schedule flexibility. UC Berkeley is a highly appropriate locus for investigating these issues because it provides a wide variety of job categories, some more tied to campus facilities and service needs than others.

It was initially hypothesized that employees with more flexibility in scheduling their own hours for being on campus would work off campus more often, be more willing to use transit and non-motorized modes and drive to campus less. Another hypothesis is that higher flexibility of work schedule would also affect parking location, where employees with more flexibility would park off campus. However, as the following sections show, the data collected from one-on-one interviews and survey indicate a far more complex and nuanced response.

6.1 BACKGROUND

Commuting choices are not only dependent upon the availability of feasible transportation modes but also on the socioeconomic characteristics of the employees and their employment and life circumstances, both of which can affect travel choices. The flexibility of work schedule can shape the selection of transportation modes and parking locations, as flexibility implies opportunity for choosing different travel times, duration of stay and frequency of commute trips.

Flexibility in work schedule can be derived from workplace rules, e.g. whether the employer requires a fixed schedule of being at work or not, from job characteristics, e.g. whether doing the work requires specialized equipment or materials, and also from personal and household characteristics, e.g. whether the individual has other obligations before or after work that constrain his or her schedule. In addition, while a number of previous studies have asserted that scheduling flexibility will reduce travel demand (Kitamura et al., 1991; Mokhtarian, 1991a), it is also possible that flexibility will actually lead to more, not less, driving. For example, employees who are able to be on campus for only a few hours a day and work at home or other off-campus locations at other times may find that transit services available off peak are not competitive with driving, and that parking, expensive if paid for on a monthly basis, is more affordable if only a few hours a day (or a few days a week) are needed. These factors could affect travel and parking behavior at UC Berkeley.

Changes in parking pricing might not lead to substantial shifts in driving but instead might shift the time of day of driving and the location of parking. Indeed, because there are alternative parking locations available that cater to the short term or occasional driver (e.g. by charging by

the hour, which is desirable for short trips, or by charging only for days actually used, which can produce cost savings), changing parking policy could actually lead to more driving, not less. The impact of any changes in parking pricing on travel behavior could also vary according to employment type and University affiliation, due to the differences in the flexibility of work schedule across academic disciplines, departments and offices on campus. Understanding how job characteristics can contribute to the flexibility of work schedule on campus will allow a better understanding of how work schedules affect transportation demand, mode choice and parking preferences.

6.2 WORK SCHEDULE, TRANSPORTATION AND PARKING CHOICES

The generic term "flexible work schedule" is used in this study for any work schedules that are not categorized as an 8:00 or 9 :00AM to 4:00 or 5:00PM, Monday to Friday, i.e. a 35 to 40-hour workweek. This is a broad definition that encompasses both formal and informal work scheduling arrangements and working at home, as well as working a compressed workweek.

Flexible work schedules can be formal, prearranged and agreed upon with supervisors, or can be at the employee's discretion. Two common formal programs for flexible work schedules are alternative work schedules (AWS) and telecommuting. As defined by the U.S. Office of Personnel Management (2014), AWS can have designated hours and days beyond regular working hour or days, when an employee must be present for work or a compressed work schedule that is an 80-hour biweekly basic work requirement for less than 10 workdays. Telecommuting occurs when some or all of the work is performed at an off-campus location, which could be at home or at another office space. A work schedule can thus be flexible because of flexible hours, flexible days or flexible location.

In addition to such formal arrangements, some employees may be allowed to set their own work schedules without having a formal agreement to do so, e.g. arriving on campus and departing at times that vary from day to day and deciding to work at home when convenient for the employee. At universities, professors and certain other researchers and administrators often fall into this category.

One of the main benefits claimed for AWS and telecommuting is that the number of private vehicle trips and hence, the total distance traveled can potentially be reduced. Studies have shown that telecommuting can reduce peak hour trips and total distance traveled. Since commuters with very long trips may be disproportionately interested in AWS and telecommuting, telecommuting can produce trip reductions disproportionate to their travel distance numbers (Balepur et al., 1998; Kitamura et al., 1991; Mokhtarian, 1991a; Pendyala et al., 1991), leading to case specific trip reductions. The reduction of private vehicle trips can reduce travel costs for employees, reduce congestion along the way to the workplace and decrease energy use, as well as emissions. In addition, telecommuting has also been found to decrease non-commute trips, due to the chaining of non-work trips to commute trips (Balepur et al., 1998; Pendyala et al., 1991; Mokhtarian, 1991b).

Flexible work schedules have been researched extensively in studies of trip scheduling, departure time and congestion (Abkowitz, 1981; Hendrickson and Kocur, 1981, Small, 1982; Ben-Akiva et

al., 1984; Smith, 1984; Daganzo, 1985; Braid, 1989; Wilson, 1989; Arnott et al., 1993, Zhang et al., 2005), especially in investigations of road pricing (Emmerink and van Beek, 1997; Saleh and Farrell, 2005), and road infrastructure and transit service utilization (Hendrickson and Plank, 1984). Noland and Small (1995) and Bates et al. (2001) included departure time choice in their discrete choice models for commuting trips.

However, fewer studies have explored how the flexibility of work schedules could affect mode choice. Mokhtarian (1991b) questioned the impact of telecommuting on ridesharing, while other studies (Mokhtarian et al., 1997; Wells et al., 2001) showed that employees drive alone more, use transit less, carpool or vanpool less, but walk or bicycle more on telecommuting days than on non-telecommuting days for general travel. These studies argued that although drive alone as a mode choice would increase on telecommuting days, overall trips will decrease in part because of a decline in trip chaining. Employees tend to chain personal trips (e.g. running errands) to work trips on non-telecommuting days.

There are a few studies on how flexible work schedules would influence parking location choice or how parking pricing would influence travel demand when work schedule is flexible. In one of the earlier studies on the impact of increasing parking prices, Miller and Everett (1982) included flexible working hours in their analysis and concluded that work schedule could induce transportation mode shift in certain employment sites in Washington DC. In Gillen's (1978) parking location choice model for the central business district of Toronto, he found that when the flexibility of work hours is higher, individuals' parking duration will be lower instead of finding parking locations with lower hourly parking rate.

Alexander et al. (2010) identified three main factors that could contribute to a flexible work schedule, namely, 1) work-related characteristics; 2) information and communication technologies (which enable working at home) and 3) socioeconomic characteristics, such as gender (e.g., women with young children may desire to work at home or close to home and their children's day care or schools). Employees in managerial, professional and clerical positions are more likely to have conventional work schedules (Vana et al., 2008), while out of these three job categories, managers were found to telecommute the most (Mokhtarian and Salomon, 1996). Residential location also contributes to the flexibility of work schedules. Yeraguntla and Bhat (2005) found that employees living in highly urbanized areas have a greater flexibility in work schedule than employees living in suburban areas.

Since UC Berkeley has a wide range of employment type and job characteristics, it serves as a rich study site with varying levels of work schedule flexibility, leading to potentially different transportation choices and parking preferences. If AWS and telecommuting were encouraged, even for just twice a month, four commute trips would be reduced per month per employee, leading to not just lower travel costs for employees, but also decreased congestion and emissions, and higher availability of parking spaces on campus.

6.3 METHODOLOGY

One-on-one interviews were conducted to examine how flexibility in work schedules will influence transportation mode choice and parking preferences. The interviews were designed to

understand how travel demand and parking preferences are connected to work schedule and employment type. A total of 86 one-on-one interviews with UC Berkeley employees, excluding student employees, were conducted over a period of two months from May to September 2013. The sample size was restricted by time constraint and although it is a small percentage of the total faculty and staff population, it represented a wide range of employment type, job levels, departments, offices, and academic disciplines.

A detailed description of the research method is provided in Chapter 3.

6.4 INTERVIEW RESULTS

Results from the 86 interviews conducted for this dissertation provide a more detailed context, and offer insights into the behaviors shown in the survey and models presented in Chapters 4 and 5. The impact of job characteristics on frequency of travel to campus and on parking choices is considered in this section.

The descriptive statistics of the interview participants, including their transportation mode and parking choices are presented in Appendix J.

6.4.1 JOB DESCRIPTION AND WORK SCHEDULE

The job descriptions of most faculty members are quite similar across academic disciplines but staff members have a wider range of responsibilities that are harder to generalize. For faculty members, common job descriptions include teaching, conducting research, managing research centers, advising students, attending seminars and committee meetings, committing to administrative duties, and participating in regular off-campus meetings. For staff members, job descriptions are divided into desk-bound and non-desk jobs. Most of the staff members interviewed have desk-bound jobs, and those with non-desk jobs are often moving around the campus at different times of the day. There were two staff members who worked as full-time telecommuters because of personal reasons and only traveled to campus a few times a year. Unlike staff members, most of the work related activities for faculty members, apart from teaching, are not at set times but can be scheduled at the faculty member's discretion.

> "I am a professor and I teach several courses a year, advise students, reading, writing, thinking, and going to seminars. I work quite independently, not in teams. I teach three formal courses and help teach two courses a year. I travel a lot and spend more time working off campus than on campus." (Faculty Member)

Faculty members have a more flexible work schedule than staff members and are usually on campus less frequently, either by the number of days per week or by the number of hours per day. However, although faculty members may have more flexible work schedules than staff members and have the option to work from home or somewhere else off campus, some faculty members prefer to be on campus and work on campus just like staff members with a regular 9:00AM – 5:00PM, Monday to Friday schedule.

> "My department is flexible and does not really care if faculty members are on campus or not. Staff members at the department are allowed to work from home but it is rare. They can work from home due to family emergencies or commitments, but every staff member is here on campus from Monday to Friday." (Faculty Member)

> "My working hours are consistent, I arrive by 8:00AM and leave at 4:00PM or 4:30PM. There is a lot of flexibility in work schedule, I just need to put in adequate hours per week. My department is very flexible and people have different working hours. People come in at different times, leave at different times, as long as they are on campus for a minimum of eight hours. My schedule does not change in the summer and is not impacted by the academic schedule. In fact, I am very busy in the summer, because we are getting near to the end of the fiscal year." (Staff Member)

Regardless of university affiliation, most of the participants arrive on campus between 7:00AM and 10:00AM and depart between 4:00PM and 6:00PM, though there were a few who depart as late as 9:00PM because of special events on campus or heavy workload at certain time periods of the year, e.g. end of fiscal year. Arrival and departure times are similar for both faculty and staff members. For employees with young children, their commute hours are usually dictated by their children's daycare or school hours.

> "I arrive on campus by 8:30AM and depart at 6:30PM. I am on campus every day, not during the weekends, but I will bring work home. I need to drop off my kids to school every morning, which is a constraint for me, both in terms of my arrival time and how I travel to campus. I have to drive because of my kids." (Faculty Member)

> "I arrive at 8:00AM or 9:00AM and leave at 5:00PM or 6:00PM. My schedule is constrained by day care hours." (Staff Member)

The biggest difference in work schedules between faculty and staff members lies within the frequency of work trips per week. It is more likely for faculty members to be working from home before and after regular working hours than for staff members, though it is also common for senior staff in managerial roles to take work home. Working from home can also mean working off campus during regular office hours, i.e. telecommuting. This was found to be more common amongst faculty members than amongst staff, though not a lot more. Of the faculty members interviewed, 38 percent are on campus only three or four days a week during a typical semester and work from home when they are not on campus. Key factors affecting the decision to work or not work from home include having crucial resources on campus, supervisor attitudes towards telecommuting, availability of home office, and the number of professional and social activities held within each department. Examples of professional and social activities include seminars, bowling events and regular coffee meetings. However, the type and frequency of such activities vary according to the department or office. In fact, not all departments/offices offer such interaction opportunities for employees.

> "It is possible for me to work from home. I have a home office, which is better and bigger than my office at the department. I have the same computer at home and all my books are at home. I would prefer to work from home but there are things that can be

done better on campus, e.g. teaching or meeting students, but writing is better off campus." (Faculty Member)

"I work from home or at a café close to home. I sometimes have meetings with students late in the afternoons and work from home in the mornings. I have the flexibility to work from home and prefer to work from home, because of my young children and utilities that are accessible at home, e.g. food. All the other faculty members at my department hate coming in to their offices because the building is too hot and noisy. I do not have to be on campus, especially when I can hold meetings and have video conferences using Skype. Technology is a great help." (Faculty Member)

"There is a faculty meeting at my department once a week, which I always try to go when I am around and there is at least one seminar every day and lab meeting once a week. There are small meetings happening every day, taking about an hour of time each. Professors in my department go to seminars closest to their fields. We see a lot of each other. Professors in my department are on campus every day, unlike my friend in the language department, who works more from home." (Faculty Member)

For faculty members, academic fields matter to a certain extent, as each field has a different level of dependence on physical assets and resources that are located on campus, which affect the ability to work off campus. For example, a faculty member in life sciences prefers to spend most of his time in his laboratory because of the equipment he needs for his research. Another faculty member, who is also in life sciences, is on campus every day of the workweek not just because of her students and researchers in the laboratory but also because of the need to retrieve high resolution published prints from the library. On the other hand, most faculty members in humanities and social sciences, or even engineering, rely more on electronic resources that are accessible at off-campus locations too. There were a couple of staff members who mentioned that they need access to high speed and powerful computers that are only available on campus in order for them to complete their work. However, this requirement also applies to specific departments and job categories. Hence, important resources on campus that were mentioned by the interviewed employees include both physical assets, such as laboratories, libraries and computers, and people, such as students, colleagues and research staff. This definition of resources is the same for both faculty and staff members.

Some staff members' daily responsibilities rely on internal servers and software, which are only available on campus or they play managerial roles in their offices. To these staff members, there are no gains from telecommuting and they would prefer to be on campus than not.

"My current role makes it harder to work from home. It is a campus culture, people expect me to talk to them in person. The University does not quite accept communicating remotely. It was easier for me to work from home five years ago [in a different position]. There is value to be on campus every day, as spontaneous conversations are beneficial to work. The university has a written policy on when is it appropriate and when not to telecommute, and as a manager, I allow working from home for my staff, but it is harder for me to do so myself." (Staff Member)

Apart from resources on campus, attitudes towards working on campus and from home play a significant role in determining how often a faculty member is on campus. Some faculty members simply prefer working on campus because they want to be available for their students beyond regular office hours and think their students' productivity will decrease when they are not around. For these professors, who are mostly in natural sciences, working from home is not as efficient as being on campus, as they prefer to interact with students and colleagues. Faculty members with administrative duties will also need to be on campus more often than faculty members without.

> "It is possible for me to work from home, but I do not do it. I am on campus every day, from Monday to Friday. There are people whom I work with in my lab, four graduate students, three research assistants and many undergraduates. I share an office space with them and I believe my lab is happier when I am around. I prefer to be on campus and interact with my students every day." (Faculty Member)

Writing and preparing lectures are tasks that almost all faculty members who are on campus for less than five days a week prefer to do off campus. Basically, most faculty members prefer to write without being interrupted or distracted regardless of academic discipline, though there was one faculty member who believes that interruptions and conversations with other people during the day help "keep things fresh." Whether working on or off campus is more distracting is highly dependent upon individual experience and preference. For example, some faculty members have mentioned that they find it distracting to work from home because of their cats or they would spend time cooking or cleaning, while others find it harder to focus on campus when they could be interrupted by students or colleagues. Some faculty members also prefer to have a mix of environment, with one citing "a variety of surroundings helps keep my mind better to focus." These findings could explain why the majority of the faculty members interviewed do not prefer to work from home even when they do not need access to any unique campus resources that are crucial to the success of their work.

The most common reason to work off campus is the availability and quality of an alternative working environment, which could be a home office or a café on campus or near a faculty member's residential location. Faculty members who prefer to work from home at least once a week have specifically described their home offices as "better and bigger," "nicer," "more conducive to thinking," "more comfortable," and with the same if not better resources, i.e. computers and books, when compared to their offices on campus.

It is important to note that AWS does not apply to faculty members but only to staff members. Although the University has its own AWS or telecommuting policies, it does not regulate individual work schedules centrally but gives each department or office on campus the authority to make the decision of who can have AWS or telecommute from home. Out of all the staff members interviewed, two of them were full time telecommuters, and three had scheduled AWS with their supervisors.

The attitude towards telecommuting is very different for staff members. Although most staff members would like to have the option of having AWS or work from home a few times a month, most staff members are on campus every day.

> "My position needs a lot of face time. My role is exclusive and if I were not here, it would be very overwhelming to catch up on things." (Staff Member)

All of the staff members interviewed are on campus for at least five days a week, unless they have arranged for AWS with their supervisors, in which case, they will take every other Friday off. Depending on the department or office of the participant, most staff members are not encouraged to work from home and apart from the full-time telecommuters, none of them work from home on a regular basis. There are a few staff members who could work from home if they need to accomplish specific projects during certain times of the year, e.g. end of a fiscal year, performance review etc. and would most probably work from home approximately two to three times a year. Some staff members have worked from home previously under special circumstances, e.g. after having a baby or surgery. Most of the staff members have never even considered the possibility of working from home. In addition, none of the supervisors and managers interviewed will allow their staff to work from home on a regular basis, citing reasons such as, "it is easier to collaborate face-to-face," "there is a lot of loss when staff are working from home and not communicating with one another" and "it is important to be on campus every day."

The number of professional and social activities held within each department varies across campus. Some faculty members attend more seminars and meetings at their departments than others and will be on campus more often to interact with colleagues either through professional or social events. Some departments have traditionally been holding more professional and social activities than others and their faculty members are more likely to interact with their colleagues and students than faculty members in departments where such activities are fewer in number. Frequent interactions with colleagues are important for at least four faculty members, who strongly believe that "shared experience is important," "people are dramatically more creative when they are surrounded by other creative people and learn from each other," "socializing with colleagues on campus is useful and enjoyable." There is also one professor who schedules daily lunch meetings with colleagues, "sometimes socially or just to talk science."

While most staff members' schedules do not change in the summer, most faculty members are not on campus as much as during the semester. Most of the faculty members interviewed are usually traveling or on campus two to four days per week if they are in Berkeley in the summer. In addition, faculty members who are already on campus for less than five days a week during the semester will be on campus even less during the summer. For faculty members whose schedules do not change in the summer, they are also on campus every day of the workweek during the semester. In general, faculty members in life sciences and physical sciences are on campus more frequently, compared to faculty members in other disciplines either during the semester or in the summer. However, the reason why they behave so is beyond the availability of resources on campus.

6.4.2 FLEXIBILITY OF WORK SCHEDULE AND TRANSPORTATION MODE CHOICE

Each of the employees interviewed had their own reasons for their specific mode choices. Amongst all the different reasons mentioned, the flexibility of work schedule was rarely mentioned. Apart from arrival and departure times, employees did not raise other factors that influence the flexibility of work schedules, such as time duration, trip frequency, and the availability of a second office.

> "I need to have a flexible schedule when taking the bus, which means no meetings in the mornings, not going to be somewhere after work at a certain time." (Staff Member)

> "I am too busy and have no time to take BART, which is too inconvenient." (Staff Member)

> "I drive to campus regularly but I used to walk, until becoming a father. I need to drive my kids to school and want to be there for them when need to. My daughter is allergic to nuts and there was once when I walked to campus and my daughter had an allergic reaction that day and needed me but I could not be there for her. I have been driving to work since then." (Faculty Member)

Non-motorized transportation modes are the second most popular mode choice amongst the faculty and staff members interviewed. Faculty and staff members prefer to walk or bicycle over other modes because they enjoy it more and also for health reasons.

> "I walk to campus every day. Half of the time, I will take the bus back home as it is an uphill walk. My daily walking time is 20 minutes to the campus and 25 minutes back home. It is too steep to bike home, so I don't bike. I enjoy walking, as it is good to walk for at least 15 minutes every day. Walking is my exercise since I do not have time to do any other exercise due to my job. I have also picked my residential location based on the proximity to my workplace. Another priority is being in a safe neighborhood." (Faculty Member)

> "I find walking a pleasant experience and it allows me to arrive home in a clean slate. I can process the day in my mind before going home to my family. Walking clears my mind." (Faculty Member)

Staff members who take AC Transit buses to campus also have access to motor vehicles. However, they do not drive to campus on a regular basis, mainly because of the costs of driving and parking. They have expressed that they would drive if parking were not an issue. Some staff members drive to campus occasionally when they need to be somewhere else for time sensitive appointments after work. AC Transit commute trips have been described to be "convenient" and a "pleasant" social experience in general, as participants get to make "bus friends" or "bus acquaintances," whom they see everyday on the bus. UC Berkeley offers subsidized AC Transit passes to all employees, which is an incentive for some employees not to

drive when they could. Some of the staff members, who take AC Transit buses to campus right now, believe that they would probably drive more without the subsidized transit passes.

> "I take the AC Transit buses to work. I own a car but was told that owning a parking permit was expensive on campus. I do not know how much it costs to park on campus, was told that it would be $100 per month so I do not want to pay for parking. I have a subsidized bus card, $36 deducted from paycheck. The buses are reliable 80 percent of the time. Bus ride takes 40 minutes to campus, 60 minutes going home, sometimes one and a half hours for an eight-mile journey. I would drive if parking were not an issue, but my car is 14 years old and needs to rest, so it is good to drive less." (Staff Member)

For some of the employees interviewed, commuting choices are based on their past experience, habit and individual preference. Major changes in life, such as death in family, divorce, moving further away from campus, and expansion of family, have contributed to mode shift in the past, mostly shifting from public transportation or walking to driving. This applies to both faculty and staff members. Some participants used to use public transportation but started driving because of their young children, as they either need to drive them to school before arriving on campus or need to be on call for any emergencies. However, once they started driving, it becomes a habit, which continues even after their children have grown up and no longer need to depend on them.

> "I drive every day. I used to take BART when I first started working at Berkeley and took it for three years, but BART added an extra hour to my total travel time and because I had two young kids at home, I started driving. Now my kids have grown up and are in their twenties but I still drive mainly because of habit, my volunteer work and other activities after work." (Staff Member)

> "I used to mostly walk to campus until my twins were born and I need to drive them to school and be there for them when need to. I live one mile away from campus, but I now have the habit of driving, even on days when I do not have to." (Faculty Member)

6.4.3 FLEXIBILITY OF WORK SCHEDULE AND PARKING PREFERENCES

Parking spaces are available for free in residential neighborhoods surrounding the campus. However, such spaces, usually within a half mile of campus are subject to the City of Berkeley's Resident Preferential Parking (RPP) regulations, which impose a two hour time limit for those lacking a resident parking permit. Hence, it is necessary for the participants to move their vehicles every two hours to avoid getting a parking citation. Most of them move their vehicles up to four times a day and two participants have described it as an enjoyable "parking game" and use it as a form of exercise. They are willing to take the risk of getting a parking citation and will usually receive a citation once every six months or longer. One participant has not received a parking citation in a few years, but this participant sometimes parks beyond the residential zones that are not subject to any time limit enforcement. Since participants who park in the residential areas need to move their vehicles every hour or two, the nature of their job and responsibilities have to be flexible enough for them to do so. This implies that they are not expected to be in their office at all times and do not have long meetings throughout the day.

Parking in RPP areas is not an option for those who cannot be absent from the office for a short period of time for every couple of hours.

> "I park in the residential neighborhood every day. My current parking location is about a two to three minute walk from my office. I move my car three to four times a day and I use it as a form of exercise and like it. I will get a ticket every six months." (Staff Member)

A few of the interviewees have second offices that come into play as they consider their travel options. For example, two of the faculty members interviewed are affiliated with the Lawrence Berkeley National Laboratory (LBL), where free parking is available. Since they are eligible for free parking at LBL, they will walk or take the shuttle to their offices on campus after they have parked their vehicles at LBL in the mornings. They will also park their vehicles at LBL on days when they are not working there but need to be at their offices on campus.

Some faculty members arrange their schedules to avoid having to pay for a full day of parking. For example, one faculty member, who drives to campus but does not have a parking permit, schedules her classes late in the day so that she can park after 4:00PM and pay for no more than two hours of metered parking. She will also find metered parking on days when she has to be on campus for meetings and will not stay longer than two hours. There were times when she has missed meetings because she does not want to "hassle with parking." She comes in only two days a week most of the time. The rest of the time, she works from home but has mentioned that if parking were not a problem, she would work at her office more frequently.

Some faculty and staff members reported that they used to park on campus but have stopped purchasing parking permits. Their reasons are mostly related to bad experiences with campus parking, e.g. unsatisfactory customer service and lack of parking spaces in campus garages in the mornings. Some also reported giving up their parking permits because of changes in lifestyle and residential location, while others have started driving and parking. For example, one staff member reported that he "played the parking game" for six years before switching to a campus parking permit because of the inconvenience of parking in neighborhoods, and because he had health problems that made the walk from residential parking (which could take as much as 20 minutes) untenable.

The majority of the staff members, who drive to campus alone most days of the week, have a campus annual parking permit and park at one of the campus parking garage or lot (76 percent). Staff members who choose not to park on campus are usually concerned with the cost of parking on campus and are willing to move their vehicles for up to four times a day and risk getting a parking ticket. However, it is more likely for staff members to park in RPP zones when they only drive to campus occasionally and ordinarily using other transportation modes.

6.5 DISCUSSION

The interviews provided some insights on UC Berkeley faculty and staff members' work schedule, transportation mode and parking choices. The flexibility of work schedules is highly dependent upon each faculty's individual preferences. As shown in Section 6.5.1, faculty

members who are on campus for at least five days a week do so not because they have to, but because they prefer to be available for their students, interact with colleagues, or because of the tradition within their departments.

Staff members' work schedules are less flexible across all job categories compared to faculty members' schedules but all work schedules in general seem to affect parking location, whether on or off campus. In particular, those who arrive on campus later in the day or stay for longer hours on campus are more likely to drive and park on campus.

It is important to emphasize that almost 40 percent of the faculty members interviewed are not on campus five days a week. Assuming this is representative of the population (the survey conducted for this dissertation suggests that it is), then faculty use of flextime is reducing parking demand substantially.

6.5.1 TELECOMMUTING AND ALTERNATIVE WORK SCHEDULES ARE UNCOMMON AMONGST STAFF

Not all staff members are eligible for AWS or are able to work from home without affecting their productivity. The higher the job level, the less likely it is possible for an employee to work from home during regular business hours or arrange to be on campus for less than five days a week. Managers and supervisors often need to interact with their team members and supervision of staff is best done in person. There are also many jobs that require the physical presence of an employee on campus in order to accomplish specific tasks, where telecommuting would be infeasible. Some examples of such job titles include laboratory assistants, campus fire marshals, health and safety specialists, and most jobs within the "Operational and Technical" job category as defined by the University. In fact, staff members who hold jobs within the "Professional" category are the only group that is likely to be able to work from home or arrange AWS. According to campus data, this group accounts for 52 percent of total staff members (UC Berkeley, 2012a). Other than job category, the ability to be able to telecommute or arrange for AWS also depends on common practice within a specific department or office, particularly what an employee's supervisor considers to be most appropriate.

In the abstract, the idea of telecommuting seems to be a perfect solution to the problems of increasing travel demand, congestion, energy use, and air pollution. Employees would work from home using technologies that will enable them to communicate and work as productively as they would be at their workplace. Without the need to commute, there would be less congestion and pollution. However, in reality, telecommuting is simply not for every job category or every level within each job category. Most departments do not encourage telecommuting and AWS, and prefer their staff members to be on campus. In some cases this is because the jobs require the physical presence of the employees but in other cases it is because managers believe face-to-face contact is important or simply because of tradition. Although almost all participants cited computers as a crucial resource for their work, there are other resources that cannot be replaced by technology, such as people. Staff members rely on one another more than faculty members do. Faculty members who choose to work on campus at least five days a week often cited the need for working together in lab settings, but some also reported that they prefer to come to work five days a week not because they need to do so but because they enjoy social and professional

interactions with their colleagues and students. Just because a job is computer based and desk-bound does not necessarily mean that it is possible or more preferable to work from home.

Although the flexibility of work schedules is in general higher for faculty than staff members, faculty members follow self-imposed schedules and if they are on campus, they will stay on campus for at least seven or eight hours, just like staff members do. This implies that future changes in parking pricing could have a low impact on parking duration for staff members and for faculty members who are already on campus for at least five days a week.

