San Francisco Urban Partnership Agreement: National Evaluation Report

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16. Abstract

This document presents the final report on the national evaluation of the San Francisco Urban Partnership Agreement (UPA) under the United States Department of Transportation (U.S. DOT) UPA Program. The UPA program targeted congestion reduction through a combination of Tolling, Transit, Telecommuting/Travel Demand Management (TDM), and Technology, also known as the 4Ts. The national evaluation focused on the San Francisco UPA projects that dealt with parking pricing in San Francisco and real-time parking information. The SF*park* parking pricing pilot implemented variable pricing in on-street and city-owned off-street parking in selected parking districts. A second project implemented methods to disseminate real-time information on parking availability and pricing to travelers by phone, websites, and Smartphone applications. The national evaluation of the San Francisco UPA projects was guided by the National Evaluation Framework, the San Francisco UPA National Evaluation Plan, and individual test plans for various types of data. This report provides information on the use and impact of the new San Francisco UPA projects. The effect of parking price on regulating the demand was examined, as was the impact of parking pricing on traffic congestion, mode usage, environmental conditions, business and goods movement. Non-technical factors contributing to the projects' success were assessed, and the benefits relative to costs were measured.

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4Ts	Tolling, Transit, Telecommuting, and Technology
ANOVA	Analysis of Variance
APC	Automatic Passenger Counter
ARB	Air Resources Board
BCA	Benefit-Cost Analysis
CBA	Cost Benefit Analysis
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CPI	Consumer Price Index
CRD	Congestion Reduction Demonstration
CVO	Commercial Vehicle Operator
DMS	Dynamic Message Sign
DMV	Department of Motor Vehicles
DOE	Department of Environment
DPT	Division of Parking and Traffic
DTAS	Division of Taxis and Accessible Services
EMFAC	EMission FACtor
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
ISP	Information Service Provider
ITS	Intelligent Transportation Systems
JPO	Joint Program Office
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transportation Commission
Muni	San Francisco Municipal Railway
NEF	National Evaluation Framework
NO_x	Nitrogen Oxide (precursor to ozone)

$PM_{2.5}$	Particulate Matter Less Than 2.5 Microns
PCO	Parking Control Officer
ROG	Reactive Organic Gases (precursor to ozone)
SFCTA	San Francisco County Transportation Authority
SFE	San Francisco Environment
SFMTA	San Francisco Metropolitan Transportation Agency
SIRA	Sensor Independent Rate Adjustment
TDM	Travel Demand Management
TG	Technology Group
UPA	Urban Partnership Agreement
U.S. DOT	U.S. Department of Transportation
VMT	Vehicle Miles Traveled
VOT	Values of Time
VPH	Vehicles Per Hour

Acknowledgements

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Executive Summary

This report presents the national evaluation of the San Francisco Urban Partnership Agreement (UPA) projects under the U.S. Department of Transportation (U.S. DOT) UPA program. The evaluation is based on information covering approximately one-year before the parking pricing pilot known as SF*park* was launched in April 2011 and data collected for 21 months of post-deployment operation ending in May 2013. The post-deployment evaluation period, beginning in September 2011 and originally scheduled to last 12 months, was extended to 21 months to enable a sufficient number of pricing adjustments to be made to reach a level of equilibrium for assessing the overall impact of variable pricing.

Background

In 2006, the U.S. DOT, in partnership with metropolitan areas, initiated the UPA program to demonstrate congestion reduction through the implementation of pricing activities (e.g., tolling) combined with necessary supporting elements. Six sites around the U.S., including San Francisco as well as Miami, Los Angeles, Atlanta, Minneapolis, and Seattle, were selected through a competitive process to conduct either UPA or Congestion Reduction Demonstration (CRD) program improvements. The selected sites were awarded funding to implement congestion reduction strategies based on four complementary strategies known as the 4Ts: Tolling, Transit, Telecommuting, (which includes additional travel demand management [TDM] strategies), and Technology.