6.5.2 PERSONAL PREFERENCES HAVE THE HIGHEST IMPACT ON WORK SCHEDULE FOR FACULTY MEMBERS

The preference to work on campus or not, regardless of academic discipline, is one of the most important factors contributing to faculty members' work schedules. Academic discipline determines work schedule flexibility to an extent, as faculty in humanities and social sciences are certainly on campus less frequently than faculty in life or physical sciences. However, their trip frequency is also determined by their own personal preferences that are affected by the condition of their office space and level of desired interactions with students, postdoctoral scholars, researchers, and colleagues, which may not be due to academic discipline or the need to use certain resources only available on campus. There are faculty members who do not need access to any unique physical resources on campus who prefer to work on campus and be on campus for at least five days a week for reasons irrelevant to their academic disciplines. Faculty members who choose to be on campus for less than five days a week or who are only on campus on days they teach do so because they prefer to work from home or because most other faculty members in their department do so too. Hence, the work culture within a certain department matters too. In certain departments, such as the Department of Civil and Environmental Engineering and the Department of Mathematics, it is a tradition to be on campus every day, even though their faculty members are self-sufficient and do not necessarily need to be on campus for at least five days a week in order to stay productive.

6.5.3 WORK SCHEDULE INFLUENCES PARKING LOCATION MORE THAN TRANSPORTATION MODE

Work schedule has not been found to significantly affect transportation mode choice but it has a greater impact on parking location choice, since arrival and departure times, as well as the number of hours on campus can all influence where a staff or faculty member chooses to park. More popular campus parking lots or garages are full by a certain time in the morning. If employees do not arrive on campus early enough, there might be no parking spaces left by the time they arrive. For faculty and staff members who are on campus early in the mornings, e.g. before 8:30AM, parking will not be a problem on campus but for others who live further away and arrive later, they would choose to park off campus because there are more spaces available. Participants who chose not to park on campus usually park off campus in residential neighborhoods or in public garages. Depending on where an employee's primary workplace is located on campus, residential parking zones may not be further away from where they work than an on-campus parking lot or garage. In some cases, walking distance is similar. This is true for public garages, since they are mostly located very close to campus.

Chapter 7

EMPLOYEES' ATTITUDES TO TRANSPORTATION AND PARKING CHOICES AND POLICIES

The focus group sessions and one-on-one interviews conducted for this study provided important insights into the attitudes of UC Berkeley employees toward current and potential transportation policies. They complement stated preference (SP) responses from the survey conducted for this study, which also reveal attitudes and potential behavioral responses to new parking options. This chapter reviews findings from the investigations of attitudes and potential behaviors and assesses their implications on policy options that might be considered for the UC Berkeley campus.

7.1 INTRODUCTION

Data from the interviews and focus groups carried out for this study support the following categorization of commuters to UC Berkeley, 1) employees who drive and park on campus and are adamant that they will not give up driving even if there are other possible alternatives and will park on campus despite any changes in parking permit pricing (Regular Drivers – High Parking Demand); 2) employees who drive regularly but may consider using other forms of transportation modes, e.g. transit, once in a while if services improve (Regular but Flexible Drivers – Moderate Parking Demand); 3) employees who do not drive regularly but would prefer a flexible parking permit over a fixed permit pricing system because they drive occasionally, e.g., when driving to campus is required because a car is needed for an off-campus appointment (Occasional Drivers – Low Parking Demand), and 4) employees who use alternative modes of transportation regularly and rarely or never drive (Non-Drivers – Near-Zero Parking Demand). Each type of commuter has a different set of characteristics, transportation needs, constraints, and preferences, which led to various reactions to potential changes in parking pricing policies.

It is well settled that socioeconomic factors, such as income are important determinants of mode choice, as are the availability of modal options and residential location (Ben-Akiva and Lerman, 1985; Cervero, 2002). Both factors are at play at UC Berkeley. Despite the relatively high level of transit service in the San Francisco Bay Area compared to other U.S. metropolitan areas, many UC Berkeley employees nonetheless live in areas where taking transit to campus would require several time consuming transfers for whom the total travel time is not competitive with driving. Others live close enough to campus that walking and biking are options along with transit (bus and train) and driving. The decision to either drive or use other forms of transportation is more complex for employees with good options than for employees with limited alternatives. In addition, the ability to schedule flexible working hours also influences both mode choice and parking location. Employees who make use of this privilege tend to arrive on campus later in the day and/or to work at home part of the time and to drive the other days.

Major life changes, such as death in family, divorce, moving further away from campus, and expansion of family, have contributed to mode shift in the past, mostly shifting from public transportation or walking to driving, and hence, parking on or around the campus. This applies to both faculty and staff members.

7.2 INTERVIEW AND FOCUS GROUP PARTICIPANTS

The summary statistics of the interview participants and focus group participants can be found in Appendix J and Appendix K respectively. Both interview and focus group participants represent a mix of different transportation modes and parking experiences.

7.3 INTERVIEW AND FOCUS GROUP RESULTS

Recurring themes and concepts from the interviews and focus group discussion sessions were identified through an analysis of the notes taken during the meeting and are presented in this section. Main findings include themes, concepts, trends, and patterns that have reappeared in various interviews or focus groups. As described in Chapter 6, the main differences between faculty and staff members are their schedules, i.e. arrival and departure times and number of days on campus per week during the semester, as well as in the summer. Apart from those differences, they have similar transportation and parking constraints and reasons for their transportation and parking choices. Amongst faculty members, academic discipline can influence mode choice to a certain extent. In general, faculty members in disciplines that require them to be on campus more often will also choose to live closer to campus, resulting them to either walk or bike to campus. As for staff members, job categories do not affect mode choice apart from its implication on income level, i.e. participants in job categories with lower wage rates tend to drive less but use unmetered on-street parking spaces without time limit enforcement more.

Greater discrepancies between faculty and staff members' transportation mode choices and parking preferences would have been noted if more faculty members had participated.

7.3.1 REASONS FOR TRANSPORTATION MODE CHOICE

There are several reasons why different employees choose certain modes and some use a combination of different modes to travel to campus, and these differences vary with frequency of driving trips. Some employees rarely choose any other mode but drive alone, while others rarely choose other mode but walk, bike, or use transit. However, most regular users of transit or non-motorized modes drive occasionally too, with driving frequency ranging from once or twice a week to a few times a year. The type of drivers discussed in this section is differentiated by the frequency of driving trips, leading to four different categories. They are, 1) regular drivers, who drive to campus every day and have specific reasons for doing so; 2) regular but flexible drivers, who drive to campus every day but are willing to use other transportation modes; 3) occasional drivers, who drive to campus less than once a week, and 4) non-drivers, who do not drive to campus at all. Reasons for each of these four driving behavior are described below.

REGULAR DRIVERS

Driving alone was the most popular transportation mode choice amongst all interview and focus group participants and it is also the only mode that at least one participant used in every focus group. However, this does not imply that all of them are regular drivers, i.e. driving to campus every day of the workweek.

As noted in Chapter 6, study participants' reasons for driving include the superior comfort of the automobile, concerns about safety, and for some, the need to transport or be available on short notice for dependents. Another group cited low transit accessibility from their homes to campus. In addition, some focus group participants reported that cost factors made driving preferable to using transit. They cited the availability of free parking close to campus and transit fares that brought transit out of pocket cost to the same or higher cost as that of driving alone.

In discussing convenience, focus group participants included the walk to and from the bus stop or transit station as an inconvenience, along with having to walk or take a shuttle from downtown Berkeley to campus. Other inconveniences cited by participants included having to coordinate travel times with transit schedules. However, the most important convenience factor favoring driving was travel time. For example, using AC Transit buses would take twice as long to commute as driving would for some participants.

> "I just want to get to work, but time would be saved when I drive compared to what a bus would take. There is a long walk to the bus stop and the bus stops so frequently, so I don't use it." (Regular Driver, Staff, Focus Group)

> "I was trying to take a bus but if I am assigned a classroom on the North side of campus, the bus only brings me to College/Bancroft and I have to get myself across campus and back in the dark, only to wait for the bus while I freeze. Also, carrying books, papers and the laptop I use for lectures is a hassle." (Regular Driver, Faculty, Interview)

> "I have taken BART a few times, about five or six times, but did not like it. I still have to drive about five miles from home to the BART station and walk from Berkeley BART station to campus. I would rather take the car." (Regular Driver, Staff, Focus Group)

> "I have tried taking the bus but it is too much for me to wait. I am a city person and I am not used to buses not showing up." (Regular Driver, Faculty, Focus Group)

> "I used to use AC Transit when I was living in Rockridge but stopped because taking the bus took longer than driving." (Regular Driver, Staff, Focus Group)

> "I have tried taking BART to work but the [lower] cost and convenience of being in my car won." (Regular Driver, Staff, Focus Group)

In the survey, 37 percent of the respondents reported having at least one dependent. For these respondents, another influential factor that leads to regular driving is the need to drop off or pick

up young children before or after work. In addition, grandchildren and even a desire to visit adult children on the way home from work were reasons given for driving.

> "My schedule is completely affected by my son's schedule. I have to drop off my son in Alameda before driving to campus and will pick him up after work every day." (Regular Driver, Staff, Focus Group)

> "My grandkids go to different day care centers and sometimes I need to pick them up. It's usually a last minute request from my son, so I need to have my car with me. It can be a couple of times a month." (Regular Driver, Staff, Focus Group)

> "My son is older now but when he was younger, I would be driving for sure, no matter what the price." (Occasional Driver, Staff, Focus Group)

> "I prefer driving (to BART or AC Transit) because I need to drop off my daughter and pick her up after work. I will always drive until my daughter is old enough to drive herself." (Regular Driver, Staff, Interview)

> "My kids also live here [in Berkeley] so I use the car after work to visit them." (Regular Driver, Staff, Focus Group)

> "My driving frequency is because of my children. My children drive my travel behavior." (Regular Driver, Faculty, Interview)

In discussing the greater comfort of driving, the ability to be in a private space and not commute by public transportation, which is subject to crowded spaces and other commuters, is desirable to some participants. Several participants mentioned comfort as the key reason why they drive to work.

> "It is nice to be in my car, in my own space after work." (Regular Driver, Staff, Focus Group)

> "I am relaxed in my car. I put on music and I am in my own environment. It is much better than BART, where I have to share the space with so many people and I have to sit on those old seats." (Occasional Driver, Staff, Focus Group)

> "Driving is more relaxed (than bus or BART), I can listen to music, wear nice shoes, and can meet friends after work." (Occasional Driver, Staff, Interview)

Driving is perceived to be a safer transportation mode than other modes. For transit and walking, safety has to do with the environment around the transit stations and bus stops, as well as the fear of crime.

> "As a woman, safety is an issue with walking if I take BART to work. Because I stay later at work, I don't think it's safe for me to walk home from the BART station." (Regular Driver, Staff, Focus Group)

> "I don't use public transportation because safety is a big concern for me. I live in Richmond Point and drive to work every day." (Regular Driver, Staff, Focus Group)

> "I drive for security and safety reasons. I arrive very early and go to the recreational sports facility (RSF) at night." (Regular Driver, Staff, Focus Group)

> "I don't want to stay on campus late at night, waiting for a bus." (Regular Driver, Staff, Focus Group)

The choice to drive every day to campus also depends on the availability of other modes for an individual. Some of the participants live in communities with limited travel options to campus. If transit services were unavailable and biking or walking infeasible, driving alone becomes the only option that commuters deem feasible.

> "I live in Petaluma, there are no other options, I am in my car every day." (Regular Driver, Staff, Focus Group)

> "I live far from transit services and AC Transit is not reliable enough to get me to work on time." (Regular Driver, Staff, Focus Group)

> "I live in a residential area in Alameda, so taking the bus and BART are not very convenient." (Regular Driver, Faculty, Interview)

REGULAR BUT FLEXIBLE DRIVERS

From the transportation and parking survey, approximately 1.44 percent of the respondents live within a half mile of campus, which is a 10 to 15 minute walk, while approximately 28 percent of the respondents reside three miles or less from campus, which is equivalent to a 20 minute (or less) bicycle ride. Another 20 percent of the respondents live within a 30 minute commute by AC Transit or BART. Thus, approximately half of the campus affiliates are able to travel to campus by transportation modes other than driving alone.

Many of the drivers classified here as "regular but flexible" drivers live in residential locations where transit services are available or where walking and biking are feasible commuting options. Most (64 percent) do not need to schedule their arrival and departure times around someone else's schedule. Some of the participants in this category would like to bicycle to work as a form of exercise or want to reduce their own transportation emissions by using public transportation. Most are in one-car households (which constitute 56 percent of the survey sample) and need to share their vehicle with other family members.

> "I occasionally take AC Transit if my son needs the car." (Regular but Flexible Driver, Staff, Focus Group)

"I have an F parking permit and was given a free AC Transit pass with it. I try to use the transit pass three times a month. I have no kids and feel fortunate to have so many transportation alternatives." (Regular but Flexible Driver, Staff, Focus Group)

"If it is not raining or if I do not have any early meetings at work, I would walk or bike more. If the stars are aligned, I will take the bus." (Regular but Flexible Driver, Staff, Focus Group)

"I usually drive to campus but bike a few times a month. Driving to campus takes 10 minutes and I feel guilty when I drive." (Regular but Flexible Driver, Faculty, Interview)

Even though many in this group would like to drive less, they do not all see the alternatives as adequate.

"Nobody wants to always drive but the alternatives are painful. Worker shuttles would help employees get to campus." (Regular but Flexible Driver, Staff, Focus Group)

"Taking the bus is convenient for me, I can get from home to campus with one bus but taking the bus takes an hour, while driving takes 20 minutes." (Regular but Flexible Driver, Staff, Interview)

OCCASIONAL DRIVERS

The most common reason for not driving regularly is due to the cost of driving being higher than using other transportation modes. The calculations done for respondents in the survey carried out for this study indicate that driving alone is more expensive than transit for the trip from the respondent's residence to campus in approximately 97 percent of the cases if the cost of parking were included. Without taking the cost of parking into consideration, six percent of the respondents' cost of driving will be less than transit, given their residential locations.

"I choose BART because of the economics of it. I will drive during BART strikes or more often for appointments. I drive to campus about one to two times a month and I use daily parking permits." (Occasional Driver, Staff, Focus Group)

"I need to take both the bus and BART to get to campus. Driving is more relaxed but I use transit because it's cheaper." (Occasional Driver, Staff, Focus Group)

Weather conditions also can lead to a decision to drive or not. Cold, rainy weather is a deterrent to transit use. In addition, some participants are more reluctant to use public transportation when it gets dark earlier in the winter and would drive more than in the summer.

"Today was cold, in the summer I would have biked, instead of driving to campus or being dropped off by my husband." (Occasional Driver, Staff, Focus Group)

"I drive when it rains, when I just want to get into my car and get home to feel protected." (Occasional Driver, Staff, Focus Group)

"Sometimes I have to drive because of the rain. I usually bike." (Occasional Driver, Staff, Focus Group)

"I only drive when it rains, otherwise I will use my motorcycle. I use street parking when I drive." (Occasional Driver, Staff, Focus Group)

"I ride my motorcycle to work every day and drive my car or take AC Transit on rainy days, which is not a lovely experience. I wish the buses ran twice as often." (Occasional Driver, Faculty, Interview)

Occasional drivers also drive to work for special events, which include personal and professional appointments, social engagements, or work events. In addition, some participants will also drive when they are running late in the mornings, working late in the evenings, or carrying heavy or bulky things to work.

"I only drive when I have something like a dentist appointment or else I will BART. I drive once every couple of months." (Occasional Driver, Staff, Focus Group)

"On the rare occasions when I must bring my car to campus, e.g. for a department event, I get a "C" hangtag from my department. Otherwise, I ride my bicycle on most occasions. Aside from parking being unaffordable, cycling is so much healthier for both me and the environment." (Occasional Driver, Staff, Focus Group)

"Driving or not depends on my work and personal schedules. Sometimes I need to come to work earlier." (Occasional Driver, Staff, Focus Group)

"I can't rely on AC Transit when I need to get somewhere on time and would then switch to driving." (Occasional Driver, Staff, Focus Group)

"I drive on days when I need to get to the city (San Francisco), when I have dentist appointments, blood tests, or other appointments at the end of the day or beginning of the day." (Occasional Driver, Staff, Interview)

"I drive when I have to bring something bulky to campus. Otherwise, I usually take MUNI and then switch to AC Transit." (Occasional Driver, Staff, Focus Group)

"I drive when I am running late for a meeting or when I need to drop off heavy equipment." (Occasional Driver, Staff, Interview)

"I usually walk to campus but drive a few times a month when I have something heavy to carry, for example books or equipment such as models for a class." (Occasional Driver, Faculty, Interview)

The physical condition of the commuter is another factor that directly affects transportation mode choice. While some physical limitations are permanent, others can be unpredictable and

vary on a daily basis. When some participants "do not feel like" using their primary modes of transportation, e.g. biking or walking, they will then choose to drive.

> "I drive three days a week because of my mobility situation. I have knee problems and do not want to walk long distances." (Occasional Driver, Staff, Focus Group)

> "I drive on days when I feel lazy and irresponsible." (Regular but Flexible Driver, Faculty, Interview)

> "I walk to campus every day but I would drive or take the bus when I am hurting or something, when I am not feeling well enough to walk." (Occasional Driver, Faculty, Interview)

Some participants simply drive occasionally because they prefer to use other transportation modes and would drive as minimally as possible. This is mostly due to the negative attributes associated with driving, such as waiting in traffic or looking for parking.

> "I do not think I will drive more even if there is a more flexible parking pricing system because I still prefer BART. Each BART ride takes an hour and a half and I work on the train, respond to e-mails on BART." (Occasional Driver, Staff, Focus Group)

> "I would rather take BART home than drive. I wouldn't want to drive on the bridge." (Occasional Driver, Staff, Focus Group)

> "My preference is to not drive. I would pick the train even if it costs the same as driving. I just do not want to deal with driving and the traffic." (Occasional Driver, Staff, Interview)

> "I bike to work but drive about five times a month on days when I go running in the Berkeley Hills. It is frustrating to drive, there is congestion, traffic lights are not synced, and trucks stop in the middle of the road. I always ask myself why am I driving on days I drive." (Occasional Driver, Staff, Interview)

> "I usually take BART to campus from San Francisco. I enjoy the ride and I find it more appealing than driving and trying to deal with traffic and parking." (Occasional Driver, Faculty, Interview)

NON-DRIVERS

There were two focus group participants and one interviewee who did not have a valid driver's license and did not know how to drive. There were also participants who live close enough to walk or bike to campus and have never driven to campus. Another common reason participants gave for being non-drivers is that they much prefer to use other transportation modes and simply do not enjoy driving to work and finding parking once they arrive on campus.

"I find parking to be stressful. I do not like to drive all the way to campus and I would not do it even if it were very cheap." (Non-Driver, Staff, Focus Group)

"I own a car but I have never driven to campus for work but I have driven here for a concert. It would take longer to find a parking space if I drive, so I prefer to bike." (Non-driver, Staff, Interview)

"I bike to campus every day. My wife uses the one family car we own to drive the kids around. I sometimes rent a car about once a month when I need to drive to meetings in Sacramento but never to campus." (Non-Driver, Faculty, Interview)

"I bike to campus every day and take BART when it rains. I like biking and find it relaxing and more enjoyable than BART or driving. I own a car but I do not like driving and do not want to pay for parking." (Non-Driver, Faculty, Interview)

"I prefer to walk, I could have telephone conversations with my family while walking." (Non-Driver, Faculty, Interview)

"I enjoy walking and it is good to walk for at least 15 min every day. That is my exercise as I do not have time to exercise due to my job." (Non-Driver, Faculty, Interview)

7.3.2 REASONS FOR PARKING LOCATION PREFERENCES

ON CAMPUS PARKING

Participants who use campus parking garages and lots value the convenience of parking on campus and would not want to spend extra time driving around the campus looking for alternative parking every morning. Additionally, their chosen campus parking locations are close to where they work and take an average of three to five minutes for them to walk to their respective offices. Employees with campus parking permits believe it is more convenient to park on campus and not having to move their vehicles around because of the time limit enforcement regulation found in RPP neighborhoods. Faculty and staff members who drive to campus and hold a campus parking permit have no incentive to park elsewhere. Since they have already paid for a campus parking permit, they will not consider using on-street or off-street off campus parking.

"When I used to work part time, I would park far, far away and then I would walk to campus. I am sure other people do that too. That's how I got my exercise, 20 minutes of walking time. But now I am a full time employee, I got an F permit. Convenience is very important." (Regular Driver, Staff, Focus Group)

"It's cheaper to buy a parking permit than to get a ticket. I am anxious enough every day, so stacked parking or not, it's good to have campus parking and not worry. Remembering where your car is on the street is a problem too." (Regular Driver, Staff, Focus Group)

"I never have to look for parking alternatives. I get here by 9:00AM and can always find a spot in an F lot." (Regular Driver, Staff, Focus Group)

"I drive every day and park in Underhill parking garage. There is always a parking spot for me when I arrive at around 8:30AM." (Regular Driver, Faculty, Interview)

"I have an annual F parking permit so that I can park in the garage next to my office when I drive on days when the weather is bad or when I am running late. I like having a permit even though I do not drive regularly. The annual parking permit takes the headache out of it." (Occasional Driver, Faculty, Interview)

Having a campus parking permit also reduces the incentive to not drive every day. Of the approximately 70 percent of the campus parking permit holders who participated in the focus groups, only three have tried to take the bus or bicycle to campus occasionally. They explained that they feel responsible to not drive every day because of environmental reasons. Although only three respondents have expressed this mentality, there could be more if incentives to not drive daily were provided through subsidized transit passes. The other parking permit holders drive every day of the workweek and have not considered using other transportation modes.

"I have an F permit but since my permit came with a free AC Transit pass, I try to take the bus three times a month when possible." (Regular Driver, Staff, Focus Group)

"I bike except when it rains. I still have a parking permit. In the beginning, I needed the security of my car because I was so exhausted after work. Now I am in this in-between place." (Occasional Driver, Staff, Focus Group)

"I have an annual C parking permit but I try to bike two to three days a week for all the usual reasons, health, environmental benefits, more responsible thing to do etc." (Regular Driver, Faculty, Interview)

OFF CAMPUS PARKING

Off-campus parking spaces are popular amongst faculty and staff who drive irregularly to campus, but it is also common for regular drivers to park off campus. They park in off-campus spaces, using on-street metered parking, or in many cases, in the residential neighborhoods close to campus.

"I have got four tickets this year. I consider it my donation to the city, so I do not feel as bad." (Regular Driver, Staff, Focus Group)

"I move my car three times a day in the residential neighborhood and can always find a spot. Sometimes I cannot get away from my office and will get a ticket." (Regular Driver, Staff, Focus Group)

"I park on the street and move my car every two hours, three times a day. I like the walk while moving my car. I get three parking tickets a year at the most. With one ticket a

month, it is all right, even getting two tickets a month is still less expensive than getting a permit." (Regular Driver, Staff, Focus Group)

"I move my car about three to four times a day. I find this parking game enjoyable and use it as my exercise of the day." (Regular Driver, Staff, Interview)

"On days when I am only here for a few hours, I will just park for free on the street and move my car once or twice. If I have to move more than twice, then it is not worth it and I will just use a daily parking permit." (Occasional Driver, Staff, Focus Group)

"I have driven a few times and did not want to bother with campus garage, so I parked at a public garage. The policy on parking on campus is very complicated." (Occasional Driver, Staff, Focus Group)

"I sometimes park at my church's parking lot on Ellsworth and walk to campus." (Regular Driver, Staff, Focus Group)

"My parents live North of campus, so I park in their driveway and walk to campus. It takes about 15 minutes." (Regular Driver, Staff, Focus Group)

"I drive to campus every day but I park in the public garages. It is a more positive social experience for me to use the public garages than campus parking garages." (Regular Driver, Faculty, Interview)

7.3.3 Opinions on Campus Parking Supply and Pricing Policies

Current Parking Supply

In general, all participants had strong opinions on the current parking supply on campus. More participants (21 percent) reported that they believe additional parking is required than respondents who did not want more parking on campus (15 percent). However, there is a general consensus amongst different focus groups that the University should stop taking existing parking away if not building more parking. The perception that the campus is taking parking spaces away but not providing better alternatives for employees was also raised more than once.

Both non-drivers and regular drivers expressed the wish to see less parking on campus. Discussions from two focus groups suggested making the campus a car free zone and connecting it to a large parking facility off campus with frequent shuttle services, like at an airport or Disneyland. However, most participants were ill-informed about the costs of such alternatives. Participants were usually shocked when told that the construction cost of a single parking space would likely be around $60,000 and this information changed their perception on whether more parking is necessary.

"I think we should not be building more parking on campus. We are supposed to be ahead of the curve and subsidize public transportation use." (Occasional Driver, Staff, Focus Group)

"Campus is making parking less attractive by taking more away, but not making alternatives more attractive." (Regular Driver, Staff, Focus Group)

"There is no need for more parking, just do not keep taking parking away." (Regular Driver, Staff, Focus Group)

"Subsidize BART cost if not building more parking spaces." (Occasional Driver, Staff, Focus Group)

"The campus does not need more parking spaces, they need to balance the distribution of parking space." (Regular Driver, Staff, Focus Group)

"What is the opportunity cost of enclosed parking? We do not want more parking." (Occasional Driver, Staff, Focus Group)

"Yes, we need more parking to replace what has been torn down and taken away." (Regular Driver, Staff, Focus Group)

"From a public policy point of view, I do not want more parking. I think we should discourage driving." (Occasional Driver, Staff, Focus Group)

LACK OF VISITOR PARKING

The general consensus from all focus groups is that there is enough parking for employees and since they work on campus every day, they have already developed a parking routine. However, some employees commented that visitors are the ones who have been experiencing parking problems, especially during major campus events, such as football game days.

"Parking is a huge problem for audiences. It is hard to find parking spaces when people come to Berkeley Theatre." (Regular Driver, Staff, Focus Group)

"We need more visitor parking for fund raisers. It is embarrassing when a 85 year old trustee can't find parking." (Occasional Driver, Staff, Focus Group)

"Other people from the community are used to having more parking and are discouraged from coming to events here on campus because of how parking works. I have thought of holding events on campus but decided against it because of the lack of parking for visitors." (Regular Driver, Faculty, Focus Group)

"Visitor parking is both expensive and poorly marked. Try explaining to someone how to get into the Wurster parking lot, good luck!" (Regular Driver, Faculty, Focus Group)

"I work at the Art Center and we do not even have spaces for the art performers to park." (Occasional Driver, Staff, Focus Group)

PREMIUM PRICE FOR RESERVED PARKING

One of the parking policy scenarios asked in the focus group discussion sessions was whether the participants would be interested in paying a premium price for a reserved parking spot. It was not a popular pricing policy and the vast majority of the participants did not express an interest in such an option. In most focus groups, nobody found it attractive.

> "We just need to have enough parking, not premium price parking." (Regular Driver, Staff, Focus Group)

> "After the 2008 recession, I will be offended if the University asks for more money." (Occasional Driver, Staff, Focus Group)

> "What if everyone does that? I will not get a spot." (Regular Driver, Staff, Focus Group)

> "I will only use it sporadically for department events, when proximity matters." (Regular Driver, Staff, Focus Group)

> "BART has reserved parking spaces with low parking occupancy at $54 per month. Different BART locations cost differently. In West Oakland, it costs $150 per month. Nobody uses those reserved parking spaces. We already have a bad example." (Occasional Driver, Staff, Focus Group)

> "It depends on when can I make the reservation. I only drive when it rains, so I would not be able to tell ahead of time." (Occasional Driver, Staff, Focus Group)

> "I would use it especially if I had a medical appointment." (Occasional Driver, Staff, Focus Group)

DISCOUNT PRICE FOR PARKING FARTHER AWAY

A hypothetical parking policy that offers a discount for parking at a space 10 minutes away from the participants' office location generated more interest than the premium parking option. This policy was attractive to the majority of the participants, regardless of how often they currently drive to campus. However, the location of this lower priced parking space is important to some participants. Several groups would only be interested if such a discounted parking space does not require a steep climb and is located at a fairly safe area.

> "Yes, walking is good for you." (Occasional Driver, Staff, Focus Group)

> "Yes, I would do it for $4 a day. Walking is healthy, even in the rain." (Occasional Driver, Staff, Focus Group)

> "In the evenings there will be a problem with security issues." (Regular Driver, Staff, Focus Group)

"I already walk that much now, walking time is about 10 minutes now. If it is not raining, sure, I would like the exercise." (Regular Driver, Staff, Focus Group)

"It depends on where it is. If we need to take a bus uphill and park our cars, then it's not going to be convenient." (Regular Driver, Staff, Focus Group)

"Is it cutting across campus or straight uphill? If it were straight uphill, then no, I would not be interested." (Regular Driver, Staff, Focus Group)

"It would depend on the location. If it is in a sketchy neighborhood, then I would question if the discount ($4) is really worth it." (Regular Driver, Staff, Focus Group)

7.3.4 OPINIONS ON ALTERNATIVE TRANSPORTATION INCENTIVES

TRANSIT PASS FOR AC TRANSIT

The question of whether a free transit pass for unlimited AC Transit rides would be attractive was asked in all the focus group discussion sessions. Overall, approximately half of the participants would find it attractive and use it regularly. However, all of these interested participants are current transit users and not regular drivers. Transit incentives are obviously more attractive for employees who are already using transit on a regular basis. However, there were also participants who chose not to use transit for non-cost related reasons. For them, having more transit incentives will not necessarily shift their transportation behavior.

"Subsidizing transit would be great, like what students get for AC Transit." (Occasional Driver, Staff, Focus Group)

"If I have a transit pass, I will use the bus more because the bus passes my house. I will use it every day." (Occasional Driver, Staff, Focus Group)

"I feel that UC could do more, $10 is not that much." (Occasional Driver, Staff, Focus Group)

"Waiting for bus takes too long, I would not use it." (Regular Driver, Staff, Focus Group)

"I would use it once in a while for going home, but it is not reliable enough for going to work." (Occasional Driver, Staff, Focus Group)

"Not for me, I use BART." (Occasional Driver, Staff, Focus Group)

"I would not use it because there are no buses available where I live." (Regular Driver, Staff, Focus Group)

"I would only use it during the rainy season, about 20 to 30 days a year." (Occasional Driver, Staff, Focus Group)

TRANSIT PASS FOR BART

A transit pass that is also good on BART seemed to be very attractive to all of the participants at every focus group discussion session. Since this question was asked right after the above question on AC Transit pass, when compared to the previous question, there would be an overwhelmingly positive response from each group, "Yes, we would be interested!" Even one participant, who is currently a regular BART user but does not enjoy the experience on BART trains found the idea of a BART pass attractive. However, it is also important to note that a few participants were skeptical about how free BART passes would help reduce driving trips.

> "I might not use it to commute to work, but would use it during the weekends going to San Francisco for non-work related trips." (Occasional Driver, Staff, Focus Group)
>
> "It would have huge advantages." (Occasional Driver, Staff, Focus Group)
>
> "BART pass is very attractive. I hope it comes to fruition." (Occasional Driver, Staff, Focus Group)
>
> "If the transit pass works on BART, it will be great, so much better." (Regular Driver, Staff, Focus Group)
>
> "I only drive once to three times a month and I like the option of having a BART pass and some daily permits together." (Occasional Driver, Staff, Focus Group)
>
> "Who would it cost? People will use it more if they knew how much it costs and will not take it if they don't use it at all. It is a waste of money for the University if people only use it 10 times a year." (Occasional Driver, Staff, Focus Group)
>
> "Having a free BART pass would still not solve the dropping off kids problem." (Regular Driver, Staff, Focus Group)

BICYCLE FACILITIES

In general, most of the focus group participants have agreed that the campus currently has neither a good bicycling environment nor culture. Participants have had bicycles stolen, experienced near death moments and do not have changing facilities in their offices or departments. The two most important facilities that bicyclists or potential bicyclists would like to have on campus are secure parking spaces and shower or changing rooms. Current non-bicyclists are willing to bicycle to campus if there were better facilities available, including distinct lanes for bicyclists.

> "I bike two times per week to work. It would be nice to have some visual presence for bikers, such as colored paths. It is good for the general public to be reminded of it. Advertising works." (Occasional Driver, Staff, Focus Group)

"There should be more protected bike spacing from cars." (Occasional Driver, Staff, Focus Group)

"I would be willing to bike if there were a secure place to park my bike, either a locker or an indoor facility." (Occasional Driver, Staff, Focus Group)

"Students treat [campus] roads as walkways, but UPS trucks treat them as roads. The roads on campus are a free for all, pedestrians, bikers and drivers, which is nuts." (Occasional Driver, Staff, Focus Group)

"Being a cyclist is really dangerous on campus. I have gone through periods where I have almost been killed once a day." (Regular Driver, Staff, Focus Group)

"Certain corridors that cyclists use a lot on campus should have separate lane markings. We should have bike lanes in certain parts of campus." (Non-Driver, Faculty, Focus Group)

"Due to the lack of secure bike parking, my colleagues bring bikes up to the office. Offices for graduate students become bike storage spaces." (Regular Driver, Staff, Focus Group)

7.3.5 OTHER FINDINGS

FACULTY HOUSING

The lack of affordable housing for new and younger faculty members at UC Berkeley was thought to be one of the main problems contributing to transportation and parking problems on campus. If the University could provide more housing support for faculty members, then they would not have to choose to drive to work and would then use other more sustainable alternative modes of transportation.

"The core problem is housing for faculty. That is why people make other transportation choices." (Regular Driver, Faculty, Focus Group)

"It's not easy for young faculty members to find housing near campus. Parking is important and the University cannot expect public transportation to fix this problem." (Occasional Driver, Faculty, Focus Group)

"Car issues are symptoms of other issues." (Non-Driver, Faculty, Focus Group)

7.4 DISCUSSION

The interview and focus group findings have provided additional information and data that the transportation and parking survey was unable to capture. The survey only collected data on primary mode choice, but based on the results presented in this chapter, there are many types of drivers in addition to employees who drive alone to campus every day of the workweek. The

majority of employees (approximately 95 percent) would have driven alone to campus at some point in time, some more than others. Regardless of what they have reported their primary mode choice to be, employees who usually use transit, bicycle, or walk also drive to campus at a frequency rate between two to three days a week to a few times a year. Carpoolers and motorcycle riders tend to be the most consistent with their behavior.

Those who are able to use a combination of modes clearly have the options to do so. Hence, their transportation behavior reflect complex decision making processes based on various factor that vary on a daily basis. Such transportation behavior is harder to predict but is also most likely to be influenced by external factors, including changes in work or personal schedules. They also do not have very strong preferences on one particular mode choice or are more flexible. Hence, it is possible for them to use transit, bicycle or walk to campus on most days, but drive on other days when they think it is better to do so.

On the other hand, respondents who have a strong preference on their chosen mode are less likely to change and have already formed habitual behavior over time. This applies to parking location choice too. Respondents with preferred parking locations are less likely to find alternative parking spaces unless there are significant changes in parking pricing.

Transit incentives were found to be attractive, which is consistent with the findings from Chapter 6. However, transit incentives may only be attractive for current transit users and improvements in transit services would have to occur in order to attract more users. Almost every interview and focus group participant has tried more than one transportation mode ever since they have started working at UC Berkeley. Hence, they are already familiar with their options and have already chosen one that they perceive to be the best fit for them, given their work schedule, lifestyle, residential location, and annual household income. Any future changes in transportation and parking policies have to address their travel needs to encourage substantial shifts in mode choice. In addition, since they are already aware of their travel options, additional information on existing transportation alternatives may not create significant shifts.

The type of information that should be publicized is the construction cost of additional parking spaces, which is largely unknown to faculty and staff members. Without knowledge of the high cost of parking, it is common for employees to assume that parking should be provided for free by the University, since the University does not have to pay for its land. However, the operation, maintenance and opportunity costs of parking are often ignored, which leads to a fundamental misunderstanding of how much it costs to provide parking. Likewise, construction costs are not widely understood and typical urban costs were shocking to most focus group members. Finally, few employees knew that UC policy requires parking to cover its costs rather than be treated as an employee benefit, which is not uncommon at most universities.

CHAPTER 8

CONCLUSIONS

Parking pricing can play a significant role in regulating transportation demand by shifting mode choice. It can also influence parking location and duration. However, as discussed in previous chapters, the impact of parking pricing varies according to the flexibility of work schedule, income and the willingness to walk from a parking space to the final destination. This chapter presents an overview of key findings derived from a combination of qualitative and quantitative methods, their policy implications and suggestions for future research studies.

8.1 OVERVIEW OF KEY FINDINGS

There were four research hypotheses introduced in Chapter 1, each of them concerning how transportation mode and parking choices would alter when parking pricing changes. The overview of key findings in this section is divided according to these four hypotheses.

8.1.1 MODE SHIFT IS MOST LIKELY TO OCCUR FOR UNIVERSITY STAFF AND MEDIUM INCOME RESPONDENTS

The first hypothesis stated that a change in current parking pricing is likely to cause a shift in transportation mode and this impact would be greater for University staff than faculty members and for medium income respondents.

Results from the discrete choice analysis show that faculty members, including adjuncts and other non-professor titled academic staff, are less likely to drive and park on campus than University staff members. In general, staff members are less price sensitive to changes in parking pricing than faculty because they prefer to drive and park on campus more than faculty do. They also tend to live in residential locations that are further away from campus that make them less likely to choose non-motorized transportation modes.

According to the results from the discrete choice analysis, medium income respondents have relatively high value of walking time and price elasticity estimate of parking options, implying that they are most likely to switch parking options when pricing changes. Medium income respondents are not more price sensitive than low income respondents in terms of mode choice. Hence, changes in parking pricing will not trigger mode shift as much as switching to another parking option. In fact, parking pricing has a greater influence on parking payment type and location than mode choice across all income groups. In this case, the only realistic parking option would be on-street parking in the City of Berkeley or public and private garages, depending on the price being considered, since campus parking is currently priced below market rates.

The impact on mode choice would be greater if there were fewer parking alternatives surrounding the UC Berkeley campus. However, the City of Berkeley has continued to allow

multi-hour free parking in neighborhoods surrounding the campus, which serves as an attractive alternative parking location should UC Berkeley raises its parking prices.

8.1.2 More Faculty Would Choose New Flexible Parking Permits Than University Staff

It is indeed true that faculty members are more likely to choose flexible parking options and not a conventional unlimited monthly parking permit compared to staff members. Results in parking choice model have shown that faculty members tend to not choose a monthly parking option when given the choice of other parking options. This is due to the fact that they have more flexible work schedules and are on campus less frequently than staff members. In addition, faculty members also tend to have more transportation options and live in residential locations that allow for non-driving mode choices. More flexible parking permits are therefore more attractive to faculty members, which will not only be more fitting for employees who are on campus for less than five days a week but also for employees who do not drive every day.

8.1.3 Lower Income Respondents May Not Change Their Transportation Behavior Significantly

Lower income respondents have been shown to have the lowest value of travel time estimates and the highest price elasticity estimate of driving demand. They also have the lowest value of walking time and lowest price elasticity of parking demand across all income groups. Although it is possible that low income respondents may shift their mode choice and not drive alone when parking pricing changes, there could be some who would still choose to drive but change their parking locations. Low income employees are more likely to prefer to park at locations that are farther away from their primary workplace on campus and priced at a lower cost, e.g. off-campus locations in residential neighborhoods. If their existing parking locations cost significantly less than newly proposed parking rates, low income employees, who do not have any other possible options but to drive to campus, will then not change their parking behavior.

Additionally, lower income employees generally fall within job categories that have less flexible work schedules, in terms of arrival time, number of days on campus per week and the number of hours on campus per day. This implies that lower income employees need to be on campus for at least seven or eight hours a day, which may be more than employees with flexible work schedules. In this case, parking options that offer hourly or daily rates will be less attractive to low income employees who choose to drive to campus.

As a result, increases in parking pricing will not affect low income employees substantially, but will greatly affect those who still choose to drive. Due to their high value of walking time ($13.43 per hour), likely to be caused by the nature of their job characteristics, they will be paying for higher parking spaces that are closer to their workplace.

8.1.4 FLEXIBLE PARKING OPTIONS COULD INDUCE CAMPUS PARKING DEMAND

The findings from both qualitative and quantitative analyses in this dissertation have not shown a distinct increase in driving and parking on campus due to the introduction of more flexible parking permits that allow employees to pay by hour or by day. In fact, the mode share for driving alone remains the same even after respondents were presented with flexible parking options. However, the availability of flexible parking options created a shift from parking off campus to parking on campus. This implies that flexible parking options will not cause more driving to campus but will generate more revenue for the University by making campus parking more competitive and attractive in the midst of alternative parking locations, e.g. public and private garages, metered on-street parking.

Moreover, employees who choose to not drive often do so for reasons unrelated to travel or parking cost. Transit users, bicyclists and employees who walk to campus may still continue to commute using their existing mode choice even if parking pricing becomes more flexible. This is because of other negative attributes associated with driving, such as congestion, being environmentally irresponsible and its unhealthy characteristic compared to bicycling or walking.

The magnitude of change in parking demand due to the availability of flexible parking options is dependent upon the cost of each parking option. As discussed in Chapter 3, the choice sets included in the stated preference experiment design consisted of monthly, daily and hourly rates that were not necessarily presented in an order where one of them is greater than the others (when converted to daily rates). For example, there would be choice sets where the monthly parking option costs more, while in other cases, it would cost less than a daily or hourly parking option. The attractiveness of each of these parking options will also depend on how frequent an employee is on campus and how long an employee stays on campus. The results described earlier in this section may differ if the monthly parking option is always presented to be more costly or less costly than the daily and hourly options.

8.2 POLICY IMPLICATIONS

There are different ways in which parking could be priced, not just for UC Berkeley but also for other employers in campus communities in other regions. The impact of parking pricing will also vary according to the existing transportation demand and parking behavior of employees. This section provides the policy implications of the results described in previous sections and earlier chapters.

The University may be concerned with a decrease in revenue generated by parking permits when monthly parking options are switched to more flexible alternatives. This dissertation has shown that parking pricing has a greater impact on parking choice, i.e. parking payment and location type, than on mode choice for the UC Berkeley study site. The majority of the employees who are currently driving will still continue to drive, apart from low income employees, but there will be a shift in parking choice. More employees who prefer to drive may now choose to park off campus, but given the constraints, including limited supply of off-campus parking and possible longer walking time, this group would still be smaller than employees who drive and park on

campus. The magnitude of change in campus parking revenue would therefore depend on the type of parking payment option implemented and the actual campus parking pricing imposed.

There will not be an overall increase in parking demand if there is also a simultaneous raise in parking pricing parking pricing, which will result in a decrease in the number of employees who will drive alone to campus. Therefore, flexible parking options that offer daily or hourly payment choices should be adopted as a way to regulate transportation demand but it has to be implemented together with higher parking prices. If the University wants to reduce drive alone mode share by 34 percent from its current level, it has to increase parking pricing to at least $20 per day. A smaller increase in parking pricing will naturally lead to a smaller decrease in drive alone mode share.

Changes in parking policy should also be coupled with transit incentives that will encourage employees to drive less frequently to campus. A free BART pass has been shown to be a significant factor in determining parking choice. It is also an attractive benefit to employees, as BART users are approximately double the number of AC Transit users at UC Berkeley. When introducing free transit passes, either for AC Transit or BART, it is important to first examine the actual use of such passes. Employees who do not use AC Transit have received free AC Transit passes as part of their parking permit packages. For example, current carpool users receive free AC Transit passes together with their carpool permits. Such passes will not trigger significant mode shift because transit cost is not the sole factor affecting whether current drivers or carpoolers drive alone or carpool with their spouses, neighbors or co-workers. Instead of offering free transit passes to all employees or employees who are currently regular drivers and carpool riders, it is more appropriate to offer them to employees who live in residential locations that are accessible by transit, who would use transit regularly and who have relatively reasonable transit travel time. This will then reduce the possibility of employees switching from transit to driving alone when future changes in parking pricing, income levels, life situations, or work schedules occur. By giving transit passes to employees who would use them, the University will also reduce the cost of purchasing such passes.

The flexibility of work schedule, which is directly related to employment type or University affiliation, seems to affect parking location more than transportation mode choice. Hence, changes in parking pricing will most likely affect the parking location of employees with flexible work schedules more than their mode choice. Since employees with flexible work schedules are on campus less frequency than employees without, their total travel demand is already lower than other employees regardless of their mode choice. Trip frequency could be as low as three days a week for some faculty, four days a week or less than ten days per fortnight for staff. It is unquestionable that some job categories are more flexible than others and have productivity levels that will not be affected whether or not an employee is on campus. These employees should be given the choice to schedule their work activities in more flexible ways, not just because less time on campus would imply less parking spaces demanded, but also because of the benefits associated with flexible work schedules.

Incentives, in the form of a parking fee refund for days not parked or discount, should be given to employees who drive alone to campus less than average or less than five days a week. This will be beneficial to employees who have flexible work schedules and are already on campus for

less than five days a week, as well as employees who use a combination of different modes and do not drive regularly. This should be bundled with campus parking options to increase the incentive for not driving alone every day once an employee has purchased a fixed priced monthly parking permit.

In addition, the current parking pricing structure provides monthly parking permits at a lower daily cost than daily parking permits, which creates little incentives for regular drivers and drivers who have other viable transportation mode choice to not drive and park on campus every day. Instead of penalizing employees who only drive and park occasionally with a higher priced daily parking permit, the daily cost of a monthly permit should be priced at a higher rate than a single daily parking permit, which should only be available for occasional drivers. Higher priced monthly parking permits could then provide incentives for regular but flexible drivers to travel to campus using other modes and drive only when necessary.

The successful application of parking pricing as a tool to manage transportation demand is affected by complex travel behavior and existing parking preferences, which are influenced by the availability of feasible parking alternatives. With a better understanding of employees' transportation demand and preferences, it is possible to design an efficient parking pricing structure that is capable of reducing private vehicle use, while maintaining a steady flow of revenue for the employer.

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APPENDIX A
INTERVIEW GUIDE

The interview guide shown in this section was used for 86 one-on-one preliminary interviews. This guide was used as a template for each interview, but depending on the participant's responses, certain follow up questions were added or eliminated as appropriate. A consent form, which is also shown in this section, was given to each participant prior to every interview session.

CONSENT TO PARTICIPATE IN RESEARCH

Impact of Parking Pricing on Transportation Demand and Behavior
at the University of California, Berkeley

Introduction

My name is Wei-Shiuen Ng. I am a graduate student at the University of California, Berkeley, working with my faculty advisor, Professor Elizabeth Deakin, in the Department of City and Regional Planning. I am planning to conduct a research study, which I invite you to take part in.

You are being invited to participate in this study because you are an employee of the University of California, Berkeley.

Purpose

The purpose of this study is to understand how employees commute to work, how parking policies and availability affect their choices, and how programs to offer more travel and parking options would be received by employees.

Procedures

If you agree to be in this study, you will be asked to do the following:

- Participate in a one-on-one interview to discuss how your travel behavior could be relevant to the nature of your employment at UC Berkeley.

Study time: Study participation will take a total of approximately 30 minutes.

Study location: All study procedures will take place at a location of your preference.

Benefits

There is no direct benefit to you anticipated from participating in this study. However, it is hoped that the information gained from the study will help transportation planners and policy makers improve the campus parking and transportation systems, as well as commute options.

Risks/Discomforts

- If any question in the questionnaire makes you uncomfortable or upset, you are free to decline to answer any questions you do not wish to at any time.

- **Breach of confidentiality:** As with all research, there is a chance that confidentiality could be compromised; however, we are taking precautions to minimize this risk.

Confidentiality

Your study data will be handled as confidentially as possible. If results of this study are published or presented, individual names and other personally identifiable information will not be used.

To minimize the risks to confidentiality, we will encrypt all data files and store them in a secure location. My faculty advisor and I will be the only people who will have access to them. None of the data collected will include any names.

We will keep your study data as confidential as possible, with the exception of certain information that we must report for legal or ethical reasons, such as child abuse, elder abuse, or intent to hurt yourself or others.

Retaining research records: When the research is completed, I may save the transcript and notes from the interview for use in future research done by myself. I will retain this study information for up to 10 years after the study is over. The same measures described above will be taken to protect confidentiality of this study data.

Costs of Study Participation

Compensation
You will not be paid for taking part in this study.

Rights
Participation in research is completely voluntary. You have the right to decline to participate or to withdraw at any point in this study without penalty or loss of benefits to which you are otherwise entitled.

Questions
If you have any questions or concerns about this study, you may contact Wei-Shiuen Ng at wei-shiuen.ng@berkeley.edu.

If you have any questions or concerns about your rights and treatment as a research subject, you may contact the office of UC Berkeley's Committee for the Protection of Human Subjects, at 510-642-7461 or subjects@berkeley.edu.

****

CONSENT
You have been given a copy of this consent form to keep.

If you wish to participate in this study, please sign and date below.

_____ _____
Participant's Name (please print) Date

_____ _____
Participant's Signature Date

_____ _____
Person Obtaining Consent Date

Faculty and Staff Interview Guide
May – August 2013

Exploring University of California, Berkeley Employee Commuting Choices and Parking Preferences

Part One: Interviewee Background and Experiences

1. How long have you been …

   _____ in your present position?

   _____ at UC Berkeley?

2. Could you give me a brief overview of what it is you do in your work?

   Probes: Is your work computer/laboratory/library (or other resources) based? Could you possibly work from home if you want to? Why or why not? What percent of the time could you work at home? Would you prefer to work from home (or at any other off campus location) or work on campus if you have a choice (reasons, influences, experiences)? Is this a common practice at your department?

   How much time (percentage) would you spend teaching, meeting students and working on research projects in your office during a workweek?
   Notes: Working from home could mean working at home during regular work hours or working at home before or after regular working hours, e.g. during the evenings or on weekends. I am interested in the former definition.

3. Could you describe some of the resources on campus that are crucial to your work?

   Probes: For example, some faculty and staff rely on certain equipment in laboratories, some may need to use supercomputing facilities, while others may need to work in art studios or use manuscripts stored in libraries on campus. What are some of the common resources that your department/office need?

4. Could you tell me about your work schedule this semester?

   Probes: How often do you usually come to campus per week?
   How long do you usually stay on campus?
   What is your typical arrival and departure time when you come to campus?
   Does your schedule change in the summer?

5. Does your job require you to be off campus (e.g. for meetings) on a regular basis?

   Probes: Where are such events usually held? For example, do members of the department have labs in Richmond Field Station or at LBL? Or do they do field work that require them to be out in the community or out of the country?
   How would you travel to such events?

   Do you have another office not on central campus (e.g. for people who are in Physics, Chemistry, Engineering etc., they might offices away from the central campus, i.e. LBL, RFS)?
   Do you have external consulting arrangements or professional practices for which you are off campus some of the time (this is the case in engineering, CED and maybe some other departments and colleges)?

Part Two: Department/Office Characteristics and Culture

6. How often do you see or interact with your colleagues?

   Probes: Through what kind of events or activities will you usually see your colleagues? Examples include faculty meetings, weekly seminars, staff events etc.
   How many full time faculty/staff members are there in your department?
   Are there any part time faculty/staff at this department? If so, how many?

FOR STAFF MEMBERS ONLY

7. Does your department/office permit alternative or variable work schedules for staff members?

   Probes: If so, what is the approximate percentage of staff working on alternative work schedules? Alternative work schedules are schedules that are not five days at eight hours. What are the alternative work hours? For example, are they part time but work 8:00AM to 5:00PM when they do come in, or do they schedule their own hours to arrive and leave? Do they schedule to work from home or not? Or do they work four 10-hr days a week or work from home on Fridays?

8. How common is it for staff members to work from home at your department/office?

   Probes: If not, do most staff members follow a regular daily routine, e.g. eight hours/day for five consecutive days within a week? If not, what are their work schedules like?

FOR FACULTY MEMBERS ONLY

9. How common is it for faculty members to work from home or take their work home at your department?

Probes: If not, what are most faculty members' work schedules like? Do faculty members follow a regular daily routine, e.g. eight hours/day for five consecutive days within a week? What is the approximate percentage of faculty members who work from home regularly?

Part Three: Transportation and Parking

10. How do you usually commute to campus?

11. Could you describe your experience with your daily transportation mode?

    Probes: How about your experience with other transportation modes that you have tried? E.g. congestion and where are the congested routes. Is there variability in your travel time?

12. Have you considered using other types of transportation modes?

    Probes: Have you ever driven, taken public transportation, carpooled, biked or walked to campus since you started working at UC Berkeley? What were the causes of the change in transportation mode?

13. If you drive, where do you usually park your vehicle?

    Probes: Is your parking location on campus or off campus? If on campus, which parking garage/lot would you park at? Do you always park at the same location? How long does it take you to walk to your office from your parking space? Would you consider paying a premium price for a parking space closer to your office? Or would you rather pay less for a parking space that is located farther away from your office?

14. What do you think about your current commute/parking cost?

    Probes: If you use public transportation, do you have a Bear Pass (subsidized AC Transit pass)? Would you consider driving to campus if parking is free? How about if there is a more flexible daily parking permit that removes the existing annual commitment? Would such a permit make you drive more?
    If you park on campus, what do you think of the current parking prices? How about a more flexible daily parking permit that allows you to pay per day or per hour parked either pay by machine or pay by cell phone? Do you think such a permit would make you drive less?

APPENDIX B
FOCUS GROUP GUIDE

A guide was used for the 10 focus groups conducted for this dissertation. Certain questions were added and some eliminated depending on the responses of the participants. The focus group guide shown in the section was used to provide structure to each discussion session. Every focus group participant was asked to read and sign a consent form, also shown in this section, prior to every discussion session.

CONSENT TO PARTICIPATE IN RESEARCH
on Parking and Transportation Preferences
at the University of California, Berkeley

Introduction
My name is Wei-Shiuen Ng. I am a graduate student at the University of California, Berkeley, working with my faculty advisor, Professor Elizabeth Deakin, in the Department of City and Regional Planning. I invite you to take part in my research study of parking and transportation preferences in which I am using the University of California as a case study.

You are being invited to participate in this study because you are an employee of the University of California, Berkeley.

Purpose
The purpose of this study is to understand how UC Berkeley employees commute to work and how parking options affect their choices.

Procedures
If you agree to be in this study, you will be asked to do the following:

You will be asked to arrive at a designated room on campus to sign in. You will fill out a questionnaire, which should take you approximately 15 – 20 minutes to complete. You then will take part in a focus group discussion on your travel preferences and your reaction to alternative parking and transportation options. Notes will be taken during this discussion, which is expected to last approximately 45 minutes.

Study time: Study participation will take a total of approximately 80- 90 minutes including sign in, completion of the questionnaire, and focus group discussion.

Study location: All study procedures will take place on the campus of UC Berkeley.

Benefits
There is no direct benefit to you anticipated from participating in this study. However, it is hoped that the information gained from the study will help transportation planners and policy makers improve the campus parking and transportation systems, as well as commute options.

Compensation
In return for your time and effort for taking part in this study, you will be provided a $50 American Express gift card at the end of the focus group session.

Risks/Discomforts
There is a small risk that some of the topics covered in the questionnaire or focus group discussion may make you uncomfortable or upset or that you may not wish to discuss some of

the topics with the other participants. You are free to decline to answer any questions you do not wish to or to leave the group at any time.

Confidentiality

- Your study data will be handled as confidentially as possible. If results of this study are published or presented, individual names and other personally identifiable information will not be used. Notes taken at the focus group meetings will record first names only.

- The surveys will be anonymous and we will not record identifying information. The focus groups will be on a first name basis only, however, there is a possibility that you will know or recognize some of the participants in the focus groups and so we cannot assure that your participation in the focus groups will be anonymous.

Retaining research records: When the research is completed, I may save the questionnaires, notes and other data collected for use in future research done by myself. I will retain this study information for up to 10 years after the study is over. The same measures described above will be taken to protect confidentiality of this study data.

Rights

Participation in research is completely voluntary. You have the right to decline to participate or to withdraw at any point in this study without penalty or loss of benefits to which you are otherwise entitled.

Questions

If you have any questions or concerns about this study, you may contact Wei-Shiuen Ng at wei-shiuen.ng@berkeley.edu.

If you have any questions or concerns about your rights and treatment as a research subject, you may contact the office of UC Berkeley's Committee for the Protection of Human Subjects, at 510-642-7461 or subjects@berkeley.edu.

****

CONSENT

You have been given a copy of this consent form to keep.

If you wish to participate in this study, please sign and date below.

_____ _____

Participant's Name *(please print)* Date

_____ _____

Participant's Signature Date

_____ _____

Person Obtaining Consent Date

Faculty and Staff Focus Group Guide
November - December 2013

Transportation and Parking Discussion

Welcome (10 min)
Sign in participants, give out name tent for them to write their first names only.
Give them CPHS consent form, ask them to sign and collect it.

Questionnaire (20 min)
Give out transportation and parking questionnaire and collect completed questionnaires.

Introduction (5 min)
Hello, my name is Wei-Shiuen Ng and I want to start by thanking you for participating in this focus group today. Let me also introduce my note taker(s), [name], who will be taking notes during this meeting but will not be joining our discussion. I would like to start by providing a few ground rules.

First, we will be on a first name basis only.

Since you all work at UC Berkeley, it is possible that some of you may know or recognize each other. That is unavoidable. I do not expect that the topics we will be discussing will be a concern but just in case, I ask that you treat what is discussed here today as confidential.

We will spend about 45 - 60 min on the discussion. Since I have a series of topics I would like to discuss with you, I will be watching the time and may have to move us along to the next topic. Also, since I want to hear from everyone, I may from time to time call on you if you are being quiet or ask you to wrap up your comments so that others can speak. Please do not be offended by this, I simply want to make sure everyone participates and that we end on time.

I also want to make it clear that we want to hear your opinions and preferences whatever they happen to be - we do not have any preconceived ideas about the responses and we don't have anything at stake here. There may be differences of opinion and that is fine, we expect and will learn from disagreements.

So with that, let me briefly describe today's objectives.

First, I would like to spend a few minutes getting your reaction to the questionnaires that you have just completed. These are called stated preference surveys and we will be doing a larger survey in the next few weeks so your responses will help us refine the surveys if need be. After that, I would like to hear about your travel to campus and to get your thoughts about alternatives that might or might not be of interest to you.

Survey Discussion (20 min)
So let's begin by discussing the survey you have just completed.

Overall, what did you think of the survey?

Was it too long?

Was any part of it confusing?

Were all the questions relevant to you and your travel choices?

Did any of the questions seem odd to you, or make you uncomfortable?

Travel to Campus (15 min)

Now let's move on to discuss travel options. I would like to start by asking each of you to tell us how did you get to campus today – what mode of transportation did you use, how far did you travel, and so on.

Do any of you ever use different modes of travel than the one you usually use? For example, take transit some days, drive some days, or bike some days, drive some days? How do you decide which mode to use on which day?

If you pretty much get to campus the same way every day, have you ever tried other modes of transportation? And what was your experience - good, not so good?

Do you usually come to campus at the same time every day or do you come in and leave at different times? How much does your arrival or departure time vary? How often do they vary?

Do any of you work at home some days during the regular Monday to Friday, 8:00AM to 5:00PM working hours? (Probe for details.)

Some people need to coordinate their schedules with other family members in order to drop off or pick up children or other family members, or to get home in time to be there when their children get home from school, or to take a pet out for a walk, or to go to a lesson or event. Does this apply to any of you? (Ask for a show of hands.) About how often does this happen – is it every day, or once a week, or less than once a week?

Driving and Parking (15 min)
For those of you who drive, either regularly or occasionally, when you drive to campus, where do you usually park? (Probe for specific garage or location.) How much do you pay for parking?

Do you ever have difficulty finding a parking space at your preferred parking location? If so what do you do then? How often does this happen?

If the campus offered reserved parking spaces for a premium price, e.g., you could reserve a space in a particular garage for say $12/day, would you be interested in it? If the reserved parking space were $20/day, would you still be interested?

If the campus were to offer a discount for parking, say, a 10 min walk off campus, would you be interested? Say the regular cost per day were $8 and the discount rate $4 – would you walk 10 extra minutes? Why or why not? What if it were a five minute walk?

Suppose the monthly rate for parking was $100 or you could choose to pay $5/day using a pay-by-phone or pay and display application. In this example, you could just pay $100 up front and park as often as you want, but you would pay the $100 even if you just came in 10 days that month. In the pay by day option, if you parked 20 days in a month you would pay the full $100, but if you only parked 15 days in a particular month you would pay only 15*5 = $75. Which of the payment systems would you prefer?

Do you think the university should build more parking spaces? Do you think the university should add more parking if one space costs $60,000? What if the cost [marginal cost] of adding more parking spaces has to be paid for by each user?

There are several different ways that parking managers price parking, e.g. to make a profit, to recover costs, to support bike and transit programs, as well as parking programs, to manage demand, or to subsidize only the lowest income travelers. How do you think parking should be priced? What is the maximum price you would be willing to pay for parking per day?

Other Travel Options (10 min)
First, how concerned are you about greenhouse gas emissions from transportation modes? Would you be interested in tracking your own individual emissions?

If the campus were to offer free ac transit passes to all employees, would you be interested? How often do you think you would use it? What if it were a transit pass also good on BART?

Is anyone in the group interested in walking as a way of getting more exercise? Biking? Is walking or biking a feasible option as a way of getting from your home to campus?

Ending
Are there any other issues you would like to bring up?

Thank you all for your participation. I have a gift card for each of you. Please sign next to your name on this list of participants to acknowledge the receipt of gift card.
(Distribute gift cards.)

APPENDIX C
TRANSPORTATION AND PARKING QUESTIONNAIRE EXAMPLE

The survey sent to campus faculty and staff members was an online survey, supported by Qualtrics, a web based survey service. The consent form approved by the Committee for the Protection of Human Subjects (CPHS) was shown on the first page of the online survey.

A set of five randomly selected choice sets, from a total possible of 384 choice sets created for the survey, were shown to each survey respondent. An example survey is presented in this appendix.

The total number of possible choice sets (384) was determined by the combination of attribute levels using a full factorial experimental design. More details can be found in Appendix D.

Transportation and Parking Survey
The Institute of Urban and Regional Development (IURD) at the University of California, Berkeley would like to invite you to take part in a research study, which concerns how UC Berkeley employees commute to work, how parking pricing and availability affect your choices, and how programs to offer more travel and parking options would be received by you. This survey will take approximately 15 - 20 minutes to complete. Your responses are important to future implementations of transportation and parking policies on campus and all responses are anonymous.

Consent to Participate in Research
Introduction and Purpose
My name is Wei-Shiuen Ng. I am a graduate student at the University of California, Berkeley, working with my faculty advisor, Professor Elizabeth Deakin in the Department of City and Regional Planning. I would like to invite you to take part in my research study, which concerns how UC Berkeley employees commute to work, how parking pricing and availability affect their choices, and how programs to offer more travel and parking options would be received by employees.

Procedures
If you agree to participate in my research, I will ask you to complete an online survey. The survey will involve questions about your current travel habits, preferences, as well as reactions to changes in parking pricing on campus and should take about 15-20 minutes to complete.

Benefits
There is no direct benefit to you from participating in this study. However, it is hoped that the information gained from the study will help transportation planners and policy makers improve the campus parking and transportation systems, as well as commute options.

Risks/Discomforts
If any of the research questions make you uncomfortable or upset, you are free to decline to answer any questions you don't wish to, or to stop participating at any time. As with all research, there is a chance that confidentiality could be compromised; however, we are taking precautions to minimize this risk.

Confidentiality
Your study data will be handled as confidentially as possible. All responses are anonymous and if results of this study are published or presented, personally identifiable information will not be used.

To minimize the risks to confidentiality, we will encrypt all data files and store them in a secure location. My faculty advisor and I will be the only people who will have access to them.

When the research is completed, I may save the data for use in future research done by myself or others. I will retain these records for up to 10 years after the study is over. The same measures described above will be taken to protect confidentiality of this study data.

Compensation
To thank you for participating in this study, you will be eligible to enter a draw for one of 25 $50 American Express gift cards after you complete the survey.

Rights
Participation in research is completely voluntary. You are free to decline to take part in the project. You can decline to answer any questions and are free to stop taking part in the project at any time. Whether or not you choose to participate, to answer any particular question, or continue participating in the project, there will be no penalty to you or loss of benefits to which you are otherwise entitled.

Questions
If you have any questions about this research, please feel free to contact me. I can be reached at (415) 990-9685 or wei-shiuen.ng@berkeley.edu.

If you have any questions about your rights or treatment as a research participant in this study, please contact the University of California at Berkeley's Committee for Protection of Human Subjects at 510-642-7461, or e-mail subjects@berkeley.edu.

If you agree to take part in the research, please check "I agree" below.

- ❍ I agree
- ❍ I decline

PART A: TRAVEL HABITS AND PREFERENCES

Thank you for agreeing to participate in this survey. This section will include questions on your transportation preferences that are relevant to your most recent commute trip to the UC Berkeley central campus. You will also be asked to recall how did you travel to campus last week.

Q1 What was your primary mode of transportation on your most recent commute trip to the UC Berkeley central campus?

- ❍ Car, Truck, or Van (Drive Alone Only)
- ❍ Carpool or Vanpool
- ❍ Motorcycle, Moped, or Scooter
- ❍ Bus (e.g. AC Transit)
- ❍ Train (e.g. BART)
- ❍ Bike
- ❍ Walk Only
- ❍ Other, please specify (8) _____

If Bus (e.g. AC Transit) Is Selected, Then Skip To Q5
If Train (e.g. BART) Is Selected, Then Skip To Q5
If Bike Is Selected, Then Skip To Q5
If Walk Only Is Selected, Then Skip To Q5

Q2 Where did you park your vehicle on your most recent commute trip to the UC Berkeley central campus?

- ❍ Campus parking garage or lot
- ❍ Public off-street parking garages or lot
- ❍ Metered on-street parking space
- ❍ Private off-street parking space
- ❍ Unmetered on-street parking space with time limit enforcement
- ❍ On-street, in residential parking zone with residential parking permit
- ❍ Unmetered on-street parking space without time limit enforcement
- ❍ Other, please specify _____

Q3 Which type of UC Berkeley parking permit do you currently have?

- ❍ Central Campus Annual "C" Permit
- ❍ Faculty/Staff Annual “F” Permit
- ❍ Central Campus Carpool Permit
- ❍ Faculty/Staff Carpool Permit
- ❍ Hill Annual Permit
- ❍ Night/Weekend Annual Permit (M-F, 1:30PM – 2:00AM)
- ❍ Emeritus Permit
- ❍ Motorcycle Permit
- ❍ Central Campus Daily Scratch Off Permit
- ❍ Faculty/Staff Daily or Scratch Off Permit
- ❍ Other, please specify _____
- ❍ I do not know

Q4 Which campus parking garage or lot did you park your vehicle on your most recent commute trip to campus?

- ❍ 4th Street
- ❍ Anna Head Court
- ❍ Anna Head
- ❍ Bancroft-Fulton
- ❍ Bancroft-Fulton West (Underground)
- ❍ Bancroft Structure
- ❍ Banway
- ❍ Boalt
- ❍ Botanical Garden
- ❍ Bowles
- ❍ Clark Kerr
- ❍ Dana/Durant
- ❍ Donner
- ❍ Dwinelle
- ❍ East
- ❍ Ellsworth
- ❍ Foothill
- ❍ Frank Schlessinger Way
- ❍ Genetics Structure (Underground)
- ❍ Hill Terrace
- ❍ Kroeber
- ❍ Lawrence Hall of Science
- ❍ Lower Hearst Structure
- ❍ Manville (Underground)
- ❍ Recreational Sports Facility Structure (Underground)
- ❍ Ridge
- ❍ Sproul
- ❍ Stadium Rim Way
- ❍ Underhill Structure
- ❍ University Hall West
- ❍ Upper Hearst Structure
- ❍ Vista
- ❍ Wellman Courtyard
- ❍ Witter Field
- ❍ Other, please specify _____

Q5 What time did you arrive on campus on your most recent commute trip to the UC Berkeley central campus?

- ❍ Before 7:00AM
- ❍ 7:00 - 7:59AM
- ❍ 8:00 - 8:59AM
- ❍ 9:00 - 9:59AM
- ❍ 10:00 - 10:59AM
- ❍ 11:00 - 11:59AM
- ❍ 12:00 - 12:59PM
- ❍ 1:00 - 1:59PM
- ❍ 2:00 - 2:59PM
- ❍ 3:00 - 3:59PM
- ❍ 4:00 - 4:59PM
- ❍ 5:00 - 5:59PM
- ❍ 6:00 - 6:59PM
- ❍ 7:00 - 7:59PM
- ❍ 8:00 - 9:00PM
- ❍ After 9:00PM

Q6 What time did you depart from campus on your most recent commute trip?

- ❍ Before 7:00AM
- ❍ 7:00 - 7:59AM
- ❍ 8:00 - 8:59AM
- ❍ 9:00 - 9:59AM
- ❍ 10:00 - 10:59AM
- ❍ 11:00 - 11:59AM
- ❍ 12:00 - 12:59PM
- ❍ 1:00 - 1:59PM
- ❍ 2:00 - 2:59PM
- ❍ 3:00 - 3:59PM
- ❍ 4:00 - 4:59PM
- ❍ 5:00 - 5:59PM
- ❍ 6:00 - 6:59PM
- ❍ 7:00 - 7:59PM
- ❍ 8:00 - 9:00PM
- ❍ After 9:00PM

Q7 Did you make any trips off campus (e.g. meetings in Downtown Berkeley, Oakland, San Francisco, or at any off-site facilities, such as the Richmond Field Station) during the work day, on your most recent commute trip to the UC Berkeley central campus?

- ❍ Yes
- ❍ No

If No Is Selected, Then Skip To Q9

Q8 Please describe the off-campus trip(s) that you have made during the day.

Destination:
Purpose:
Time of Departure:
Transportation Mode:

Q9 We have asked questions that are relevant to your most recent commute trip so far. However, we are also interested in knowing more about your transportation mode choices for different days of the week. How did you travel **to campus** last week? Please select **one** primary mode of transportation for each day of the week. For days when you were not on campus, you may select "Not On Campus" in the table below.

	Mon	**Tue**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**
Car, Truck, or Van (Drive Alone Only)	❍	❍	❍	❍	❍	❍	❍
Carpool or Vanpool	❍	❍	❍	❍	❍	❍	❍
Motorcycle, Moped, or Scooter	❍	❍	❍	❍	❍	❍	❍
Bus (e.g. AC Transit)	❍	❍	❍	❍	❍	❍	❍
Train (e.g. BART)	❍	❍	❍	❍	❍	❍	❍
Bike	❍	❍	❍	❍	❍	❍	❍
Walk Only	❍	❍	❍	❍	❍	❍	❍
Other	❍	❍	❍	❍	❍	❍	❍
Not On Campus	❍	❍	❍	❍	❍	❍	❍

Q10 How did you travel **from campus** last week? Please select **one** primary mode of transportation for each day of the week. For days when you were not on campus, you may select "Not On Campus" in the table below.

	Mon	**Tue**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**
Car, Truck, or Van (Drive Alone Only)	❍	❍	❍	❍	❍	❍	❍
Carpool or Vanpool	❍	❍	❍	❍	❍	❍	❍
Motorcycle, Moped, or Scooter	❍	❍	❍	❍	❍	❍	❍
Bus (e.g. AC Transit)	❍	❍	❍	❍	❍	❍	❍
Train (e.g. BART)	❍	❍	❍	❍	❍	❍	❍
Bike	❍	❍	❍	❍	❍	❍	❍
Walk Only	❍	❍	❍	❍	❍	❍	❍
Other	❍	❍	❍	❍	❍	❍	❍
Not On Campus	❍	❍	❍	❍	❍	❍	❍

Q11 Does your work schedule, i.e. arrival time to and departure time from campus, change in the summer?

❍ Yes

❍ No

❍ I do not know

PART B: TRANSPORTATION AND PARKING SCENARIOS

In this section, we will be asking questions about possible transportation and parking policies. In the following **five** questions, you will be shown four types of parking options and you will be asked to indicate which one of the four options would you choose, assuming that these are the only paid parking options available. You may select "None of the Options" if you choose to not drive to campus at all or drive but park elsewhere. Each transportation and parking scenario will present different parking costs, amount of parking refund for days not parked, free transit pass availability, and walking time from the parking space to your office on campus.

We ask five such comparisons so that we can better understand your preferences.

The parking costs, parking refund for days not parked, free transit pass availability, and walking time from the parking space to your office on campus associated with each parking option will be **different** for each of the following five questions.

NOTE: These options are for research study purposes only. They are not specifically under consideration by UC Berkeley or the City of Berkeley officials.

Q12 In the following question, you will be shown four types of parking options and you will be asked to indicate which one of the four options would you prefer, assuming that these are the only paid parking options available. *You may select "None of the Options" if you choose not to drive to campus or drive but park elsewhere.*

Option A: A monthly campus parking permit with unlimited access. If you are carpooling, a carpool permit costs 34% of the cost of parking shown in the table below, which is comparable to the current campus parking pricing for each carpool user.
Option B: A monthly restricted campus parking permit for parking 4 days a workweek (unlimited on weekends). If you are carpooling, a carpool permit costs 34% of the cost of parking shown in the table below, which is comparable to the current campus parking pricing for each carpool user.
Option C: A daily campus parking permit, without any restriction on the number of permits that can be purchased annually. Daily permits can be purchased from parking machines at any campus parking garage/lot.
Option D: Hourly parking at an off-campus location with no time limit enforcement.

	Option A	Option B	Option C	Option D
Cost of Parking	$180/month	$108/month	$16/day	$1.25/hour
Parking Fee Refund for Days Not Parked	0	0	0	0
Free Monthly Pass for AC Transit	No	Yes	No	No
Walking Time from Parking Space to Office	3 min	3 min	8 min	15 min

Which **one** of the four parking options would you choose?

- ❍ Option A
- ❍ Option B
- ❍ Option C
- ❍ Option D
- ❍ None of the Options

Q13 Given the parking option you have chosen in the above question, how would you now travel to campus? Please select **one** mode of transportation for each day of the week.

	Mon	**Tue**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**
Drive alone only using parking Option A or B	❍	❍	❍	❍	❍	❍	❍
Drive alone only using parking Option C	❍	❍	❍	❍	❍	❍	❍
Drive alone only using parking Option D	❍	❍	❍	❍	❍	❍	❍
Drive alone using none of the above parking options	❍	❍	❍	❍	❍	❍	❍
Carpool or Vanpool	❍	❍	❍	❍	❍	❍	❍
Motorcycle, Moped, or Scooter	❍	❍	❍	❍	❍	❍	❍
Bus (e.g. AC Transit)	❍	❍	❍	❍	❍	❍	❍
Train (e.g. BART)	❍	❍	❍	❍	❍	❍	❍
Bike	❍	❍	❍	❍	❍	❍	❍
Walk Only	❍	❍	❍	❍	❍	❍	❍
Other	❍	❍	❍	❍	❍	❍	❍
Not On Campus	❍	❍	❍	❍	❍	❍	❍

Q14 In the following question, you will be shown four types of parking options and you will be asked to indicate which one of the four options would you prefer, assuming that these are the only paid parking options available. *You may select "None of the Options" if you choose not to drive to campus or drive but park elsewhere.*

Option A: A monthly campus parking permit with unlimited access. If you are carpooling, a carpool permit costs 34% of the cost of parking shown in the table below, which is comparable to the current campus parking pricing for each carpool user.
Option B: A monthly restricted campus parking permit for parking 4 days a workweek (unlimited on weekends). If you are carpooling, a carpool permit costs 34% of the cost of parking shown in the table below, which is comparable to the current campus parking pricing for each carpool user.
Option C: A daily campus parking permit, without any restriction on the number of permits that can be purchased annually. Daily permits can be purchased from parking machines at any campus parking garage/lot.
Option D: Hourly parking at an off-campus location with no time limit enforcement.

	Option A	**Option B**	**Option C**	**Option D**
Cost of Parking	$180/month	$133/month	$16/day	$0.30/hour
Parking Fee Refund for Days Not Parked	0	0	0	0
Free Monthly Pass for AC Transit	No	No	No	No
Walking Time from Parking Space to Office	8 min	5 min	3 min	15 min

Which one of the four parking options would you choose?

- ❍ Option A
- ❍ Option B
- ❍ Option C
- ❍ Option D
- ❍ None of the Options

Q15 Given the parking option you have chosen in the above question, how would you now travel to campus? Please select **one** mode of transportation for each day of the week.

	Mon	**Tue**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**
Drive alone only using parking Option A or B	❍	❍	❍	❍	❍	❍	❍
Drive alone only using parking Option C	❍	❍	❍	❍	❍	❍	❍
Drive alone only using parking Option D	❍	❍	❍	❍	❍	❍	❍
Drive alone using none of the above parking options	❍	❍	❍	❍	❍	❍	❍
Carpool or Vanpool	❍	❍	❍	❍	❍	❍	❍
Motorcycle, Moped, or Scooter	❍	❍	❍	❍	❍	❍	❍
Bus (e.g. AC Transit)	❍	❍	❍	❍	❍	❍	❍
Train (e.g. BART)	❍	❍	❍	❍	❍	❍	❍
Bike	❍	❍	❍	❍	❍	❍	❍
Walk Only	❍	❍	❍	❍	❍	❍	❍
Other	❍	❍	❍	❍	❍	❍	❍
Not On Campus	❍	❍	❍	❍	❍	❍	❍

Q16 In the following question, you will be shown four types of parking options and you will be asked to indicate which one of the four options would you prefer, assuming that these are the only paid parking options available. *You may select "None of the Options" if you choose not to drive to campus or drive but park elsewhere.*

Option A: A monthly campus parking permit with unlimited access. If you are carpooling, a carpool permit costs 34% of the cost of parking shown in the table below, which is comparable to the current campus parking pricing for each carpool user.
Option B: A monthly restricted campus parking permit for parking 4 days a workweek (unlimited on weekends). If you are carpooling, a carpool permit costs 34% of the cost of parking shown in the table below, which is comparable to the current campus parking pricing for each carpool user.
Option C: A daily campus parking permit, without any restriction on the number of permits that can be purchased annually. Daily permits can be purchased from parking machines at any campus parking garage/lot.
Option D: Hourly parking at an off-campus location with no time limit enforcement.

	Option A	Option B	Option C	Option D
Cost of Parking	$198/month	$170/month	$13/day	$1.25/hour
Parking Fee Refund for Days Not Parked	0	0	0	0
Free Monthly Pass for AC Transit	Yes	Yes	No	No
Walking Time from Parking Space to Office	3 min	10 min	8 min	20 min

Which one of the four parking options would you choose?

- ❍ Option A
- ❍ Option B
- ❍ Option C
- ❍ Option D
- ❍ None of the Options

Q17 Given the parking option you have chosen in the above question, how would you now travel to campus? Please select **one** mode of transportation for each day of the week.

	Mon	**Tue**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**
Drive alone only using parking Option A or B	❍	❍	❍	❍	❍	❍	❍
Drive alone only using parking Option C	❍	❍	❍	❍	❍	❍	❍
Drive alone only using parking Option D	❍	❍	❍	❍	❍	❍	❍
Drive alone using none of the above parking options	❍	❍	❍	❍	❍	❍	❍
Carpool or Vanpool	❍	❍	❍	❍	❍	❍	❍
Motorcycle, Moped, or Scooter	❍	❍	❍	❍	❍	❍	❍
Bus (e.g. AC Transit)	❍	❍	❍	❍	❍	❍	❍
Train (e.g. BART)	❍	❍	❍	❍	❍	❍	❍
Bike	❍	❍	❍	❍	❍	❍	❍
Walk Only	❍	❍	❍	❍	❍	❍	❍
Other	❍	❍	❍	❍	❍	❍	❍
Not On Campus	❍	❍	❍	❍	❍	❍	❍

Q18 In the following question, you will be shown four types of parking options and you will be asked to indicate which one of the four options would you prefer, assuming that these are the only paid parking options available. *You may select "None of the Options" if you choose not to drive to campus or drive but park elsewhere.*

Option A: A monthly campus parking permit with unlimited access. If you are carpooling, a carpool permit costs 34% of the cost of parking shown in the table below, which is comparable to the current campus parking pricing for each carpool user.
Option B: A monthly restricted campus parking permit for parking 4 days a workweek (unlimited on weekends). If you are carpooling, a carpool permit costs 34% of the cost of parking shown in the table below, which is comparable to the current campus parking pricing for each carpool user.
Option C: A daily campus parking permit, without any restriction on the number of permits that can be purchased annually. Daily permits can be purchased from parking machines at any campus parking garage/lot.
Option D: Hourly parking at an off-campus location with no time limit enforcement.

	Option A	**Option B**	**Option C**	**Option D**
Cost of Parking	$225/month	$200/month	$10/day	$1.25/hour
Parking Fee Refund for Days Not Parked	$2/day	0	0	0
Free Monthly Pass for AC Transit	No	Yes	No	No
Walking Time from Parking Space to Office	15 min	5 min	18 min	5 min

Which one of the four parking options would you choose?

- ❍ Option A
- ❍ Option B
- ❍ Option C
- ❍ Option D
- ❍ None of the Options

Q19 Given the parking option you have chosen in the above question, how would you now travel to campus? Please select **one** mode of transportation for each day of the week.

	Mon	**Tue**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**
Drive alone only using parking Option A or B	❍	❍	❍	❍	❍	❍	❍
Drive alone only using parking Option C	❍	❍	❍	❍	❍	❍	❍
Drive alone only using parking Option D	❍	❍	❍	❍	❍	❍	❍
Drive alone using none of the above parking options	❍	❍	❍	❍	❍	❍	❍
Carpool or Vanpool	❍	❍	❍	❍	❍	❍	❍
Motorcycle, Moped, or Scooter	❍	❍	❍	❍	❍	❍	❍
Bus (e.g. AC Transit)	❍	❍	❍	❍	❍	❍	❍
Train (e.g. BART)	❍	❍	❍	❍	❍	❍	❍
Bike	❍	❍	❍	❍	❍	❍	❍
Walk Only	❍	❍	❍	❍	❍	❍	❍
Other	❍	❍	❍	❍	❍	❍	❍
Not On Campus	❍	❍	❍	❍	❍	❍	❍

Q20 In the following question, you will be shown four types of parking options and you will be asked to indicate which one of the four options would you prefer, assuming that these are the only paid parking options available. *You may select "None of the Options" if you choose not to drive to campus or drive but park elsewhere.*

Option A: A monthly campus parking permit with unlimited access. If you are carpooling, a carpool permit costs 34% of the cost of parking shown in the table below, which is comparable to the current campus parking pricing for each carpool user.
Option B: A monthly restricted campus parking permit for parking 4 days a workweek (unlimited on weekends). If you are carpooling, a carpool permit costs 34% of the cost of parking shown in the table below, which is comparable to the current campus parking pricing for each carpool user.
Option C: A daily campus parking permit, without any restriction on the number of permits that can be purchased annually. Daily permits can be purchased from parking machines at any campus parking garage/lot.
Option D: Hourly parking at an off-campus location with no time limit enforcement.

	Option A	Option B	Option C	Option D
Cost of Parking	$99/month	$85/month	$9/day	$1.50/hour
Parking Fee Refund for Days Not Parked	$2/day	0	0	0
Free Monthly Pass for AC Transit	No	No	No	No
Walking Time from Parking Space to Office	1 min	15 min	10 min	8 min

Which one of the four parking options would you choose?

- ❍ Option A
- ❍ Option B
- ❍ Option C
- ❍ Option D
- ❍ None of the Options

Q21 Given the parking option you have chosen in the above question, how would you now travel to campus? Please select **one** mode of transportation for each day of the week.

	Mon	**Tue**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**
Drive alone only using parking Option A or B	❍	❍	❍	❍	❍	❍	❍
Drive alone only using parking Option C	❍	❍	❍	❍	❍	❍	❍
Drive alone only using parking Option D	❍	❍	❍	❍	❍	❍	❍
Drive alone using none of the above parking options	❍	❍	❍	❍	❍	❍	❍
Carpool or Vanpool	❍	❍	❍	❍	❍	❍	❍
Motorcycle, Moped, or Scooter	❍	❍	❍	❍	❍	❍	❍
Bus (e.g. AC Transit)	❍	❍	❍	❍	❍	❍	❍
Train (e.g. BART)	❍	❍	❍	❍	❍	❍	❍
Bike	❍	❍	❍	❍	❍	❍	❍
Walk Only	❍	❍	❍	❍	❍	❍	❍
Other	❍	❍	❍	❍	❍	❍	❍
Not On Campus	❍	❍	❍	❍	❍	❍	❍

PART C: SOCIOECONOMIC AND OTHER QUESTIONS

In this section, we will ask you for some information about yourself so that we can measure the representativeness of the survey responses and understand how your unique characteristics influence your travel preferences. These data are anonymous and will be used for this research analysis only and not for other purposes.

Q22 What is your affiliation with UC Berkeley?

- ❍ Professor / Associate Professor
- ❍ Assistant Professor
- ❍ Adjunct Professor
- ❍ Visiting Faculty / Scholar
- ❍ Lecturer
- ❍ Other Faculty / Academic (including Emeriti and UC Berkeley Extension)
- ❍ Management and Senior Professionals (MSP) / Senior Management Group (SMG)
- ❍ Professional Staff (PSS)
- ❍ Operational / Technical Staff (PSS)
- ❍ Staff (classified and represented)
- ❍ Contract
- ❍ Postdoctoral Scholar
- ❍ Other, please specify _____

Q23 Are you affiliated with the Lawrence Berkeley National Laboratory?

- ❍ Yes
- ❍ No

Q24 In which building on campus is your primary workplace located?

Name of Building on Campus: _____

Q25 Do you have a second office on or off campus?

- ❍ Yes
- ❍ No

If No Is Selected, Then Skip To Q27
If Yes Is Selected, Then Skip To Q26

Q26 Where is your second office on or off campus?

Building Name or Nearest Intersection if Off Campus: _____

City: _____

Zip Code: _____

Q27 Where is your primary residential location? This information is collected strictly for this research project and will not be used for any other purposes.

Nearest Intersection: _____

City: _____

Zip Code: _____

Q28 Do you have a valid driver's license?

- ❍ Yes
- ❍ No

Q29 How many motor vehicles do you have in your household that are available for your own personal use to commute to campus?

- ❍ 0
- ❍ 1
- ❍ 2
- ❍ 3
- ❍ More than 3

Q30 How many motorcycles, mopeds, or scooters do you have in your household that are available for your own personal use to commute to campus?

- ❍ 0
- ❍ 1
- ❍ 2
- ❍ 3
- ❍ More than 3

Q31 How many bicycles do you have in your household that are available for your own personal use to commute to campus?

- ❍ 0
- ❍ 1
- ❍ 2
- ❍ 3
- ❍ More than 3

Q32 Including yourself, how many members do you have in your household? Please do not include anyone who usually lives somewhere else or is just visiting, such as a college student away at school or a partner who has another residence.

- ❍ 1
- ❍ 2
- ❍ 3 - 4
- ❍ 5 - 6
- ❍ More than 6

Q33 How many dependents do you have? Please include all dependents who require your transportation assistance at least 50 percent of the time, such as young children or elderly family members.

- ❍ 0
- ❍ 1
- ❍ 2
- ❍ 3 - 4
- ❍ 5 - 6
- ❍ More than 6

Q34 What is your sex?

- ❍ Male
- ❍ Female

Q35 What is your age?

- ❍ Under 21
- ❍ 21 - 29
- ❍ 30 - 39
- ❍ 40 - 49
- ❍ 50 - 59
- ❍ 60 - 69
- ❍ 70 and over

Q36 What is the highest level of education you have completed?

- ❍ Less than High School
- ❍ High School / GED
- ❍ Some College
- ❍ 2-year College Degree
- ❍ 4-year College Degree
- ❍ Masters Degree
- ❍ Doctoral Degree
- ❍ Professional Degree (e.g. JD, MD)

Q37 Which of the following categories best describes your estimated total annual household income? (Although this question is optional, income data are crucial to this research study, as it will allow the analysis of travel preferences across income groups.)

- ❍ Under $29,999
- ❍ $30,000 - $49,999
- ❍ $50,000 - $89,999
- ❍ $90,000 - $119,999
- ❍ $120,000 - $149,999
- ❍ $150,000 - $179,999
- ❍ $180,000 - $199,999
- ❍ $200,000 - $249,999
- ❍ $250,000 - $299,999
- ❍ $300,000 and over
- ❍ I prefer not to answer

Q38 The technology to pay for parking by phone is now widely available and could be introduced to various parking locations on or off campus in the near future. In order to pay by phone, you would require a smartphone. Which type of the following smartphones do you currently use or own as your primary mobile phone? Please select all that apply.

- ❑ Android
- ❑ iPhone
- ❑ Palm
- ❑ RIM/Blackberry
- ❑ Windows
- ❑ Other, please specify _____
- ❑ I do not use a smartphone

Thank you for taking the time to complete this questionnaire. Your assistance in providing this information is very much appreciated. If you have any comments on the survey or parking pricing and your travel behavior in general, please do so in the space provided below.

APPENDIX D
COST CATEGORIES OF PARKING OPTIONS

As described in Chapter 3, there were four parking options in the stated preference choice sets. The costs of Parking Option A, a monthly parking option, varied from $90 to $225. Specific rates tested in this study are shown in Table AD-1.

The costs of Parking Options B and C were pivoted against Parking Option A, i.e. their costs depend on Parking Option A's cost. For example, if Level 1 of the cost of Parking Option A and Level 2 of the cost of Parking Option C were required for a choice set, instead of selecting $4.21 for Option C, its pivoted value would be $3.94 (Table AD-1). Hence, instead of having eight cost categories, Parking Options B and C each had 64 cost categories.

Table AD-1 shows the complete cost categories for all parking options. Although the cost values are presented in two decimal places in Table AD-1, they were rounded to a whole number, except for Parking Option D in the survey for the convenience of the respondents.

Table AD-1. Parking Option Cost Categories and Levels

Level	Cost of Parking Option A ($/month)	Cost of Parking Option B-3 ($/month)	Cost of Parking Option B-4 ($/month)	Cost of Parking Option C ($/day)	Cost of Parking Option D ($/hour)
1	90	43.20	54.00	3.83	0.30
		45.00	58.50	3.94	
		52.20	66.60	4.28	
		54.00	72.00	4.50	
		64.80	77.40	4.95	
		70.20	80.10	6.08	
		77.40	83.70	6.75	
		85.50	87.30	8.10	
2	99	47.52	59.40	4.21	0.60
		49.50	64.35	4.33	
		57.42	73.26	4.70	
		59.40	79.20	4.95	
		71.28	85.14	5.45	
		77.22	88.11	6.68	
		85.14	92.07	7.43	
		94.05	96.03	8.91	
3	113	54.24	67.80	4.80	1.00
		56.50	73.45	4.94	
		65.54	83.62	5.37	
		67.80	90.40	5.65	
		81.36	97.18	6.22	
		88.14	100.57	7.63	
		97.18	105.09	8.48	
		107.35	109.61	10.17	
4	126	60.48	75.60	5.36	1.25
		63.00	81.90	5.51	
		73.08	93.24	5.99	
		75.60	100.80	6.30	

Level	Cost of Parking Option A ($/month)	Cost of Parking Option B-3 ($/month)	Cost of Parking Option B-4 ($/month)	Cost of Parking Option C ($/day)	Cost of Parking Option D ($/hour)
		90.72	108.36	6.93	
		98.28	112.14	8.51	
		108.36	117.18	9.45	
		119.70	122.22	11.34	
5	153	73.44	91.80	6.50	1.50
		76.50	99.45	6.69	
		88.74	113.22	7.27	
		91.80	122.40	7.65	
		110.16	131.58	8.42	
		119.34	136.17	10.33	
		131.58	142.29	11.48	
		145.35	148.41	13.77	
6	180	86.40	108.00	7.65	1.75
		90.00	117.00	7.88	
		104.40	133.20	8.55	
		108.00	144.00	9.00	
		129.60	154.80	9.90	
		140.40	160.20	12.15	
		154.80	167.40	13.50	
		171.00	174.60	16.20	
7	198	95.04	118.80	8.42	2.00
		99.00	128.70	8.66	
		114.84	146.52	9.41	
		118.80	158.40	9.90	
		142.56	170.28	10.89	
		154.44	176.22	13.37	
		170.28	184.14	14.85	
		188.10	192.06	17.82	
8	225	108.00	135.00	9.56	2.25

Level	Cost of Parking Option A ($/month)	Cost of Parking Option B-3 ($/month)	Cost of Parking Option B-4 ($/month)	Cost of Parking Option C ($/day)	Cost of Parking Option D ($/hour)
		112.50	146.25	9.84	
		130.50	166.50	10.69	
		135.00	180.00	11.25	
		162.00	193.50	12.38	
		175.50	200.25	15.19	
		193.50	209.25	16.88	
		213.75	218.25	20.25	

Note. Parking Option A is an unrestricted monthly parking permit. Parking Option B-3 indicates a restricted monthly parking permit that allows parking for three days a workweek on campus, while Parking Option B-4 allows parking for four days a workweek. Parking Option C is a daily parking permit, while Parking Option D is an hourly parking option without any time limit enforcement.

APPENDIX E
DESIGN OF CHOICE EXPERIMENTAL PROFILES

A full factorial experiment design was conducted in order to construct the choice sets required for the stated preference component of the survey. The software R was used to create the codes for the design of the experimental profiles using the *rotation.design* function in the package *support.CEs*, which supports the implementation of choice experiments. This function was used to generate a choice experiment design using the mix-and-match method that depends on an orthogonal main-effect array. A choice experiment design is created when all alternatives are assigned to *N* choice sets (Aizaki, 2012).

Table AE.1 shows the design codes generated by R, while Table AE.2 shows the profiles translated from the design codes. There are four attributes (A, B, C, and D) for each parking option, where A is parking cost, B denotes parking fee refund, C indicates availability of free transit pass, and D represents walking time (Table AE-1). Each code was replaced by a corresponding level shown in Chapter 3 to produce the profiles in Table AE-2. The number of levels for attributes A, B, C, and D is eight, three, two, and eight respectively. The resulting combination of profiles was then used to create the choice sets presented in the survey. Every parking option and their attributes were also reviewed to ensure that there was no parking option that would appear to be significantly more attractive than the other three options within a choice set.

Table AE-1. Full Factorial Experiment Design Codes for Parking Options

Choice Set	Parking Option A				Parking Option B				Parking Option C				Parking Option D			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
1	5	3	1	4	3	2	2	4	3	3	2	6	4	1	1	3
2	1	3	1	3	3	1	2	7	8	3	1	2	2	1	1	6
3	5	1	2	5	8	1	2	3	6	2	2	7	3	3	1	4
4	8	2	2	6	8	2	1	8	3	2	2	8	2	1	1	8
5	2	3	1	7	8	2	2	8	7	3	2	8	5	2	2	7
6	2	1	2	6	4	1	1	7	4	1	2	8	5	1	1	2
7	4	2	2	4	7	1	1	8	4	3	2	5	1	2	2	2
8	3	1	2	7	1	2	2	7	5	1	2	5	8	2	2	4
9	4	1	1	1	3	1	1	5	8	3	1	8	8	1	2	4
10	3	2	1	1	6	2	1	7	1	1	2	4	4	3	1	5
11	3	2	2	6	8	3	1	4	3	3	2	3	7	1	1	5
12	5	3	1	5	5	2	2	2	1	2	1	4	8	3	1	5
13	1	3	2	5	4	2	1	1	1	1	1	2	3	1	2	2
14	5	3	1	6	1	2	1	7	4	1	1	2	1	2	1	8
15	8	3	2	1	8	1	2	6	7	1	2	3	3	1	1	4
16	2	2	1	6	4	3	1	5	1	2	2	8	5	2	1	1
17	6	2	2	1	5	1	2	3	3	1	2	1	3	1	1	8
18	3	3	1	3	5	1	1	5	1	1	1	5	7	1	1	7
19	6	3	2	6	8	3	2	5	2	2	2	6	6	1	2	4
20	1	1	2	2	8	1	1	2	6	2	1	1	5	1	1	8
21	8	2	1	5	3	1	1	8	3	1	2	6	2	2	2	3
22	1	3	2	2	1	1	1	5	5	1	1	2	1	1	1	7
23	1	2	2	2	5	2	1	2	8	2	1	3	2	3	1	8
24	5	2	1	4	3	3	1	7	3	2	1	4	6	3	2	2
25	1	3	1	7	5	2	1	8	7	2	2	8	4	1	2	1
26	1	1	1	5	1	3	2	1	4	1	2	7	8	2	2	1
27	7	3	2	8	5	3	2	3	3	2	1	2	4	2	2	1

Choice Set	Parking Option A				Parking Option B				Parking Option C				Parking Option D			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
28	8	3	1	4	8	1	1	6	2	1	1	3	6	3	1	2
29	8	1	1	8	6	2	2	3	1	1	2	1	7	3	1	6
30	3	2	2	1	6	2	2	2	2	2	2	2	5	2	1	4
31	3	1	1	7	6	3	1	4	1	1	2	3	5	1	2	1
32	4	2	2	7	3	2	2	3	8	1	2	4	4	1	2	4
33	4	3	1	2	4	1	2	3	7	2	1	8	8	1	2	3
34	5	3	2	6	6	2	1	6	4	2	2	3	5	2	1	2
35	3	1	1	4	5	2	1	3	2	3	2	6	6	2	1	7
36	4	1	1	4	6	1	1	7	8	1	1	3	8	1	2	5
37	7	2	1	4	7	3	2	6	3	3	1	3	3	2	1	4
38	7	2	1	8	2	3	2	8	5	3	2	8	3	1	2	8
39	8	3	1	6	8	3	2	3	6	3	2	5	2	3	2	4
40	3	2	2	3	3	2	2	7	1	3	1	4	6	1	2	7
41	5	2	1	8	7	2	1	4	8	1	2	3	5	3	2	7
42	8	1	2	4	8	3	1	8	2	2	2	1	2	1	2	1
43	4	2	1	7	8	2	1	4	1	3	2	1	8	2	2	3
44	6	1	1	2	2	2	1	8	8	3	1	4	4	2	2	6
45	5	1	2	1	5	2	2	5	6	2	2	1	3	1	1	3
46	1	3	1	4	5	3	2	5	6	3	2	2	4	3	2	5
47	2	3	2	7	7	1	2	3	2	3	2	4	6	2	2	6
48	1	2	1	1	2	3	1	3	8	1	1	5	8	2	1	3
49	6	2	1	5	5	3	2	1	4	2	2	4	6	2	2	7
50	3	3	2	4	4	3	2	6	7	2	1	1	7	1	2	3
51	8	1	2	5	4	3	1	3	6	2	1	4	7	2	1	3
52	1	3	2	4	6	3	1	1	6	2	2	5	8	1	1	4
53	3	1	2	1	7	3	2	8	5	3	2	1	3	1	1	7
54	2	3	1	1	5	1	1	1	8	3	2	7	4	2	2	3
55	5	1	2	2	7	3	1	1	3	1	2	4	8	2	1	6

Choice Set	Parking Option A				Parking Option B				Parking Option C				Parking Option D			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
56	1	1	2	7	8	2	2	1	4	1	2	5	3	2	2	4
57	8	1	2	7	6	2	2	6	5	3	2	5	7	3	2	5
58	7	1	2	3	8	3	2	7	4	1	1	4	5	2	2	8
59	1	3	2	6	5	1	2	8	7	1	2	1	1	1	2	7
60	3	2	2	8	5	3	1	4	1	2	2	7	8	2	2	2
61	1	1	1	8	3	3	2	2	4	1	1	6	4	1	2	5
62	2	3	1	4	6	1	2	2	4	3	2	4	2	1	1	1
63	8	3	1	8	7	3	1	8	4	1	2	1	8	1	2	7
64	3	1	1	6	4	3	1	7	4	2	1	6	5	2	2	2
65	7	2	2	1	4	1	1	1	3	1	2	8	8	2	1	2
66	7	2	1	3	4	1	1	5	3	2	1	3	1	3	2	4
67	7	1	2	7	3	1	1	3	6	2	1	8	3	1	2	3
68	1	2	1	5	6	1	2	5	7	1	2	8	5	3	1	1
69	7	1	1	8	3	2	1	6	2	2	1	7	3	3	2	3
70	2	2	2	7	4	3	2	4	5	2	1	8	1	1	1	8
71	2	2	2	8	7	3	2	1	3	3	1	7	5	2	1	5
72	6	2	1	7	4	1	1	3	7	1	1	3	7	1	1	8
73	4	1	1	5	2	2	2	8	4	2	1	5	1	3	1	1
74	2	2	2	2	6	3	1	5	8	2	2	2	3	2	2	5
75	1	2	2	4	8	3	2	1	7	3	2	2	3	3	2	8
76	2	1	1	7	1	1	1	6	8	2	1	4	1	3	1	5
77	8	2	2	1	3	3	1	6	4	3	2	3	7	1	2	8
78	2	3	1	6	2	2	1	2	2	3	1	1	7	3	1	8
79	1	1	1	3	4	2	1	6	1	3	2	7	7	2	1	8
80	5	2	2	1	7	3	2	5	2	2	1	1	7	3	1	4
81	3	1	2	5	5	1	1	6	3	2	2	2	2	3	2	8
82	8	3	2	5	3	2	1	4	5	1	2	6	6	1	2	1
83	7	1	2	2	7	1	1	5	7	2	2	3	7	3	1	7

Choice Set	Parking Option A				Parking Option B				Parking Option C				Parking Option D			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
84	2	2	2	6	7	1	2	5	8	2	2	4	1	1	1	3
85	7	2	1	1	2	1	1	3	1	2	1	7	7	2	1	5
86	5	2	1	1	3	2	1	3	8	2	1	7	6	2	2	5
87	4	1	1	2	2	3	1	6	3	3	1	6	4	2	1	4
88	5	1	1	8	3	2	2	5	3	3	2	1	8	2	2	6
89	2	1	2	3	8	1	2	7	6	1	2	5	4	3	2	2
90	2	2	1	8	2	3	1	1	7	3	2	6	4	2	2	5
91	6	2	2	8	3	2	1	2	7	2	2	5	4	3	1	8
92	6	3	2	5	7	2	2	2	5	3	1	6	5	2	2	5
93	8	2	2	4	8	3	1	2	1	2	1	1	7	2	2	4
94	1	3	2	8	6	1	2	7	3	3	2	5	7	2	2	6
95	1	1	1	4	3	2	1	1	1	3	1	3	8	2	2	5
96	1	3	2	1	8	1	1	4	8	1	1	7	2	3	2	1
97	5	2	2	6	3	1	2	6	5	2	1	5	1	1	2	4
98	5	1	1	6	2	2	2	2	3	1	2	2	7	3	1	5
99	4	3	2	2	2	3	2	1	6	2	1	2	3	3	1	8
100	4	1	1	3	2	1	1	7	2	3	2	3	6	3	2	1
101	5	3	1	1	1	2	1	1	3	3	2	4	4	1	1	7
102	1	2	2	1	4	2	2	4	8	1	1	2	8	2	1	7
103	4	3	2	6	5	3	2	7	5	1	1	3	6	1	1	3
104	6	1	2	1	4	3	1	8	1	3	1	5	2	2	2	8
105	7	1	2	5	1	2	2	5	7	3	1	5	7	3	1	1
106	7	3	1	1	3	3	2	4	4	3	2	8	8	3	2	8
107	8	2	1	8	4	3	1	6	5	2	2	7	7	1	2	5
108	3	1	2	2	2	3	1	2	8	1	2	2	6	3	1	8
109	1	1	2	5	6	3	2	6	5	3	1	3	4	2	1	7
110	5	2	1	5	3	3	1	2	4	2	1	8	5	3	2	3
111	8	3	1	7	5	3	1	1	5	2	1	7	8	3	2	4

Choice Set	Parking Option A				Parking Option B				Parking Option C				Parking Option D			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
112	3	2	1	2	4	1	2	2	5	2	1	2	8	2	2	8
113	3	3	1	1	3	1	2	5	6	2	2	8	1	3	2	2
114	4	2	2	6	7	3	2	7	2	1	1	7	2	2	1	6
115	3	1	1	2	5	1	1	3	8	3	2	2	3	1	1	5
116	8	3	1	3	1	2	2	1	6	3	1	6	6	1	1	6
117	2	1	1	4	8	2	1	6	8	1	2	7	1	2	2	8
118	4	2	1	5	5	3	2	2	1	2	1	8	7	2	2	8
119	6	2	1	2	7	2	1	2	5	2	2	4	5	3	2	1
120	1	1	2	1	7	1	1	2	8	2	2	5	3	2	2	2
121	4	2	1	3	7	3	2	3	6	1	2	8	8	2	2	7
122	2	1	2	8	8	3	1	1	4	2	1	7	7	2	1	4
123	7	3	2	3	7	3	2	2	5	2	2	2	1	1	1	1
124	6	1	2	5	5	1	2	5	4	2	2	8	3	3	2	2
125	6	1	1	6	2	3	1	8	2	1	1	2	7	3	1	2
126	8	1	1	7	3	3	1	1	4	1	1	8	6	2	2	4
127	3	1	2	3	8	2	1	3	7	2	1	6	8	1	2	2
128	8	1	1	2	1	2	1	5	7	2	1	7	5	2	2	6
129	8	1	2	3	1	1	1	8	7	2	2	7	7	2	2	3
130	4	2	2	1	4	3	2	2	8	1	2	6	7	2	1	1
131	5	2	1	2	4	3	2	8	6	1	1	7	8	1	1	5
132	3	2	1	5	6	1	1	1	5	1	1	6	3	2	1	7
133	6	3	1	2	1	3	2	6	7	3	2	5	4	1	1	1
134	5	1	1	7	8	3	1	6	4	2	2	7	2	3	2	6
135	6	3	1	7	5	2	2	4	5	1	1	4	8	2	1	8
136	2	3	2	4	3	2	1	7	3	1	1	3	5	3	1	5
137	8	3	2	7	2	1	2	3	4	2	1	4	4	2	1	5
138	2	1	1	6	1	1	2	3	3	2	1	8	8	1	1	7
139	2	1	2	4	7	3	1	4	2	3	1	7	7	2	2	5

Choice Set	Parking Option A				Parking Option B				Parking Option C				Parking Option D			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
140	7	3	1	4	7	1	2	8	4	2	1	3	2	3	2	2
141	1	2	2	6	8	2	2	6	1	3	2	8	3	3	1	1
142	6	2	1	6	7	3	1	5	2	1	2	4	4	3	2	1
143	2	1	1	1	3	1	2	4	8	2	1	2	3	3	2	5
144	2	2	1	2	2	3	1	7	1	3	2	6	4	3	1	7
145	1	2	2	7	1	2	1	3	3	2	2	6	3	1	2	7
146	4	3	1	7	3	3	1	8	3	1	2	5	6	2	2	3
147	4	3	2	7	3	3	2	6	2	2	1	2	4	3	2	3
148	1	2	2	3	2	1	2	6	8	1	2	5	1	2	1	5
149	8	1	1	1	6	1	2	3	8	1	2	1	2	2	1	4
150	8	2	2	2	5	3	1	8	1	1	1	6	3	1	1	2
151	4	2	2	2	7	3	1	6	5	1	2	7	5	2	1	3
152	5	3	1	8	6	1	2	6	7	1	1	5	8	3	2	6
153	4	3	1	4	2	1	1	6	7	2	2	4	2	3	1	4
154	2	1	1	2	7	3	1	7	6	2	2	6	4	1	1	4
155	7	2	1	7	4	2	2	1	6	1	1	3	5	1	2	2
156	8	2	2	8	2	2	2	1	1	3	2	5	8	3	1	3
157	2	1	2	2	1	3	1	6	3	1	1	5	3	2	2	8
158	2	3	2	2	1	1	2	1	1	2	2	2	8	3	2	5
159	6	3	1	5	7	1	2	2	2	1	2	8	4	1	2	6
160	7	2	1	6	1	3	1	4	5	2	2	3	2	1	2	6
161	7	1	2	6	8	3	1	5	5	3	1	7	1	3	1	2
162	1	1	2	4	6	1	1	6	1	2	1	3	3	3	2	1
163	5	2	2	4	6	3	2	3	5	2	1	3	2	3	1	2
164	8	1	1	6	3	1	2	8	5	3	1	2	6	3	2	8
165	6	3	2	1	8	1	1	7	2	2	1	6	6	3	2	5
166	6	3	1	1	6	2	1	2	2	3	1	8	5	1	2	4
167	4	3	1	1	6	3	1	8	8	2	2	8	6	3	1	7

Choice Set	Parking Option A				Parking Option B				Parking Option C				Parking Option D			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
168	7	2	2	7	7	1	2	7	5	2	1	4	5	2	1	8
169	6	1	2	7	5	1	1	2	5	1	1	7	6	3	2	4
170	4	3	2	1	2	2	2	5	4	3	1	1	6	2	1	6
171	5	3	1	2	2	1	2	8	2	1	2	5	4	2	1	3
172	4	2	2	5	2	1	1	8	6	1	2	7	1	2	2	5
173	2	1	2	5	1	2	2	4	2	2	2	4	8	1	1	2
174	7	1	1	3	2	1	2	1	5	3	2	6	1	1	2	8
175	7	1	1	7	7	1	1	6	1	1	2	5	1	3	2	3
176	8	1	1	5	1	2	2	3	3	1	1	7	5	3	1	8
177	3	3	2	2	6	3	2	7	6	1	1	4	6	2	1	3
178	1	2	1	8	2	1	2	5	8	2	1	1	2	2	1	1
179	2	2	2	5	1	2	1	4	8	3	1	7	6	2	2	1
180	4	1	2	2	7	1	2	6	6	1	2	1	3	2	1	5
181	6	2	1	4	4	1	2	4	3	3	2	2	2	2	2	4
182	6	3	2	3	1	1	1	1	7	2	2	2	5	2	2	4
183	1	3	1	2	4	2	2	3	4	3	1	7	4	3	2	7
184	1	2	2	5	5	1	1	7	5	3	2	7	3	3	1	6
185	5	1	2	7	2	1	1	5	6	3	1	5	5	1	2	8
186	8	2	1	7	5	2	1	5	3	2	2	7	3	3	1	5
187	5	2	1	7	2	2	1	1	4	1	2	6	7	3	2	2
188	3	2	1	3	6	3	1	7	2	1	2	1	3	3	1	2
189	4	3	2	8	3	3	1	5	5	1	1	8	1	2	2	7
190	3	3	1	5	8	2	2	3	3	2	2	1	2	2	2	2
191	5	2	2	2	2	3	2	5	5	3	2	2	6	1	2	6
192	3	2	1	7	4	1	2	8	2	3	1	6	4	1	2	3
193	8	3	1	5	7	1	2	4	8	2	1	8	7	2	1	7
194	7	3	2	7	8	1	2	4	8	2	1	6	6	1	1	1
195	8	2	2	5	1	1	1	3	2	1	2	6	6	1	1	7

Choice Set	Parking Option A				Parking Option B				Parking Option C				Parking Option D			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
196	4	1	2	3	3	2	2	6	7	3	1	3	1	2	2	3
197	1	2	1	2	7	1	1	3	5	3	1	8	1	1	2	5
198	4	1	1	6	2	3	2	4	4	3	1	5	7	1	2	2
199	8	3	1	1	8	2	1	2	5	2	1	1	8	2	1	4
200	8	1	2	6	1	3	1	7	2	2	2	8	2	1	1	3
201	1	1	1	7	5	1	1	8	5	3	1	5	4	3	1	1
202	6	1	2	2	1	2	1	2	8	2	2	6	4	3	1	4
203	6	1	2	4	3	1	2	3	8	2	2	3	1	2	1	6
204	8	3	1	2	7	1	1	1	6	1	1	8	3	2	2	7
205	7	1	1	2	5	3	1	5	6	2	2	4	4	1	2	8
206	8	3	2	6	6	3	1	3	2	3	2	7	4	3	1	3
207	6	3	2	2	1	1	2	7	7	1	1	1	7	3	2	3
208	4	1	2	7	6	2	2	7	2	3	1	5	4	2	1	1
209	7	2	2	6	1	1	1	2	6	1	1	5	1	3	2	7
210	4	2	2	8	4	3	1	1	5	3	1	4	6	1	2	8
211	6	3	1	3	5	1	1	4	7	3	1	8	5	1	1	5
212	8	1	2	2	2	2	2	4	4	3	1	2	3	3	1	3
213	4	2	1	6	8	2	2	4	4	1	1	5	6	1	2	3
214	2	3	2	1	5	1	2	6	8	3	2	4	5	1	2	5
215	1	2	1	6	5	2	1	4	1	2	1	5	1	3	1	4
216	2	3	1	2	3	3	2	8	6	3	2	1	2	1	2	4
217	2	2	2	3	1	3	1	5	8	1	1	4	7	1	1	3
218	8	2	2	7	1	1	1	4	6	2	1	7	7	2	2	2
219	2	2	1	3	4	3	2	1	6	2	2	2	8	1	1	1
220	5	3	1	3	4	2	1	7	3	1	1	1	6	3	1	5
221	5	3	2	1	5	3	1	6	2	3	2	2	1	3	2	6
222	7	3	2	4	7	2	2	6	1	2	2	3	5	3	1	2
223	4	2	2	3	6	2	2	4	6	2	1	6	1	2	1	3

Choice Set	Parking Option A				Parking Option B				Parking Option C				Parking Option D			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
224	4	3	1	5	5	1	2	1	5	1	2	8	7	1	2	7
225	8	1	1	3	7	1	1	7	4	2	2	5	4	1	1	8
226	8	2	1	3	6	1	2	4	2	2	1	3	4	2	2	8
227	6	2	2	7	2	2	1	6	4	3	2	1	6	1	1	5
228	7	3	1	6	4	2	1	2	2	1	2	3	4	2	2	7
229	5	1	1	1	4	2	2	7	2	3	2	5	7	3	2	7
230	1	3	1	8	2	2	1	5	3	3	1	4	7	3	2	6
231	5	1	1	2	5	3	2	4	3	3	1	8	2	2	1	3
232	6	2	2	3	7	2	2	8	1	2	2	1	1	1	2	2
233	3	3	1	6	8	3	1	7	6	1	1	2	2	1	1	5
234	1	2	1	3	2	2	2	7	1	1	1	1	1	3	1	3
235	8	3	2	4	6	1	1	5	3	1	2	3	3	2	1	3
236	4	3	1	8	8	1	1	8	1	2	1	2	2	1	2	3
237	5	2	2	3	3	3	2	3	3	3	1	1	3	2	2	1
238	8	3	2	3	2	3	1	4	6	1	2	2	5	1	1	1
239	6	1	1	5	4	1	2	1	7	3	2	7	8	3	2	2
240	6	2	1	8	8	3	1	3	7	3	1	6	6	2	1	4
241	5	2	1	6	3	1	1	7	2	1	2	7	7	1	2	1
242	6	3	1	8	8	1	2	8	5	2	2	8	4	3	1	6
243	3	3	1	8	4	2	2	6	4	1	2	2	6	3	1	3
244	8	1	2	1	7	2	1	3	2	2	2	7	5	3	1	6
245	7	3	1	7	8	2	1	5	6	1	2	6	1	1	2	1
246	6	1	2	6	4	2	1	3	2	3	2	8	8	1	1	6
247	3	3	2	3	6	2	1	4	1	1	1	3	5	3	2	5
248	7	1	2	8	2	3	2	7	6	2	2	3	7	1	1	1
249	7	2	2	5	1	1	2	8	8	1	1	1	8	1	2	8
250	4	1	2	8	3	1	1	6	5	1	1	1	1	3	2	8
251	5	3	2	4	6	3	2	2	8	1	1	6	2	2	2	1

Choice Set	Parking Option A				Parking Option B				Parking Option C				Parking Option D			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
252	1	3	1	6	7	3	2	4	6	3	2	3	4	3	2	4
253	3	1	2	6	4	2	2	5	1	3	2	2	2	3	1	5
254	1	1	1	6	6	3	2	8	4	2	1	1	7	2	1	2
255	2	2	1	5	3	3	2	5	1	1	2	7	4	2	1	6
256	6	2	2	6	7	2	2	4	2	3	1	4	5	1	2	3
257	5	1	2	3	6	2	2	1	2	1	2	2	1	2	1	4
258	5	1	2	8	3	1	1	2	3	1	2	7	6	2	1	1
259	3	1	2	4	2	1	1	4	4	1	1	7	1	1	2	3
260	6	2	2	2	1	2	2	2	7	2	2	1	6	1	1	8
261	4	3	2	5	3	3	1	4	4	3	2	6	5	3	1	7
262	5	3	2	5	6	2	1	3	3	2	2	5	2	1	1	7
263	1	3	1	1	1	3	2	8	2	1	1	5	3	1	2	1
264	8	3	2	8	1	2	1	6	1	1	1	8	1	3	2	1
265	7	1	2	4	3	2	1	8	6	3	1	2	8	3	1	4
266	5	3	1	7	7	2	1	5	5	1	2	3	2	2	2	7
267	4	1	2	6	8	3	2	6	7	3	1	4	2	1	2	2
268	5	3	2	2	3	2	2	2	8	1	2	8	6	3	1	1
269	3	2	2	5	5	2	1	1	5	2	1	6	7	3	2	4
270	6	1	2	8	2	1	2	2	1	1	1	4	4	1	1	6
271	2	3	1	8	5	3	2	8	5	1	1	5	2	2	1	5
272	8	2	1	4	8	2	2	2	6	3	1	4	2	3	1	3
273	7	1	1	5	4	1	1	4	6	1	2	4	1	2	2	6
274	8	2	1	6	5	2	2	1	7	2	1	5	3	1	2	4
275	8	2	1	2	1	1	2	5	6	1	1	6	6	1	1	2
276	4	3	1	3	7	2	2	5	6	1	2	3	5	3	2	8
277	7	2	2	8	6	1	1	2	3	1	1	4	4	1	2	2
278	2	2	1	7	1	3	2	3	7	1	1	4	6	3	2	3
279	7	2	2	4	5	1	2	7	2	1	1	8	8	3	1	6

Choice Set	Parking Option A				Parking Option B				Parking Option C				Parking Option D			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
280	6	3	2	4	4	1	2	7	7	3	2	3	5	3	2	6
281	6	3	1	6	2	2	1	3	7	1	1	2	3	3	2	4
282	2	3	1	5	5	2	2	7	7	1	1	6	3	2	2	6
283	1	1	2	8	1	1	2	2	5	2	2	5	8	3	1	2
284	4	1	1	7	7	2	2	3	1	1	2	8	3	2	1	1
285	1	1	1	2	3	2	1	5	1	3	2	3	7	2	2	7
286	6	1	1	1	1	3	1	8	6	3	1	8	1	2	2	1
287	1	2	2	8	7	2	1	6	4	3	1	3	3	1	2	6
288	2	1	1	8	8	2	1	7	8	2	2	1	6	3	1	6
289	3	3	2	6	7	3	1	3	8	3	1	1	8	3	2	1
290	3	1	1	5	4	1	1	6	7	3	2	4	7	1	2	4
291	2	1	2	1	7	2	2	1	6	3	2	8	4	2	1	8
292	8	1	2	8	5	3	1	3	7	1	2	4	8	1	1	3
293	4	2	1	4	1	2	2	6	3	3	1	5	7	3	1	3
294	7	3	2	2	6	3	2	5	4	3	2	7	3	2	1	8
295	6	3	2	8	3	3	2	1	1	3	1	2	1	2	1	7
296	2	2	2	4	7	2	2	7	5	3	1	1	2	3	2	7
297	1	1	2	6	3	3	2	7	7	2	2	6	2	2	2	6
298	7	3	1	5	4	3	1	2	3	1	1	2	4	1	1	5
299	5	1	1	4	8	2	2	5	8	3	1	6	3	2	1	6
300	2	2	2	1	6	2	1	8	3	1	1	6	4	2	2	2
301	7	3	2	5	4	2	2	2	7	1	1	7	1	2	1	1
302	2	1	1	3	8	3	2	8	3	2	1	1	3	1	2	5
303	4	3	1	6	6	3	2	4	4	1	2	3	4	1	1	2
304	5	2	1	3	4	3	2	3	5	1	2	2	5	3	1	3
305	5	2	2	5	1	3	1	2	6	3	2	6	8	1	2	1
306	2	3	1	3	4	3	2	7	8	3	2	3	3	1	1	1
307	3	1	1	1	3	2	2	1	3	3	2	7	5	2	2	1

Choice Set	Parking Option A				Parking Option B				Parking Option C				Parking Option D			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
308	4	1	2	1	8	1	1	5	6	3	1	3	5	1	2	7
309	1	1	1	1	2	1	2	7	6	3	2	4	6	2	1	8
310	3	1	2	8	2	3	1	5	5	3	2	4	5	1	1	6
311	4	1	1	8	4	1	1	2	6	2	1	3	5	2	2	3
312	2	2	1	4	1	1	1	7	1	3	1	1	8	2	1	5
313	3	3	1	4	4	1	2	5	1	1	2	2	4	1	2	7
314	3	3	2	5	4	1	1	8	2	3	1	2	8	3	2	7
315	4	2	1	1	4	1	2	6	5	2	2	6	3	2	2	3
316	1	3	1	5	7	1	1	4	7	3	2	1	3	3	2	7
317	1	3	2	3	6	1	2	8	4	2	2	6	2	3	1	6
318	6	2	1	3	1	2	1	8	3	2	1	7	2	2	1	2
319	3	3	2	8	2	3	2	6	8	3	1	3	1	1	1	5
320	5	2	2	8	1	3	2	7	4	1	2	4	1	1	2	6
321	4	3	2	4	4	2	1	8	7	1	1	8	3	3	2	6
322	5	1	1	5	1	1	2	4	2	2	1	4	6	2	2	8
323	6	1	2	3	1	3	2	5	2	2	1	8	5	1	1	3
324	3	1	1	3	5	3	1	2	8	3	2	5	2	3	1	1
325	6	3	2	7	3	1	2	1	1	2	1	6	5	1	2	6
326	7	2	2	3	4	3	2	5	1	1	2	6	6	3	2	7
327	8	2	2	3	8	2	1	1	8	2	2	7	8	3	1	1
328	6	3	1	4	2	2	2	3	7	1	2	6	2	1	1	2
329	4	1	2	4	3	2	2	8	7	1	2	5	6	1	2	5
330	3	2	2	4	2	1	1	1	8	1	1	8	6	2	1	2
331	1	3	2	7	6	2	2	5	6	3	1	7	1	3	1	7
332	6	2	1	1	4	2	2	8	3	2	2	4	5	2	1	7
333	1	2	1	4	6	1	1	4	5	3	2	3	1	2	2	4
334	5	2	2	7	5	3	2	6	1	2	2	5	8	1	2	6
335	1	2	1	7	7	1	2	1	1	3	2	4	2	2	1	7

Choice Set	Parking Option A				Parking Option B				Parking Option C				Parking Option D			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
336	2	3	2	6	4	2	1	4	4	2	2	1	6	3	2	6
337	7	3	2	6	2	1	2	4	5	1	2	4	7	1	1	6
338	7	1	2	1	8	1	1	1	1	3	1	8	1	2	1	2
339	7	3	1	8	6	3	1	2	2	1	1	6	2	1	1	4
340	3	3	2	1	5	1	2	4	4	2	2	2	2	3	1	7
341	3	3	2	7	5	2	2	3	3	1	1	8	3	3	1	7
342	4	3	2	3	3	1	2	2	8	3	2	6	6	1	1	4
343	3	2	2	7	6	3	2	1	4	3	1	4	8	3	1	7
344	7	2	2	2	5	2	2	8	1	2	2	4	2	2	1	8
345	4	2	1	2	8	1	2	5	8	3	2	1	5	2	1	6
346	8	2	1	1	1	3	2	4	2	2	2	3	8	1	1	8
347	6	1	1	7	6	3	1	6	7	2	1	4	1	3	1	8
348	3	2	2	2	2	3	2	3	4	3	2	2	6	1	2	2
349	6	1	1	8	7	2	1	7	2	2	1	5	7	1	1	4
350	3	2	1	8	6	1	2	1	4	1	1	1	7	1	1	2
351	6	1	1	3	8	1	2	2	3	2	1	5	1	1	1	6
352	3	3	1	2	7	2	1	1	4	3	1	6	7	2	2	1
353	5	1	2	4	6	2	1	5	6	3	1	1	1	3	2	5
354	7	1	1	6	2	2	2	6	6	3	2	7	6	2	1	5
355	7	3	1	2	1	3	1	1	4	2	1	2	4	3	1	2
356	2	3	2	8	8	3	2	2	4	3	1	8	4	3	2	8
357	5	3	2	8	7	3	1	2	7	2	1	3	6	2	2	2
358	7	3	2	1	1	2	2	8	7	3	1	7	8	3	1	8
359	2	1	2	7	8	2	2	7	7	3	1	2	7	1	2	6
360	3	3	1	7	3	3	1	3	8	2	1	5	7	2	1	6
361	5	1	2	6	3	1	1	4	7	1	2	2	5	3	2	2
362	7	2	1	2	8	1	2	1	2	3	1	3	8	3	2	3
363	7	3	1	3	2	2	1	4	2	2	2	5	5	1	1	4

Choice Set	Parking Option A				Parking Option B				Parking Option C				Parking Option D			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
364	5	3	2	7	6	2	2	8	1	3	1	7	2	1	2	8
365	7	2	1	5	2	3	2	2	1	1	1	7	6	3	1	4
366	8	3	2	2	1	1	2	6	6	1	1	1	7	3	2	8
367	3	2	1	4	8	3	2	4	3	2	2	3	7	3	2	1
368	5	1	1	3	5	2	2	6	7	2	1	2	2	2	2	5
369	5	3	2	3	2	2	1	7	8	3	1	5	4	2	2	4
370	3	1	1	8	5	2	1	6	5	1	2	1	2	1	2	7
371	2	3	2	5	5	3	1	7	2	1	1	1	4	3	2	6
372	2	2	1	1	8	1	1	3	2	3	2	1	1	1	1	4
373	2	3	2	3	6	1	1	3	7	3	1	1	5	3	1	4
374	6	2	2	4	5	2	1	7	1	2	2	6	5	3	2	4
375	2	1	1	5	6	2	1	1	2	1	1	4	3	2	1	2
376	4	2	1	8	7	2	1	8	7	1	2	7	2	3	2	5
377	7	1	1	4	3	1	1	1	3	2	1	6	4	2	1	2
378	4	1	2	5	6	1	1	8	3	3	2	8	2	1	2	5
379	3	2	1	6	2	1	1	2	4	1	1	3	2	3	2	3
380	7	1	1	1	5	1	2	2	8	3	2	8	1	3	1	6
381	6	2	2	5	4	2	1	5	3	3	1	2	1	1	1	2
382	1	1	2	3	4	3	1	4	1	3	1	6	5	1	1	7
383	6	1	1	4	1	3	1	3	5	2	2	1	8	2	1	1
384	8	1	1	4	1	3	2	2	6	2	1	5	3	1	1	6

Note. Each parking option has four attributes (A, B, C, and D), where A is parking cost, B denotes parking fee refund, C indicates availability of free transit pass, and D represents walking time. The levels for attributes A, B, C, and D are eight, three, two, and eight respectively. Attribute B (parking fee refund) was only valid for Parking Option A. Hence, the codes for B shown in the table were ignored for Parking Options B, C and D when constructing the final choice sets for the survey. Similarly, attribute C (availability of free transit pass) was only relevant to Parking Options A and B and were ignored in Parking Options C and D.

Table AE-2. Profiles Constructed for Choice Sets

Choice Set	Parking Cost A ($/month)	Parking Cost B ($/month)	Parking Cost C ($/day)	Parking Cost D ($/hour)	Parking Fee Refund ($)	Transit Pass A	Transit Pass B	Walking Time A (min)	Walking Time B (min)	Walking Time C (min)	Walking Time D (min)
1	153	89	7	1.25	2	1	0	8	8	15	5
2	90	52	8	0.60	2	1	0	5	18	3	15
3	153	145	10	1.00	0	0	0	10	5	18	8
4	225	214	11	0.60	1	0	1	15	20	20	20
5	99	94	7	1.50	2	1	0	18	20	20	18
6	99	59	5	1.50	0	0	1	15	18	20	3
7	126	108	7	0.30	1	0	1	8	20	10	15
8	113	54	6	2.25	0	0	0	18	18	10	8
9	126	73	11	2.25	0	1	1	1	10	20	8
10	113	88	5	1.25	1	1	1	1	18	8	10
11	113	107	5	2.00	1	0	1	15	8	5	10
12	153	110	7	2.25	2	1	0	10	3	8	10
13	90	54	4	1.00	2	0	1	10	1	3	15
14	153	73	8	0.30	2	1	1	15	18	3	20
15	225	214	17	1.00	2	0	0	1	15	5	8
16	99	59	4	1.50	1	1	1	15	10	20	1
17	180	130	9	1.00	1	0	0	1	10	1	20
18	113	81	6	2.00	2	1	1	5	10	10	18
19	180	171	8	1.75	2	0	0	15	10	15	8
20	90	86	6	1.50	0	0	1	3	3	1	20
21	225	131	11	0.60	1	1	1	10	20	15	5
22	90	43	5	0.30	2	0	1	3	10	3	18
23	90	65	8	0.60	1	0	1	3	3	5	20
24	153	89	7	1.75	1	1	1	8	18	8	3
25	90	65	7	1.25	2	1	1	18	20	20	1
26	90	43	5	2.25	0	1	0	10	1	18	1
27	198	143	9	1.25	2	0	0	1	5	3	20
28	225	214	10	1.75	2	1	1	8	15	5	3
29	225	176	10	2.00	0	1	0	3	5	1	15

Choice Set	Parking Cost A ($/month)	Parking Cost B ($/month)	Parking Cost C ($/day)	Parking Cost D ($/hour)	Parking Fee Refund ($)	Transit Pass A	Transit Pass B	Walking Time A (min)	Walking Time B (min)	Walking Time C (min)	Walking Time D (min)
30	113	88	5	1.50	1	0	0	1	3	3	8
31	113	88	5	1.50	0	1	1	18	8	5	1
32	126	73	11	1.25	1	0	0	18	5	8	8
33	126	76	9	2.25	2	1	0	3	5	20	5
34	153	119	8	1.50	2	0	1	15	15	5	3
35	113	81	5	1.75	0	1	1	8	5	15	18
36	126	98	11	2.25	0	1	1	8	18	5	10
37	198	170	9	1.00	1	1	0	8	15	5	8
38	198	99	10	1.00	1	1	0	20	20	20	20
39	225	214	15	0.60	2	1	0	15	5	10	8
40	113	66	5	1.75	1	0	0	5	18	8	18
41	153	132	14	1.50	1	1	1	8	8	5	18
42	225	214	10	0.60	0	0	1	8	20	1	20
43	126	120	5	2.25	1	1	1	18	8	1	5
44	180	90	16	1.25	0	1	1	3	20	8	15
45	153	110	10	1.00	0	0	0	1	10	1	5
46	90	65	6	1.25	2	1	0	8	10	3	10
47	99	85	4	1.75	2	0	0	18	5	8	15
48	90	45	8	2.25	1	1	1	15	5	10	5
49	180	130	9	1.75	1	1	0	10	1	8	18
50	113	68	14	2.00	2	0	0	8	15	1	5
51	225	135	15	2.00	0	0	1	10	5	8	5
52	90	70	6	2.25	2	0	1	8	1	10	8
53	113	97	6	1.00	0	0	0	1	20	1	18
54	99	71	9	1.25	2	1	1	1	1	18	5
55	153	132	7	2.25	0	0	1	3	1	8	15
56	90	86	5	1.00	0	0	0	18	1	10	8
57	225	176	12	2.00	0	0	0	18	15	10	10
58	198	188	10	1.50	0	0	0	5	18	8	20
59	90	65	7	0.30	2	0	0	15	20	1	18

Choice Set	Parking Cost A ($/month)	Parking Cost B ($/month)	Parking Cost C ($/day)	Parking Cost D ($/hour)	Parking Fee Refund ($)	Transit Pass A	Transit Pass B	Walking Time A (min)	Walking Time B (min)	Walking Time C (min)	Walking Time D (min)
60	113	81	5	2.25	1	0	1	20	8	18	3
61	90	52	5	1.25	0	1	0	20	3	15	10
62	99	77	5	0.60	2	1	0	8	3	8	1
63	225	194	11	2.25	2	1	1	1	3	1	3
64	113	68	6	1.50	0	1	1	15	18	15	3
65	198	119	9	2.25	1	0	1	1	1	15	3
66	198	119	9	0.30	1	1	1	5	10	5	8
67	198	115	13	1.00	0	0	1	3	5	5	15
68	90	70	7	1.50	1	1	0	10	10	20	1
69	198	115	9	1.00	0	1	1	3	15	18	15
70	99	59	5	0.30	1	0	0	18	8	20	20
71	99	85	5	1.50	1	0	0	20	1	18	10
72	180	108	14	2.00	1	1	1	18	5	5	20
73	126	63	6	0.30	0	1	0	10	20	10	20
74	99	77	9	1.00	1	0	1	3	10	3	10
75	90	86	7	1.00	1	0	0	8	1	3	20
76	99	48	9	0.30	0	1	1	18	15	8	10
77	225	131	11	2.00	1	0	1	1	15	5	20
78	99	50	4	2.00	2	1	1	15	3	1	3
79	90	54	4	2.00	0	1	1	5	15	18	3
80	153	132	7	2.00	1	0	0	1	10	1	8
81	113	81	5	0.60	0	0	1	10	15	3	20
82	225	131	12	1.75	2	0	1	10	8	15	1
83	198	170	15	2.00	0	0	1	3	10	5	3
84	99	85	9	0.30	1	0	0	15	10	8	5
85	198	99	8	2.00	1	1	1	1	5	18	10
86	153	89	14	1.75	1	1	1	1	5	1	10
87	126	63	6	1.25	0	1	1	3	15	15	8
88	153	89	7	2.25	0	1	0	20	10	1	15
89	99	94	7	1.25	0	0	0	5	18	10	3

Choice Set	Parking Cost A ($/month)	Parking Cost B ($/month)	Parking Cost C ($/day)	Parking Cost D ($/hour)	Parking Fee Refund ($)	Transit Pass A	Transit Pass B	Walking Time A (min)	Walking Time B (min)	Walking Time C (min)	Walking Time D (min)
90	99	50	7	1.25	1	1	1	20	1	15	10
91	180	104	14	1.25	1	0	1	5	3	10	20
92	180	155	10	1.50	2	0	0	10	3	15	10
93	225	214	10	2.00	1	0	1	8	3	1	8
94	90	70	4	2.00	2	0	0	20	18	10	15
95	90	52	4	2.25	0	1	1	8	1	5	10
96	90	86	8	0.60	2	0	1	1	8	18	1
97	153	89	8	0.30	1	0	0	15	15	10	8
98	153	77	7	2.00	0	1	0	15	3	3	10
99	126	63	9	1.00	2	0	0	3	1	3	20
100	126	63	6	1.75	0	1	1	5	18	5	1
101	153	73	7	1.25	2	1	1	1	1	8	18
102	90	54	8	2.25	1	0	0	1	8	3	18
103	126	91	7	1.75	2	0	0	10	18	5	5
104	180	108	8	0.60	0	0	1	1	20	10	20
105	198	95	15	2.00	0	0	0	10	10	10	1
106	198	2	10	2.25	2	1	0	1	8	20	1
107	225	135	12	2.00	1	1	1	1	15	18	10
108	113	57	10	1.75	0	0	1	3	3	3	20
109	90	70	5	1.25	0	0	0	10	15	5	18
110	153	89	8	1.50	1	1	1	10	3	20	5
111	225	162	12	2.25	2	1	1	18	1	18	8
112	113	68	6	2.25	1	1	0	3	3	3	1
113	113	66	8	0.30	2	1	0	1	10	20	3
114	126	108	6	0.60	1	0	0	15	18	18	15
115	113	81	10	1.00	0	1	1	3	5	3	10
116	225	108	15	1.75	2	1	0	5	1	15	15
117	99	94	9	0.30	0	1	1	15	8	1	20
118	126	91	5	2.00	1	1	0	10	3	20	3
119	180	155	10	1.50	1	1	1	3	3	8	1

Choice Set	Parking Cost A ($/month)	Parking Cost B ($/month)	Parking Cost C ($/day)	Parking Cost D ($/hour)	Parking Fee Refund ($)	Transit Pass A	Transit Pass B	Walking Time A (min)	Walking Time B (min)	Walking Time C (min)	Walking Time D (min)
120	90	77	8	1.00	0	0	1	1	3	10	18
121	126	108	9	2.25	1	1	0	5	5	20	3
122	99	94	5	2.00	0	0	1	20	1	18	8
123	198	170	11	0.30	2	0	0	5	3	3	20
124	180	130	9	1.00	0	0	0	10	10	20	15
125	180	90	8	2.00	0	1	1	15	20	18	3
126	225	131	11	1.75	0	1	1	1	15	20	8
127	113	107	8	2.25	0	0	1	5	5	15	3
128	225	108	17	1.50	0	1	1	3	10	3	10
129	225	108	17	2.00	0	0	1	5	20	3	18
130	126	76	11	2.00	1	0	0	1	3	15	1
131	153	92	10	2.25	1	1	0	3	20	18	10
132	113	88	6	1.00	1	1	1	10	1	20	15
133	180	86	14	1.25	2	1	0	3	15	10	1
134	153	145	8	0.60	0	1	1	18	20	10	18
135	180	130	10	2.25	2	1	0	10	8	8	1
136	99	57	5	1.50	2	0	1	5	18	8	10
137	225	113	11	1.25	2	0	0	3	5	8	10
138	99	48	5	2.25	0	1	0	15	5	20	3
139	99	85	4	2.00	0	0	1	8	8	18	3
140	198	170	10	0.60	2	1	0	8	3	5	18
141	90	86	4	1.00	1	0	0	15	15	20	1
142	180	155	8	1.25	1	1	1	15	10	8	1
143	99	57	9	1.00	0	1	0	1	8	3	10
144	99	50	4	1.25	1	1	1	3	18	18	15
145	90	43	4	1.00	1	0	1	18	5	15	18
146	126	73	6	1.75	2	1	1	5	8	18	10
147	126	73	6	1.25	2	0	0	18	15	3	5
148	90	45	8	0.30	1	0	0	10	15	5	18
149	225	176	20	0.60	0	1	0	1	5	1	8

Choice Set	Parking Cost A ($/month)	Parking Cost B ($/month)	Parking Cost C ($/day)	Parking Cost D ($/hour)	Parking Fee Refund ($)	Transit Pass A	Transit Pass B	Walking Time A (min)	Walking Time B (min)	Walking Time C (min)	Walking Time D (min)
150	225	162	10	1.00	1	0	1	3	20	3	15
151	126	108	7	1.50	1	0	1	3	15	18	5
152	153	119	11	2.25	2	1	0	20	15	10	10
153	126	63	9	0.60	2	1	1	8	10	8	18
154	99	85	7	1.25	0	1	1	3	18	15	8
155	198	119	13	1.50	1	1	0	18	1	3	5
156	225	113	10	2.25	1	0	0	1	1	10	5
157	99	48	5	1.00	0	0	1	3	15	20	10
158	99	48	4	2.25	2	0	0	3	1	10	3
159	180	155	8	1.25	2	1	0	10	3	15	20
160	198	95	11	0.60	1	1	1	15	8	5	15
161	198	188	11	0.30	0	0	1	15	10	3	18
162	90	70	4	1.00	0	0	1	8	15	3	1
163	153	119	8	0.60	1	0	0	8	5	5	15
164	225	131	12	1.75	0	1	0	15	20	8	5
165	180	171	8	1.75	2	0	1	1	18	15	10
166	180	140	8	1.25	2	1	1	1	3	20	8
167	126	98	11	1.75	2	1	1	1	20	20	18
168	198	170	11	1.50	1	0	0	18	18	8	20
169	180	130	10	1.75	0	0	1	18	3	18	8
170	126	63	6	1.75	2	0	0	1	10	15	1
171	153	77	7	1.25	2	1	0	3	20	10	5
172	126	63	9	0.30	1	0	1	10	18	10	20
173	99	48	4	2.25	0	0	0	10	8	8	3
174	198	99	11	0.30	0	1	0	5	1	15	20
175	198	170	8	0.30	0	1	1	18	15	10	20
176	225	108	11	1.50	0	1	0	10	5	20	18
177	113	88	8	1.75	2	0	0	3	18	8	5
178	90	45	8	0.60	1	1	0	20	10	1	18
179	99	48	9	1.75	1	0	1	10	8	18	1

Choice Set	Parking Cost A ($/month)	Parking Cost B ($/month)	Parking Cost C ($/day)	Parking Cost D ($/hour)	Parking Fee Refund ($)	Transit Pass A	Transit Pass B	Walking Time A (min)	Walking Time B (min)	Walking Time C (min)	Walking Time D (min)
180	126	108	9	1.00	0	0	0	3	15	1	10
181	180	108	9	0.60	1	1	0	8	8	3	18
182	180	86	14	1.50	2	0	1	5	1	3	8
183	90	54	5	1.25	2	1	0	3	5	18	10
184	90	65	5	1.00	1	0	1	10	18	18	15
185	153	77	10	1.50	0	0	1	18	10	10	8
186	225	162	11	1.00	1	1	1	18	10	10	15
187	153	77	8	2.00	1	1	1	18	1	15	3
188	113	88	5	1.00	1	1	1	5	18	1	3
189	126	73	7	0.30	2	0	1	20	10	8	18
190	113	107	5	0.60	2	1	0	10	5	15	20
191	153	77	8	1.75	1	0	0	3	10	15	3
192	113	68	5	1.25	1	1	0	18	20	15	5
193	225	209	20	2.25	2	1	0	10	8	20	18
194	198	192	18	1.75	2	0	0	18	8	1	15
195	225	135	10	1.75	1	0	1	10	5	18	15
196	126	93	9	0.30	0	0	0	5	15	5	20
197	90	84	5	0.30	1	1	1	3	5	8	20
198	126	82	6	2.00	0	1	0	15	8	10	3
199	225	218	12	2.25	2	1	1	1	3	1	8
200	225	135	10	0.60	0	0	1	15	18	5	20
201	90	77	5	1.25	0	1	1	18	20	10	1
202	180	108	16	1.25	0	0	1	3	3	8	15
203	180	133	16	0.30	0	0	0	8	5	3	15
204	225	209	15	1.00	2	1	1	5	1	3	18
205	198	170	13	1.25	0	1	1	3	10	8	20
206	225	200	10	1.25	2	0	1	15	5	18	5
207	180	108	14	2.00	2	0	0	3	18	1	5
208	126	112	6	1.25	0	0	0	10	18	18	1
209	198	119	13	0.30	1	0	1	15	3	10	18

Choice Set	Parking Cost A ($/month)	Parking Cost B ($/month)	Parking Cost C ($/day)	Parking Cost D ($/hour)	Parking Fee Refund ($)	Transit Pass A	Transit Pass B	Walking Time A (min)	Walking Time B (min)	Walking Time C (min)	Walking Time D (min)
210	126	101	7	1.75	1	0	1	20	1	15	8
211	180	155	14	1.50	2	1	1	5	8	20	10
212	225	146	11	1.00	0	0	0	3	8	10	5
213	126	122	6	1.75	1	1	0	15	8	10	5
214	99	85	9	1.50	2	0	0	1	15	10	8
215	90	77	4	0.30	1	1	1	8	8	15	20
216	99	73	7	0.60	2	1	0	3	20	1	8
217	99	59	9	2.00	1	0	1	10	10	5	3
218	225	135	15	2.00	1	0	1	5	8	10	3
219	99	79	7	2.25	1	1	0	5	1	3	1
220	153	122	7	1.75	2	1	1	5	18	1	10
221	153	132	7	0.30	2	0	1	1	15	3	15
222	198	184	8	1.50	2	0	0	8	15	5	3
223	126	112	9	0.30	1	0	0	5	8	10	20
224	126	108	7	2.00	2	1	0	10	1	8	3
225	225	209	11	1.25	0	1	1	5	18	10	20
226	225	200	10	1.25	1	1	0	3	8	8	10
227	180	117	9	1.75	1	0	1	18	15	10	1
228	198	158	9	1.25	2	1	1	15	3	18	5
229	153	122	7	2.00	0	1	0	1	18	18	10
230	90	59	4	2.00	2	1	1	15	10	20	10
231	153	132	7	0.60	0	1	0	3	8	20	18
232	180	167	8	0.30	1	0	0	5	1	15	20
233	113	110	8	0.60	2	1	1	15	18	3	10
234	90	59	4	0.30	1	1	0	5	18	1	5
235	225	200	11	1.00	2	0	1	8	10	5	18
236	126	122	5	0.60	2	1	1	15	15	18	3
237	153	113	7	1.00	1	0	0	5	5	15	1
238	225	146	15	1.50	2	0	1	5	8	1	3
239	180	144	14	2.25	0	1	0	18	1	10	3

Choice Set	Parking Cost A ($/month)	Parking Cost B ($/month)	Parking Cost C ($/day)	Parking Cost D ($/hour)	Parking Fee Refund ($)	Transit Pass A	Transit Pass B	Walking Time A (min)	Walking Time B (min)	Walking Time C (min)	Walking Time D (min)
240	180	175	14	1.75	1	1	1	20	5	15	8
241	153	113	7	2.00	1	1	1	15	18	18	1
242	180	175	10	1.25	2	1	0	20	15	15	10
243	113	90	6	1.75	2	1	0	3	15	15	5
244	225	209	10	1.50	0	0	1	1	5	18	15
245	198	192	13	0.30	2	1	1	18	10	10	20
246	180	144	8	2.25	0	0	1	15	5	20	15
247	113	101	5	1.50	2	0	1	5	8	5	10
248	198	129	13	2.00	0	0	0	20	18	5	1
249	198	119	18	2.25	1	0	0	10	20	1	20
250	126	93	7	0.30	0	0	1	20	15	1	20
251	153	136	14	0.60	2	0	0	8	3	1	15
252	90	84	6	1.25	2	1	0	15	10	8	5
253	113	90	5	0.60	0	0	0	15	10	18	20
254	90	80	5	2.00	0	1	1	15	20	10	3
255	99	73	4	1.25	1	1	0	10	10	18	15
256	180	167	8	1.50	1	0	0	15	8	8	5
257	153	136	7	0.30	0	0	0	3	1	10	20
258	153	113	7	1.75	0	0	1	20	3	18	1
259	113	73	6	0.30	0	0	1	18	15	8	20
260	180	108	14	1.75	1	0	0	5	5	1	20
261	126	93	6	1.50	2	0	1	10	8	18	10
262	153	136	7	0.60	2	0	1	10	5	10	18
263	90	54	4	1.00	2	1	0	1	20	10	1
264	225	135	10	0.30	2	0	1	1	18	15	20
265	198	147	13	2.25	0	0	1	8	20	3	8
266	153	142	8	0.60	2	1	1	18	10	5	18
267	126	122	9	0.60	0	0	0	15	15	8	18
268	153	113	14	1.75	2	0	0	3	3	1	10
269	113	97	6	2.00	1	0	1	10	1	15	8

Choice Set	Parking Cost A ($/month)	Parking Cost B ($/month)	Parking Cost C ($/day)	Parking Cost D ($/hour)	Parking Fee Refund ($)	Transit Pass A	Transit Pass B	Walking Time A (min)	Walking Time B (min)	Walking Time C (min)	Walking Time D (min)
270	180	117	8	1.25	0	0	0	20	3	8	15
271	99	85	5	0.60	2	1	0	20	20	10	10
272	225	218	15	0.60	1	1	0	8	8	3	18
273	198	158	13	0.30	0	1	1	10	8	8	15
274	225	194	17	1.00	1	1	0	15	1	10	8
275	225	135	15	1.75	1	1	0	3	10	15	3
276	126	117	9	1.50	2	1	0	5	10	5	5
277	198	176	9	1.25	1	0	1	20	3	8	3
278	99	59	7	1.75	1	1	0	18	5	8	5
279	198	170	9	2.25	1	0	0	8	18	20	15
280	180	144	14	1.50	2	0	0	8	18	5	15
281	180	117	14	1.00	2	1	1	15	5	3	8
282	99	85	7	1.00	2	1	0	10	18	15	15
283	90	54	5	2.25	0	0	0	20	3	10	1
284	126	117	5	1.00	0	1	0	18	5	20	1
285	90	67	4	2.00	0	1	1	3	10	18	5
286	180	108	12	0.30	0	1	1	8	8	1	20
287	90	84	5	1.00	1	0	1	5	15	20	15
288	99	96	9	1.75	0	1	1	20	18	1	15
289	113	105	10	1.75	2	0	1	15	5	15	1
290	113	90	8	2.00	0	1	1	10	15	8	8
291	99	92	7	1.25	0	0	0	1	1	20	20
292	225	194	17	2.25	0	0	1	20	5	8	5
293	126	76	6	2.00	1	1	0	8	15	10	5
294	198	176	10	1.00	2	0	0	3	10	18	20
295	180	133	8	0.30	2	0	0	15	1	3	18
296	99	92	5	0.60	1	0	0	8	18	1	18
297	90	67	7	0.60	0	0	0	15	18	15	15
298	198	158	9	1.25	2	1	1	10	3	3	10
299	153	148	14	1.00	0	1	0	8	10	3	15

Choice Set	Parking Cost A ($/month)	Parking Cost B ($/month)	Parking Cost C ($/day)	Parking Cost D ($/hour)	Parking Fee Refund ($)	Transit Pass A	Transit Pass B	Walking Time A (min)	Walking Time B (min)	Walking Time C (min)	Walking Time D (min)
300	99	88	5	1.25	1	0	1	1	20	15	3
301	198	158	15	0.30	2	0	0	10	3	15	20
302	99	96	5	1.00	0	1	0	5	20	10	1
303	126	112	6	1.25	2	1	0	15	8	5	3
304	153	122	8	1.50	1	1	0	5	5	5	3
305	153	92	10	2.25	1	0	1	10	3	15	1
306	99	79	9	1.00	2	1	0	5	18	5	1
307	113	84	5	1.50	0	1	0	1	1	18	1
308	126	122	9	1.50	0	0	1	1	10	5	8
309	90	59	6	1.75	0	1	0	1	18	8	20
310	113	73	6	1.50	0	0	1	20	10	8	15
311	126	101	9	1.50	0	1	1	20	3	5	5
312	99	59	4	2.25	1	1	1	8	18	10	1
313	113	90	5	1.25	2	1	0	8	10	18	3
314	113	90	5	2.25	2	0	1	10	20	18	3
315	126	101	7	1.00	1	1	0	1	15	15	5
316	90	84	7	1.00	0	1	1	10	8	1	18
317	90	80	5	0.60	2	0	0	5	20	15	15
318	180	108	9	0.60	1	1	1	5	20	18	3
319	113	73	10	0.30	2	0	0	18	15	5	20
320	153	92	8	0.30	1	0	0	15	18	8	20
321	126	101	9	1.00	2	0	1	8	20	20	15
322	153	92	7	1.75	0	1	0	10	8	8	20
323	180	108	8	1.50	0	0	0	5	10	20	5
324	113	97	10	0.60	0	1	1	5	3	10	20
325	180	133	8	1.50	2	0	0	18	1	15	15
326	198	144	8	1.75	1	0	0	5	10	15	18
327	225	218	20	2.25	1	0	1	10	1	5	1
328	180	117	14	0.60	2	1	0	8	5	15	20
329	126	93	9	1.75	0	0	0	8	20	10	10

Choice Set	Parking Cost A ($/month)	Parking Cost B ($/month)	Parking Cost C ($/day)	Parking Cost D ($/hour)	Parking Fee Refund ($)	Transit Pass A	Transit Pass B	Walking Time A (min)	Walking Time B (min)	Walking Time C (min)	Walking Time D (min)
330	113	73	10	1.75	1	0	1	8	1	20	3
331	90	80	6	0.30	2	0	0	10	10	18	20
332	180	144	9	1.50	1	1	0	1	20	8	18
333	90	80	5	0.30	1	1	1	8	8	5	15
334	153	132	7	2.25	1	0	0	18	15	10	15
335	90	84	4	0.60	1	1	0	18	1	8	18
336	99	79	5	1.75	2	0	1	15	8	18	15
337	198	129	11	2.00	2	0	0	15	8	8	15
338	198	192	8	0.30	0	0	1	1	1	20	20
339	198	176	9	0.60	2	1	1	20	3	15	8
340	113	97	6	0.60	2	0	0	1	8	3	18
341	113	97	5	1.00	2	0	0	18	5	20	18
342	126	93	11	1.75	2	0	0	5	3	15	8
343	113	101	6	2.25	1	0	0	18	1	8	18
344	198	170	8	0.60	1	0	0	3	20	8	20
345	126	122	11	1.50	1	1	0	3	10	1	15
346	225	135	10	2.25	1	1	0	1	8	5	3
347	180	160	14	0.30	0	1	1	18	15	8	20
348	113	73	6	1.75	1	0	0	3	5	3	3
349	180	167	8	2.00	0	1	1	20	18	10	8
350	113	101	6	2.00	1	1	0	20	1	1	3
351	180	175	9	0.30	0	1	0	5	3	10	15
352	113	105	6	2.00	2	1	1	3	1	15	1
353	153	136	10	0.30	0	0	1	8	10	1	18
354	198	129	13	1.75	0	1	0	15	15	18	10
355	198	119	10	1.25	2	1	1	3	1	3	3
356	99	96	5	1.25	2	0	0	20	3	20	20
357	153	167	11	1.75	2	0	1	20	3	5	3
358	198	119	15	2.25	2	0	0	1	20	18	15
359	99	96	7	2.00	0	0	0	18	18	15	10

Choice Set	Parking Cost A ($/month)	Parking Cost B ($/month)	Parking Cost C ($/day)	Parking Cost D ($/hour)	Parking Fee Refund ($)	Transit Pass A	Transit Pass B	Walking Time A (min)	Walking Time B (min)	Walking Time C (min)	Walking Time D (min)
360	113	84	10	2.00	2	1	1	18	5	10	15
361	153	113	11	1.50	0	0	1	15	8	3	3
362	198	192	9	2.25	1	1	0	3	1	5	5
363	198	129	9	1.50	2	1	1	5	8	10	8
364	153	136	7	0.60	2	0	0	18	20	18	20
365	198	129	8	1.75	1	1	0	10	3	18	8
366	225	135	15	2.00	2	0	0	3	15	1	20
367	113	110	5	2.00	1	1	0	8	8	5	1
368	153	132	11	0.60	0	1	0	5	15	3	10
369	153	99	14	1.25	2	0	1	5	18	10	8
370	113	97	6	0.60	0	1	1	20	15	1	18
371	99	85	4	1.25	2	0	1	10	18	15	10
372	99	96	4	0.30	1	1	1	1	5	8	18
373	99	88	7	1.50	2	0	1	5	5	1	8
374	153	132	7	1.50	1	0	1	8	18	15	8
375	99	88	4	1.00	0	1	1	10	1	8	3
376	126	117	9	0.60	1	1	1	20	20	18	10
377	198	147	9	1.25	0	1	1	8	1	15	3
378	126	112	6	0.60	0	0	1	10	20	10	20
379	113	73	6	0.60	1	1	1	15	3	5	5
380	198	170	18	0.30	0	1	0	1	3	10	20
381	180	144	9	0.30	1	0	1	10	10	3	18
382	90	72	4	1.50	0	0	1	5	8	18	15
383	180	108	10	2.25	0	1	1	8	5	8	1
384	225	135	15	1.00	0	1	0	8	3	10	15

APPENDIX F
DESCRIPTIVE STATISTICS OF EXPLANATORY VARIABLES

The explanatory variables included in Table AF-1 were gathered through revealed preference and socioeconomic questions in the transportation and parking survey conducted for this study.

Table AF-1. Frequency Distributions of Explanatory Variables in Transportation and Parking Survey

Variable	Count	Percent	Total Responses
Primary Mode of Transportation			**3,767**
Car, Truck, or Van (Drive Alone Only)	1,832	48.63%	
Carpool or Vanpool	251	6.66%	
Motorcycle, Moped, or Scooter	47	1.25%	
Bus (e.g. AC Transit)	271	7.19%	
Train (e.g. BART)	603	16.01%	
Bike	307	8.15%	
Walk Only	293	7.78%	
Other	163	4.33%	
Parking Location			**2,278**
Campus parking garage or lot	1,584	69.53%	
Public off-street parking garages or lot	125	5.49%	
Metered on-street parking space	97	4.26%	
Private off-street parking space	44	1.93%	
Unmetered on-street parking space with time limit enforcement	99	4.35%	
On-street, in residential parking zone with residential parking permit	28	1.23%	
Unmetered on-street parking space without time limit enforcement	118	5.18%	
Other	183	8.03%	
Parking Permit Type			**1,573**
Central Campus Annual "C" Permit	289	18.37%	
Faculty/Staff Annual "F" Permit	869	55.24%	
Central Campus Carpool Permit	47	2.99%	
Faculty/Staff Carpool Permit	110	6.99%	
Hill Annual Permit	24	1.53%	
Night/Weekend Annual Permit	8	0.51%	
Emeritus Permit	40	2.54%	
Hill Area Annual	5	0.32%	

Variable	Count	Percent	Total Responses
Motorcycle Permit	6	0.38%	
Central Campus Daily Scratch Off Permit	14	0.89%	
Faculty/Staff Daily or Scratch Off Permit	108	6.87%	
Other	53	3.37%	
Campus Parking Garage and Lot			**1,400**
4th Street	20	1.43%	
Anna Head Court	5	0.36%	
Anna Head	6	0.43%	
Boalt	73	5.21%	
Botanical Garden	2	0.14%	
Bowles	27	1.93%	
Clark Kerr	11	0.79%	
Dana/Durant	50	3.57%	
Dwinelle	50	3.57%	
East	3	0.21%	
Ellsworth	31	2.21%	
Foothill	18	1.29%	
Frank Schlessinger Way	22	1.57%	
Genetics Structure (Underground)	112	8.00%	
Hill Terrace	5	0.36%	
Kroeber	7	0.50%	
Lawrence Hall of Science	21	1.50%	
Lower Hearst Structure	144	10.29%	
Recreational Sports Facility Structure	96	6.86%	
Ridge	6	0.43%	
Sproul	18	1.29%	
Stadium Rim Way	3	0.21%	
Underhill Structure	272	19.43%	
University Hall West	32	2.29%	
Upper Hearst Structure	138	9.86%	
Wellman Courtyard	13	0.93%	
Witter Field	8	0.57%	
Other	207	14.79%	
Arrival Time to Campus			**3,697**
Before 7:00AM	226	6.11%	
7:00 - 7:59AM	763	20.64%	
8:00 - 8:59AM	1,353	36.60%	
9:00 - 9:59AM	750	20.29%	
10:00 - 10:59AM	245	6.63%	
11:00 - 11:59AM	114	3.08%	
12:00 - 12:59PM	64	1.73%	
1:00 - 1:59PM	72	1.95%	

Variable	Count	Percent	Total Responses
2:00 - 2:59PM	43	1.16%	
3:00 - 3:59PM	26	0.70%	
4:00 - 4:59PM	9	0.24%	
5:00 - 5:59PM	6	0.16%	
6:00 - 6:59PM	8	0.22%	
7:00 - 7:59PM	6	0.16%	
8:00 - 9:00PM	10	0.27%	
After 9:00PM	2	0.05%	
Departure Time from Campus			**3,696**
Before 7:00AM	12	0.32%	
7:00 - 7:59AM	42	1.14%	
8:00 - 8:59AM	31	0.84%	
9:00 - 9:59AM	19	0.51%	
10:00 - 10:59AM	18	0.49%	
11:00 - 11:59AM	33	0.89%	
12:00 - 12:59PM	55	1.49%	
1:00 - 1:59PM	55	1.49%	
2:00 - 2:59PM	95	2.57%	
3:00 - 3:59PM	225	6.09%	
4:00 - 4:59PM	737	19.94%	
5:00 - 5:59PM	1,478	39.99%	
6:00 - 6:59PM	582	15.75%	
7:00 - 7:59PM	173	4.68%	
8:00 - 9:00PM	67	1.81%	
After 9:00PM	74	2.00%	
Off Campus Trips			**3,694**
Yes	864	23.39%	
No	2,830	76.61%	
Summer Schedule			**3,612**
Yes	763	21.12%	
No	2,694	74.58%	
I do not know	155	4.29%	
University Affiliation			**3,253**
Professor / Associate Professor	252	7.75%	
Assistant Professor	41	1.26%	
Adjunct Professor	20	0.61%	
Visiting Faculty / Scholar	17	0.52%	
Lecturer	97	2.98%	
Other Faculty / Academic	232	6.39%	
Management and Senior Professionals / Senior Management Group	251	7.72%	

Variable	Count	Percent	Total Responses
Professional Staff	1,121	32.06%	
Operational / Technical Staff	130	4.00%	
Staff (classified and represented)	872	26.81%	
Contract	34	1.05%	
Postdoctoral Scholar	186	5.72%	
Lawrence Berkeley National Laboratory Affiliation			**3,254**
Yes	93	2.86%	
No	3,161	97.14%	
Second Office			**3,249**
Yes	445	13.70%	
No	2,804	86.30%	
Driver's License			**3,236**
Yes	3,170	97.96%	
No	66	2.04%	
Number of Motor Vehicles Available			**3,230**
0	281	8.70%	
1	1,805	55.88%	
2	932	28.85%	
3	170	5.26%	
More than 3	42	1.30%	
Number of Motorcycles Available			**3,231**
0	2,981	92.26%	
1	204	6.31%	
2	33	1.02%	
3	11	0.34%	
More than 3	2	0.06%	
Number of Bicycles Available			**3,228**
0	1,707	52.88%	
1	961	29.77%	
2	399	12.36%	
3	94	2.91%	
More than 3	67	2.08%	
Number of Household Members			**3,218**
1	698	21.69%	
2	1,296	40.27%	
3 - 4	1,091	33.90%	
5 - 6	117	3.64%	
More than 6	16	0.50%	
Number of Dependents			**3,211**
0	2,048	63.78%	

Variable	Count	Percent	Total Responses
1	600	18.69%	
2	436	13.58%	
3 - 4	115	3.58%	
5 - 6	11	0.34%	
More than 6	1	0.03%	
Gender			**3,201**
Male	1,222	38.18%	
Female	1,979	61.82%	
Age			**3,196**
Under 21	2	0.06%	
21 - 29	425	13.30%	
30 - 39	787	24.62%	
40 - 49	665	20.81%	
50 - 59	793	24.81%	
60 - 69	408	12.77%	
70 and over	116	3.63%	
Education			**3,208**
Less than High School	0	0.00%	
High School / GED	32	1.00%	
Some College	209	6.51%	
2-year College Degree	114	3.55%	
4-year College Degree	1,100	34.29%	
Masters Degree	814	25.37%	
Doctoral Degree	798	24.88%	
Professional Degree (e.g. JD, MD)	141	4.40%	
Annual Household Income			**3,166**
Under $30,000	53	1.67%	
$30,000 - $49,999	341	10.77%	
$50,000 - $89,999	954	30.13%	
$90,000 - $119,999	486	15.35%	
$120,000 - $149,999	337	10.64%	
$150,000 - $179,999	242	7.64%	
$180,000 - $199,999	148	4.67%	
$200,000 - $249,999	180	5.69%	
$250,000 - $299,999	89	2.81%	
$300,000 and over	105	3.32%	
I prefer not to answer	231	7.30%	
Smart Phone Type			**3,209**
Android	766	23.87%	
iPhone	1,788	55.72%	
Palm	9	0.28%	

Variable	Count	Percent	Total Responses
RIM/Blackberry	24	0.75%	
Windows	35	1.09%	
Other, please specify	29	0.90%	
I do not use a smartphone	646	20.13%	

APPENDIX G
RESIDENTIAL LOCATIONS

Residential locations by zip code were used to identify the most popular cities of residence for UC Berkeley employees who responded to the survey conducted for this study. The top four cities accounted for two thirds of the respondents, i.e. Berkeley (31 percent of the survey sample), Oakland (21 percent), San Francisco (8.5 percent), and Richmond (8.2 percent). Another 11 cities represented 83 percent of all respondents' residential locations, as shown in Table AG-1.

Residential locations can also be clustered by corridor. For example, Orinda, Lafayette, Pleasant Hill, Walnut Creek, and Concord are arrayed along the Concord BART line and together account for 8.4 percent of the residences in the sample. Another example, Albany, El Cerrito and Vallejo are arrayed along I-80N (and are served by the Richmond BART line) and together account for 20.6 percent of the respondents' residency.

Table AG-1. Top 15 Cities of Survey Respondents' Residential Locations

City/Zip Code	Number of Respondents	Percentage (%)
Berkeley		
94702	104	
94703	112	
94704	85	
94705	95	
94707	101	
94708	128	
94709	96	
94710	39	
94720	49	
Subtotal	809	31.45
Oakland		
94601	12	
94602	44	
94603	9	
94605	32	
94606	33	
94607	16	
94609	69	
94610	82	
94611	114	
94612	15	
94618	73	

City/Zip Code	Number of Respondents	Percentage (%)
94619	39	
94621	2	
Subtotal	540	21.00
San Francisco		
94102	5	
94103	13	
94105	2	
94107	8	
94108	4	
94109	7	
94110	39	
94111	1	
94112	7	
94113	1	
94114	29	
94115	8	
94116	8	
94117	16	
94118	4	
94121	5	
94122	11	
94123	7	
94124	4	
94127	9	
94130	2	
94131	14	
94132	1	
94133	7	
94134	4	
94158	3	
Subtotal	219	8.51
Richmond		
94801	18	
94803	38	
94804	85	
94805	34	
94806	35	
Subtotal	210	8.16
El Cerrito		
94530	143	

City/Zip Code	Number of Respondents	Percentage (%)
95430	2	
Subtotal	145	5.64
Albany		
94706	143	
Subtotal	143	5.56
Alameda		
94501	71	
94502	22	
Subtotal	93	3.62
Walnut Creek		
94536	6	
94595	8	
94596	16	
94597	28	
94598	23	
Subtotal	81	3.15
Emeryville		
94608	72	
Subtotal	72	2.80
Concord		
94518	16	
94519	10	
94520	11	
94521	28	
Subtotal	65	2.53
San Leandro		
94577	29	
94578	17	
94579	12	
Subtotal	58	2.26
Lafayette		
94549	36	
Subtotal	36	1.40
Orinda		
94563	35	
Subtotal	35	1.36
Pleasant Hill		

City/Zip Code	Number of Respondents	Percentage (%)
94523	34	
Subtotal	34	1.32
Vallejo		
94589	2	
94590	11	
94591	19	
Subtotal	32	1.24
Total in 15 Cities	**2,572**	**100**
Total Sample Size for Zip Codes (n)	**3,109**	
Sample Representation		**82.73**

Note. These 15 cities shown in the table constituted 83 percent of all residential locations reported (n = 3,109).

APPENDIX H
NUMBER OF DAYS ON CAMPUS

The frequencies and descriptive statistics of the number of days on campus are shown in this section. The number of days on campus variable was derived from the transportation mode choice question in the survey, where respondents selected their mode choice for each day of the week, including days when they were working from home or not on campus. Therefore, the number of days on campus variable reflects days when respondents were working from home or not on campus. The statistics for the number of days on campus variable excluding weekends and including weekends are shown in Tables AH-1 and AH-2 respectively. Data that exclude weekends are shown in Figure AH-1, while Figure AH-2 shows the frequency of days not on campus including weekends.

Table AH-1. Statistics of Days on Campus Variable Excluding Weekends

Statistics	
N	3,767
Mean	4.22
Std. Error of Mean	0.02
Std. Deviation	1.43
Variance	2.04
Skewness	-1.92
Std. Error of Skewness	0.04
Kurtosis	2.57
Std. Error of Kurtosis	0.08
Minimum	0
Maximum	5
Percentiles	
25	4
50	5
75	5

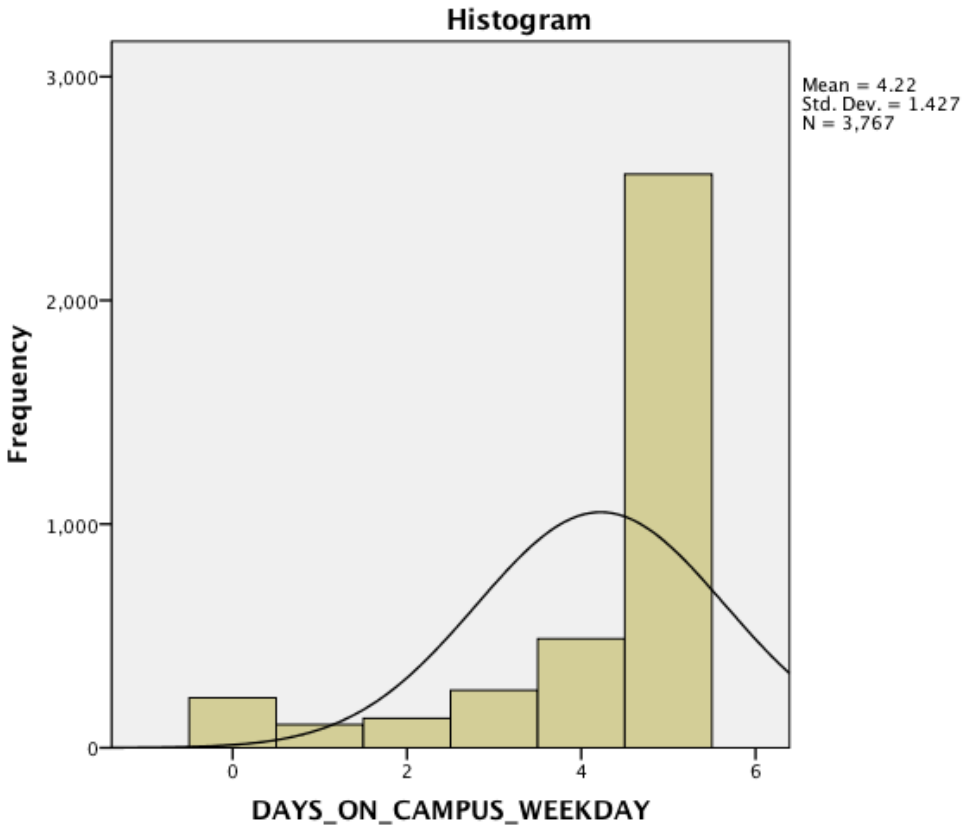

Figure AH-1. Frequency of days on campus data excluding weekends.
Note. Histogram was generated by SPSS.

Table AH-2. Statistics of Days on Campus Variable Including Weekends

Statistics	
N	3,767
Mean	4.45
Std. Error of Mean	0.03
Std. Deviation	1.58
Variance	2.51
Skewness	-1.39
Std. Error of Skewness	0.04
Kurtosis	1.88
Std. Error of Kurtosis	0.08
Minimum	0
Maximum	7
Percentiles	
25	4
50	5
75	5

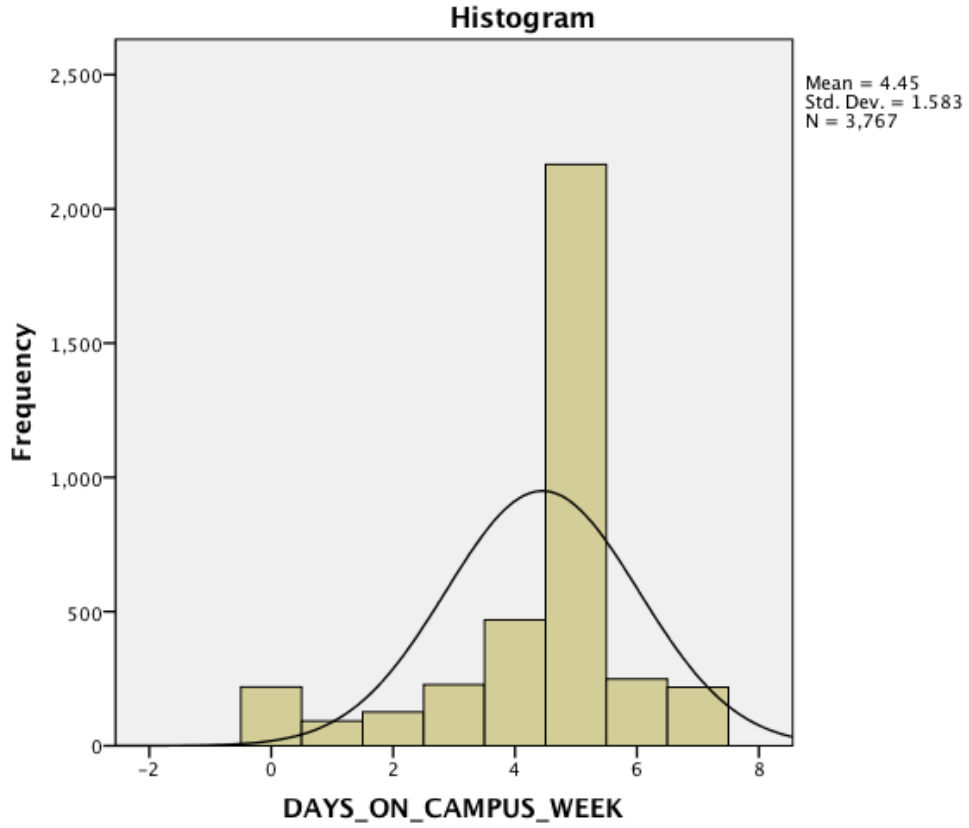

Figure AH-2. Frequency of days on campus data including weekends.
Note. Histogram was generated by SPSS.

Data on the number of days on campus in a five-day workweek were further analyzed by University affiliation and academic discipline and presented in Tables AH-3 and AH-4 respectively. Academic discipline was derived from the survey through the names of the buildings the respondents specified as their primary workplace.

A lower percentage of employees with a professor or associate professor title (58 percent) are on campus for five days a week than assistant professors (63 percent) but in general, a higher percentage of all staff members are on campus more often than faculty members. Professors, including associate and assistant professors, are more likely to be on campus for three days a week (15 percent) compared to staff members (4 – 7 percent) (Table AH-3). However, the percentage of faculty who are on campus for four days a week is similar to the percentage of staff members.

Table AH-4 shows the number of days on campus by academic discipline for faculty only. A significantly higher percentage of faculty members (81 percent) in life sciences are on campus for five days a week compared to all other faculty members. Only 40 percent of faculty members in humanities and social sciences are on campus every day of the workweek, while 22 percent of them are on campus three days a workweek. On the other hand, five percent of faculty from life sciences and six percent from physical sciences are on campus three days a workweek. As a result, 44 percent of the faculty members are not on campus every day, which is consistent with the findings from the one-on-one interviews.

Table AH-3. Number of Days on Campus Per Workweek by University Affiliation (n = 3,502)

	UC Berkeley Affiliation											
Number of Days on Campus (Per Workweek)	**Professor / Associate Professor**	**Assistant Professor**	**Adjunct Professor**	**Other Faculty / Academic[a]**	**MSP / SMG [b]**	**Professional Staff**	**Operational / Technical Staff**	**Staff (classified and represented)**	**Contract**	**Postdoctoral Scholar**	**Other[c]**	Total
0	12	1	1	9	4	13	6	32	1	0	23	102
	4%	3%	5%	3%	1%	1%	5%	3%	3%	0%	18%	3%
1	10	2	0	37	2	12	0	25	5	7	3	103
	4%	5%	0%	10%	1%	1%	0%	3%	13%	3%	2%	3%
2	12	0	6	44	0	11	2	19	0	8	10	112
	4%	0%	30%	12%	0%	1%	2%	2%	0%	4%	8%	3%
3	40	6	5	53	19	54	5	53	2	11	7	255
	15%	15%	25%	15%	7%	5%	4%	6%	5%	5%	6%	7%
4	41	6	3	66	36	154	22	112	6	18	13	477
	15%	15%	15%	18%	13%	14%	18%	12%	15%	8%	10%	14%
5	159	25	5	149	216	832	91	704	25	176	71	2453
	58%	63%	25%	42%	78%	77%	72%	75%	64%	80%	56%	70%
Total	274	40	20	358	277	1076	126	945	39	220	127	3502
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note. [a]The category "Other Faculty / Academic" includes visiting faculty, scholars, lecturers, emeriti professors, and UC Berkeley extension.
[b]MSP is Management and Senior Professionals and SMG is Senior Management Group.
[c]The "Other" University affiliation category includes survey respondents who hold dual or multiple positions, recalled retirees and respondents who are unsure of their job category. This is a relatively small percentage of respondents, constituting three percent of the total number of respondents.
Summary Statistics.
X^2 = (60, n = 3,502) = 672.99, p = 0.00
Eta Number of Days on Campus = 0.31
Eta University Affiliation = 0.17

Table AH-4. Number of Days on Campus Per Workweek by Academic Discipline (Faculty Only) (n = 894)

	Academic Discipline					
Number of Days on Campus (Per Workweek)	**Life Sciences**	**Computer Science, Math, Engineering**	**Physical Sciences**	**Humanities & Social Sciences**	**Professional Fields**	**Total**
0	1	12	1	4	4	22
	0%	9%	1%	1%	3%	3%
1	3	8	2	18	24	55
	1%	6%	2%	6%	20%	6%
2	5	8	5	40	12	70
	2%	6%	6%	13%	10%	8%
3	12	21	5	67	9	114
	5%	15%	6%	22%	7%	13%
4	24	17	10	58	22	131
	10%	12%	12%	19%	18%	15%
5	191	74	63	122	52	502
	81%	53%	73%	40%	42%	56%
Total	236	140	86	309	123	894
	100%	100%	100%	100%	100%	100%

Summary Statistics.
X^2 = (20, n = 894) = 192.54, p = 0.00
Eta Number of Days on Campus = 0.34
Eta Academic Discipline = 0.32

APPENDIX I
MODEL ESTIMATION RESULTS WITH TRAVEL COST AND INCOME INTERACTION VARIABLES

The MNL model estimation results in this section consist of mode choice models (Table AI-1) and a parking choice model (Table AI-2). Both models are identical to Tables 5.2 and 5.7 in Chapter 5. The only difference is the inclusion of three travel cost and income interaction variables that were used to derive the value of time and elasticity estimates by income using the parameters shown in Tables AI-1 and AI-2.

Table AI-1. Multinomial Logit Model (MNL): Joint Estimation of SP and RP Transportation Mode Choices with Travel Cost and Income Interaction Variables

	RP			SP			RP + SP		
Explanatory Variables	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**
Drive alone park on campus constant (RP)	-1.540	-9.55	0.00				-1.210	-9.15	0.00
Drive alone park off campus constant (RP)	-2.110	-9.87	0.00				-1.620	-9.69	0.00
Carpool constant (RP)	-2.820	-15.23	0.00				-2.240	-15.34	0.00
Motorcycle constant (RP)	-4.290	-13.45	0.00				-4.210	-18.19	0.00
Transit constant (RP)	0.094	0.67	0.50				0.396	3.62	0.00
Bicycle constant (RP)	-1.420	-8.74	0.00				-0.695	-5.61	0.00
Walk only constant (RP)	-	-	-				-	-	-
Work at home constant (RP)	-4.620	-17.95	0.00				-4.360	-21.36	0.00
Not on campus constant (RP)	-4.080	-19.19	0.00				-3.370	-18.80	0.00
Drive alone park on campus constant (SP)				0.603	7.59	0.00	0.914	6.19	0.00
Drive alone park off campus constant (SP)				-1.240	-11.03	0.00	-3.510	-17.68	0.00
Carpool constant (SP)				-0.543	-6.46	0.00	-1.970	-13.03	0.00
Motorcycle constant (SP)				-2.140	-18.07	0.00	-5.170	-19.86	0.00

	RP			SP			RP + SP		
Explanatory Variables	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**
Transit constant (SP)				0.797	11.87	0.00	1.430	11.83	0.00
Bicycle constant (SP)				0.363	5.21	0.00	-0.123	-1.01	0.31
Walk only constant (SP)				-	-	-	-	-	-
Work at home constant (SP)				-2.060	-18.46	0.00	-5.010	-21.72	0.00
Not on campus constant (SP)				-1.640	-16.55	0.00	-4.670	-22.33	0.00
Age - Drive alone park on campus	0.196	6.93	0.00	0.085	6.14	0.00	0.201	9.44	0.00
Age - Drive alone park off campus	0.284	8.31	0.00	-0.020	-0.97	0.33	0.170	6.10	0.00
Age - Carpool	0.055	1.48	0.14	-0.035	-2.09	0.04	0.002	0.09	0.93
Age - Motorcycle	0.119	2.00	0.05	0.029	1.40	0.16	0.116	3.09	0.00
Age - Transit	0.078	2.73	0.01	-0.039	-2.79	0.01	0.008	0.39	0.70
Age - Bicycle	-0.111	-3.35	0.00	-0.241	-15.96	0.00	-0.305	-12.42	0.00
Age - Work at home	0.091	1.82	0.07	0.019	0.88	0.38	0.079	2.23	0.03
Age - Not on campus	0.250	6.33	0.00	-0.021	-1.13	0.26	0.135	4.50	0.00
Dependents - Drive alone park on campus	0.517	8.51	0.00	0.143	5.46	0.00	0.418	10.07	0.00
Dependents - Drive alone park off campus	0.589	9.00	0.00	0.277	8.69	0.00	0.561	12.35	0.00
Dependents - Carpool	0.483	6.77	0.00	0.021	0.71	0.48	0.273	5.55	0.00
Dependents - Motorcycle	0.353	3.56	0.00	0.038	0.96	0.34	0.212	3.18	0.00
Dependents - Transit	0.308	4.93	0.00	0.080	3.03	0.00	0.237	5.68	0.00
Dependents - Bicycle	0.436	6.42	0.00	0.005	0.18	0.86	0.233	5.01	0.00
Dependents - Work at home	0.332	3.91	0.00	0.131	3.76	0.00	0.310	5.50	0.00
Dependents - Not on campus	0.290	4.05	0.00	0.113	3.64	0.00	0.252	5.18	0.00
Faculty dummy - Drive alone park on campus	-0.118	-1.20	0.23	0.071	1.48	0.14	-0.009	-0.12	0.90
Faculty dummy - Drive alone park off campus	-0.333	-2.80	0.01	-0.137	-1.83	0.07	-0.306	-3.16	0.00

	RP			SP			RP + SP		
Explanatory Variables	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**
Faculty dummy - Carpool	-0.822	-5.40	0.00	0.034	0.56	0.57	-0.387	-3.93	0.00
Faculty dummy - Motorcycle	0.181	0.76	0.45	-0.309	-3.39	0.00	-0.343	-2.03	0.04
Faculty dummy - Transit	-0.772	-7.32	0.00	-0.246	-4.84	0.00	-0.683	-8.61	0.00
Faculty dummy - Bicycle	0.454	3.96	0.00	0.489	9.32	0.00	0.752	8.93	0.00
Faculty dummy - Work at home	1.200	7.66	0.00	0.640	9.36	0.00	1.300	11.59	0.00
Faculty dummy - Not on campus	0.815	6.70	0.00	0.229	3.67	0.00	0.731	7.72	0.00
Gender - Drive alone park on campus	-0.632	-8.13	0.00	-0.071	-1.84	0.07	-0.426	-7.09	0.00
Gender - Drive alone park off campus	-0.628	-6.84	0.00	-0.096	-1.72	0.09	-0.470	-6.36	0.00
Gender - Carpool	-0.479	-4.70	0.00	-0.200	-4.34	0.00	-0.470	-6.32	0.00
Gender - Motorcycle	0.945	5.19	0.00	0.531	8.21	0.00	1.060	9.11	0.00
Gender - Transit	-0.142	-1.85	0.06	-0.037	-0.97	0.33	-0.113	-1.93	0.05
Gender - Bicycle	0.517	5.55	0.00	0.498	12.15	0.00	0.793	11.84	0.00
Gender - Work at home	-0.606	-4.44	0.00	-0.305	-4.90	0.00	-0.662	-6.60	0.00
Gender - Not on campus	-0.511	-4.97	0.00	-0.205	-3.93	0.00	-0.470	-6.00	0.00
Income ($) - Drive alone park on campus	0.131	5.51	0.00	0.001	0.07	0.94	0.079	4.40	0.00
Income ($) - Drive alone park off campus	-0.029	-0.92	0.36	0.001	0.05	0.96	-0.020	-0.87	0.38
Income ($) - Carpool	0.142	5.58	0.00	0.049	3.97	0.00	0.129	6.79	0.00
Income ($) - Motorcycle	-0.085	-1.97	0.05	0.007	0.42	0.67	-0.026	-0.93	0.35
Income ($) - Transit	-0.015	-0.66	0.51	0.007	0.65	0.51	-0.001	-0.04	0.97
Income ($) - Bicycle	0.047	1.94	0.05	0.041	3.65	0.00	0.069	3.94	0.00
Income ($) - Work at home	0.147	4.41	0.00	0.040	2.74	0.01	0.118	5.01	0.00
Income ($) - Not on campus	0.147	5.55	0.00	0.050	3.75	0.00	0.129	6.42	0.00
Travel Cost * Low Income	-0.080	-8.38	0.00	-0.042	-11.99	0.00	-0.085	-12.82	0.00
Travel Cost * Medium Income	-0.064	-6.64	0.00	-0.036	-9.84	0.00	-0.072	-10.72	0.00
Travel Cost * High Income	-0.066	-6.65	0.00	-0.033	-9.84	0.00	-0.073	-11.38	0.00
Travel time (min)	-0.019	-27.07	0.00	-0.007	-24.44	0.00	-0.018	-29.31	0.00
Inertia dummy				2.780	226.91	0.00	6.340	26.92	0.00
Scale (μ)							0.436	27.60	0.00

	RP			SP			RP + SP		
Explanatory Variables	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**	**Parameter Estimates**	**T-test**	**P-value**
Summary Statistics									
Number of observations	12,496			74,059			86,555		
Log-Likelihood (0)	-28,797			-162,724			-190,181		
Log-Likelihood (Model)	-21,669			-83,455			-105,357		
Likelihood ratio test	14,256			158,538			169,647		
Rho square	0.06			0.24			0.20		

Table AI-2. Parking Choice Model Results with Travel Cost and Income Interaction Variables

Explanatory Variables	Parameter Estimates	T-test	P-value
Alternative specific constants			
Parking Option A – Unlimited monthly parking permit	-4.810	-13.47	0.00
Parking Option B – Restricted monthly parking permit	-0.945	-3.11	0.00
Parking Option C – Daily parking permit	-0.461	-1.57	0.12
Parking Option D – Hourly parking option	-	-	-
Parking Option E – None of the given parking options	-1.760	-6.34	0.00
Attributes in choice set			
Cost of Parking Option * Low income	-0.206	-31.05	0.00
Cost of Parking Option * Medium income	-0.179	-25.94	0.00
Cost of Parking Option * High income	-0.173	-25.85	0.00
Parking fee refund in Parking Option A ($)	0.091	3.33	0.00
Free transit pass in Parking Option A (yes = 1, no = 0)	0.278	6.29	0.00
Free transit pass in Parking Option B (yes = 1, no = 0)	0.471	9.53	0.00
Walking time (min)	-0.046	-21.78	0.00
BART pass dummy in Parking Options A and B (yes = 1, no = 0)	0.137	3.64	0.00
Scheduling characteristics of respondents			
Arrival time - Unlimited monthly parking permit	0.308	2.29	0.02
Arrival time - Restricted monthly parking permit	0.270	2.09	0.04
Arrival time - Daily parking permit	0.122	0.85	0.39
Arrival time - None of the given parking options	0.209	1.69	0.09
Departure time - Unlimited monthly parking permit	-0.376	-2.78	0.01
Departure time - Restricted monthly parking permit	-0.337	-2.60	0.01
Departure time - Daily parking permit	-0.103	-0.72	0.47
Departure time - None of the given parking options	-0.246	-1.98	0.05
Hours on campus (hours / day) - Unlimited monthly parking permit	0.500	3.55	0.00
Hours on campus (hours / day) - Restricted monthly parking permit	0.425	3.15	0.00

Explanatory Variables	Parameter Estimates	T-test	P-value
Hours on campus (hours / day) - Daily parking permit	0.197	1.32	0.19
Hours on campus (hours / day) - None of the given parking options	0.322	2.50	0.01
Days on campus (days / 5-day workweek) - Unlimited monthly parking permit	0.790	14.92	0.00
Days on campus (days / 5-day workweek) - Restricted monthly parking permit	0.161	4.46	0.00
Days on campus (days / 5-day workweek) - Daily parking permit	0.010	0.28	0.78
Days on campus (days / 5-day workweek) - None of the given parking options	0.225	6.47	0.00
Off-campus trips (yes = 1, no = 0) - Unlimited monthly parking permit	-0.266	-2.68	0.01
Off-campus trips (yes = 1, no = 0) - Restricted monthly parking permit	-0.029	-0.28	0.78
Off-campus trips (yes = 1, no = 0) - Daily parking permit	0.015	0.15	0.88
Off-campus trips (yes = 1, no = 0) - None of the given parking options	0.194	2.14	0.03
Availability of second office (yes = 1, no = 0) - Unlimited monthly parking permit	-0.272	-2.59	0.01
Availability of second office (yes = 1, no = 0) - Restricted monthly parking permit	-0.244	-2.24	0.03
Availability of second office (yes = 1, no = 0) - Daily parking permit	-0.331	-3.03	0.00
Availability of second office (yes = 1, no = 0) - None of the given parking options	-0.488	-5.05	0.00
Changes in summer schedule (yes = 1, no = 0) - Unlimited monthly parking permit	-0.246	-2.37	0.02
Changes in summer schedule (yes = 1, no = 0) - Restricted monthly parking permit	-0.182	-1.70	0.09
Changes in summer schedule (yes = 1, no = 0) - Daily parking permit	-0.376	-3.55	0.00
Changes in summer schedule (yes = 1, no = 0) - None of the given parking options	-0.555	-5.79	0.00
Socioeconomic characteristics of respondents			
Age - Unlimited monthly parking permit	0.074	2.38	0.02
Age - Restricted monthly parking permit	-0.042	-1.32	0.19
Age - Daily parking permit	-0.012	-0.37	0.71
Age - None of the given parking options	0.019	0.66	0.51
Faculty dummy (faculty = 1, staff = 0) - Unlimited monthly parking permit	-0.324	-2.80	0.01
Faculty dummy (faculty = 1, staff = 0) - Restricted monthly parking permit	-0.400	-3.27	0.00
Faculty dummy (faculty = 1, staff = 0) - Daily parking permit	-0.095	-0.82	0.41
Faculty dummy (faculty = 1, staff = 0) - None of the given parking options	-0.086	-0.81	0.42

Explanatory Variables	Parameter Estimates	T-test	P-value
Total annual household income ($) - Unlimited monthly parking permit	0.146	6.95	0.00
Total annual household income ($) - Restricted monthly parking permit	0.061	2.78	0.01
Total annual household income ($) - Daily parking permit	0.078	3.55	0.00
Total annual household income ($) - None of the given parking options	0.000	0.00	1.00
Summary Statistics			
Number of observations	13,376		
Log-Likelihood (O)	-20,341		
Log-Likelihood (Model)	-17,709		
Likelihood ratio test	5,263		
Rho square	0.02		

APPENDIX J
SUMMARY STATISTICS OF INTERVIEW PARTICIPANTS

The description of the 86 interviews participants is shown in Table AJ-1. To capture the anticipated range of flexibility in work scheduling, the interview participants were sampled based on job title and field of work. Since Berkeley has over 60 academic departments, UC Berkeley's definition of academic fields were used to sample faculty members. These different fields are, 1) Arts and Humanities; 2) Biological Sciences; 3) Mathematical and Physical Sciences; 4) Social Sciences; 5) Engineering, and 6) Professional Schools. Staff members were selected from all three official job categories, as defined by UC Berkeley's Human Resources, which include, 1) operational and technical; 2) professional, and 3) supervisors and managers.

Table AJ-1. Summary Statistics of Interview Participants

Participants	Number	Percentage (%)
Gender		
Male	48	56
Female	38	44
University Affiliation		
Faculty		
Professor	16	37
Associate Professor	6	14
Assistant Professor	21	49
Staff		
Supervisors and Managers	11	26
Professional	29	67
Operational and Technical	3	7
Academic Discipline (Faculty Only)		
Arts and Humanities	9	21
Biological Sciences	3	7
Engineering	7	16
Mathematical and Physical Sciences	5	12
Social Sciences	13	30
Professional Schools	6	14
Total	**86**	**100**

Out of the total number of interviews, 43 were conducted with faculty, while the other half of the interviews were conducted with staff members. Faculty members include assistant professors, associate professors and professors. Since there are approximately 10 staff members to every

faculty member, the faculty members were disproportionately represented here. However, it is important to include at least 40 faculty members in the sample since they are disproportionate users of central campus parking and are highly influential stakeholders.

The transportation and parking choices in Table AJ-2 reflect the participants' usual behavior on a typical day.

Table AJ-2. Transportation Mode and Parking Location Choices of Interview Participants

	Faculty	Staff	All Employees	Percentage (%)
Transportation Mode Choice				
Drive Alone	17	17	34	40
Carpool	0	1	1	1
Motorcycle	1	0	1	1
Bus (AC Transit)	1	4	5	6
Train (BART)	5	9	14	16
Bicycle	8	4	12	14
Walk Only	10	6	16	19
Dropped Off	1	0	1	1
Telecommuting (Full Time)	0	2	2	2
Total	43	43	86	100
Parking Location Choice				
On Campus	12	13	25	74
Off Campus	5	4	9	26
Total	17	17	34	100

Different employees explain that they drive to campus for different reasons but some of the more commonly listed factors include driving's shorter travel time than using public transportation or other modes, its greater convenience, comfort, and relaxing atmosphere, and for some, the need to drive young children to school before arriving on campus or to pick them up in the afternoon. Every interview participant with young children reported that they drive their children to school in the mornings and expressed the desire to be available for them when necessary, to be on call, as a reason to drive.

According to the interview results, work schedule, including arrival and departure times, as well as the number of hours on campus influence where a faculty or staff member chooses to park. However, consistent with the Gillen (1978) study, work schedule does not seem to influence mode choice as much. Some of the interviewees make use of public and private garages that offer daily parking at rates ranging from $9 (early bird rate) to $16 a day, paying for parking only on the days they need it. Others make use of metered spaces, with some staying for short periods only, others moving their cars from space to space, or feeding the meter for time beyond the limited period (a behavior that the city apparently does not enforce against very effectively, since meter feeders report that they rarely get tickets for dong this). The rest reported that they use non-resident parking in unmetered Resident Preferential Parking (RPP) zones. While the

RPP zones are legally restricted to those with a resident permit or others who are parking for two hours or less, respondents noted that enforcement is imperfect and those who are willing to feed the meter or move their cars after two hours generally can avoid a ticket.

At the time of the study, meter rates were $1.25 per hour and most metered spaces allowed either one hour or two hours of parking. Rates at some meters have since been raised and time limits in a few locations have been lengthened, but the minimum charge for parking at a meter for nine hours would be $11.25, which is less than the cost of an unrestricted daily permit on campus. In addition, RPP zones still limit non-resident parking to two hours but impose no charge (Moylan et al., 2014).

Depending on where an employee's primary workplace is located on campus, RPP zones may not be further away from where they work than an on-campus parking lot or garage. In other words, in some cases, the walking distance is similar. This is also true for public and private garages and parking lots, since they are mostly located very close to campus. About a quarter of the employees interviewed chose to park off campus, out of which approximately half of them park in RPP neighborhoods, regardless of University affiliation. Faculty members for the most part are using these spaces for short durations, on days when they do not have to be on campus for more than two hours. Except for scheduled classes and meetings, most of the work related activities for faculty members could be scheduled at the faulty member's discretion. Therefore, faculty's work schedules are considerably more flexible than staff members, and even if they choose to be on campus every day, they are not expected to nor do they necessarily stay on campus all day. Staff members, in contrast, reported for the most part that they were expected to be on campus for six to nine hours a day and those who park in RPP zones would need to move their vehicles to avoid parking tickets. In other words, both faculty and staff members choose to park in RPP zones, but faculty members do so because it is more convenient for them, whereas staff do so to avoid paying for parking and have to move their vehicles for up to three or four times a day.

APPENDIX K
SUMMARY STATISTICS OF FOCUS GROUP PARTICIPANTS

The description of the 113 focus group participants is shown in Table AK-1. These data were collected through a transportation and parking survey that each participant was asked to complete.

Table AK-1. Summary Statistics of Focus Group Participants

Characteristic	Number	Percentage (%)
Transportation Mode (Day of Focus Group)		
Drive Alone	43	38
Carpool / Vanpool	7	6
Motorcycle	1	1
Bus	11	10
Train	24	21
Bike	16	14
Walk Only	11	10
University Affiliation		
Faculty	8	7
Staff	105	93
Gender		
Male	41	36
Female	72	64
Age		
22 - 29	8	7
30 - 39	22	19
40 - 49	31	27
50 - 59	37	33
60 - 69	15	13
Annual Household Income[1]		
Less than $50,000	8	7
$50,000 to $149,999	83	77
$150,000 to $199,999	13	12
$200,000 or more	4	4
Number of Household Members		
1	35	31
2	40	35
3	33	29

Characteristic	Number	Percentage (%)
4 or more	5	4
Number of Dependents		
0	83	73
1	17	15
2	10	9
3 or more	3	3
Total	113	100

Note. [1]There were five participants who did not wish to provide their income in the transportation and parking questionnaire distributed at the beginning of the focus group discussion sessions. Hence, the total number of participants in this category is 108, instead of 113, which is the total number of participants.

The majority of the focus group participants drove alone to campus on the day of the discussion session (38 percent). Their transportation mode choices mirror those of the interview participants'. Non-motorized transportation modes, i.e. bicycling and walking remain the second most popular choice, while train is more popular than bus as a primary commute mode choice. Most of the focus group participants were female employees (64 percent), between 50 and 59 years old (33 percent), had an annual household income of between $50,000 and $149,999 (77 percent), lived in relatively small households with one or two household members (66 percent) and 73 percent of them had no dependents. Hence, the majority of the participants do not have transportation choices that are constrained by someone else's schedules.