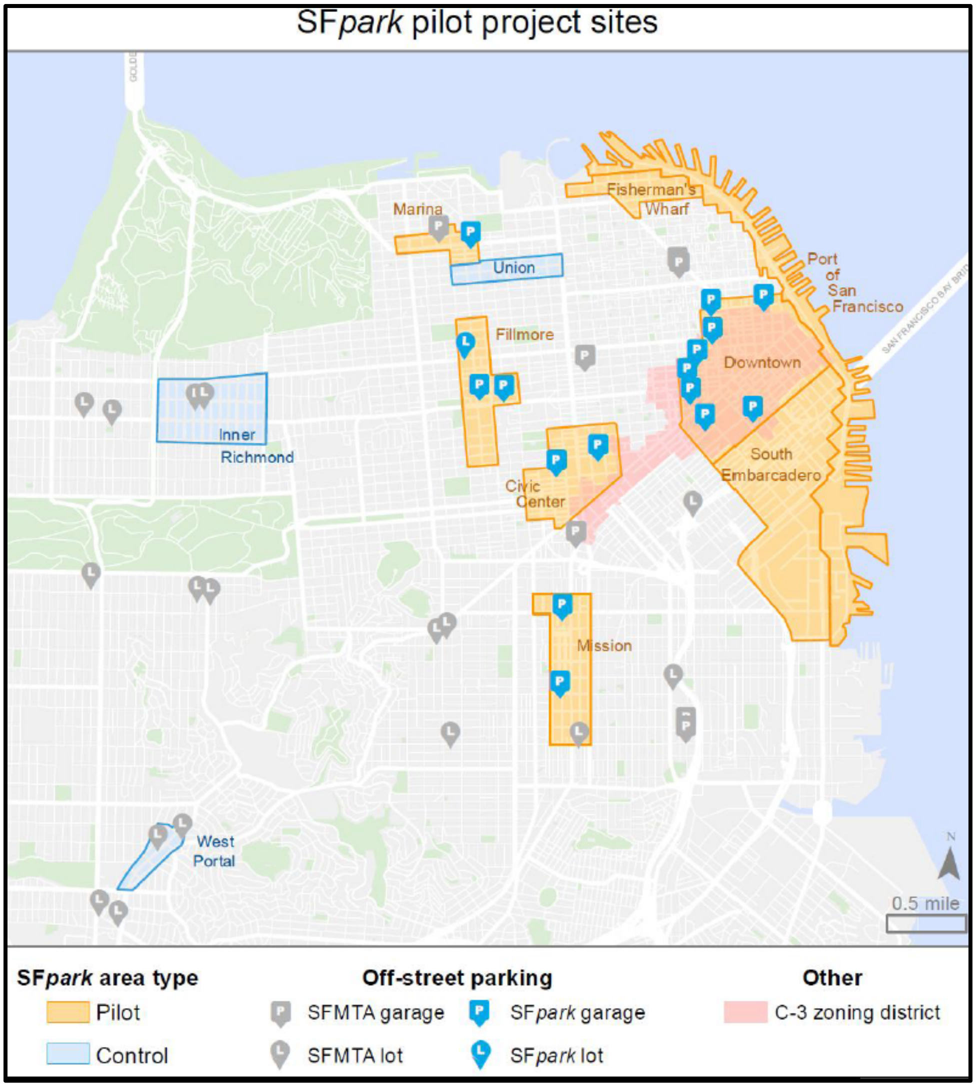
The U.S. DOT sponsored the UPA and CRD national evaluation, with the overall conduct of the national evaluation being the responsibility of the Intelligent Transportation Systems Joint Program Office (ITS JPO), part of the Office of the Assistant Secretary for Research and Technology. Representatives from the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) were actively involved in the national evaluation. The Battelle team was selected by the U.S. DOT to conduct the national evaluation through a competitive procurement process.

The purpose of the national evaluation was to assess the impacts of the UPA/CRD projects in a comprehensive and systematic manner across all sites. The national evaluation generated information and produced technology transfer materials to support deployment of the strategies in other metropolitan areas. The national evaluation also generated findings for use in future federal policy and program development related to mobility, congestion, and facility pricing. The Battelle team developed a National Evaluation Framework (NEF) to provide a foundation for evaluation of the UPA/CRD sites. The NEF was based on the 4T congestion reduction strategies and the questions that the U.S. DOT sought to answer through the evaluation. The NEF was used to develop the San Francisco UPA National Evaluation Strategy, the San Francisco UPA National Evaluation Plan, and ten Test Plans. These plans guided the San Francisco UPA National Evaluation.

The San Francisco UPA

The San Francisco UPA partners consisted of three public agencies. Two of the partners represented the City of San Francisco--the San Francisco County Transportation Authority (SFCTA) and the San Francisco Municipal Transportation Agency (SFMTA). The third partner was the Metropolitan Transportation Commission (MTC), the metropolitan planning organization for the Bay Area.

The San Francisco UPA projects focused on reducing traffic congestion related to parking in San Francisco. Drivers circling to look for parking and drivers who double-park were widely believed to contribute to traffic congestion on local streets in San Francisco, resulting in traffic delays and difficulties accessing desired destinations. To address these challenges, SFMTA, the agency responsible for managing the city's public parking facilities, both on- and off-street, implemented SF*park,* the innovative demand-based parking pricing system. Intelligent transportation systems (ITS) are the foundation of SF*park*, including technologies such as networked parking sensors, smart parking meters, and real-time parking information. Figure ES-1 shows the seven pilot areas where demand-based pricing was implemented and three areas designated as controls for assessing the impact of the pricing changes.



Source: SFMTA, 2013.

Figure ES-1. SF*park* Parking Areas

The projects included in the national evaluation were the SF*park* pricing project and technologies to disseminate real-time parking information, including MTC's upgrades to its regional 511 traveler information system on its website and telephone service and the SF*park* website and Smartphone applications. Another project conducted by SFCTA and sister agency San Francisco Environment (SFE) that used an existing alternate commute program to increase awareness among employers and commuters about SF*park* and the parking enhancements on 511 was discontinued and, thus, not included in the evaluation report.

The implementation of the San Francisco UPA projects did not occur in a vacuum, and factors other than the projects themselves could have influenced their impact. For example, the projects were deployed against a backdrop of economic change following the nationwide recession. After a spike in the unemployment rate in early 2010, the unemployment rate for San Francisco County generally decreased from a high of 9.6 percent in November 2010 to a low of 5.3 percent at the end of the post-deployment period in May 2013. An improving economy could have resulted in more travel demand which could have attenuated the UPA projects' effectiveness and be reflected in the evaluation findings. In addition, the price of gasoline fluctuated throughout the pre-deployment and post-deployment periods from a low of $3.03 per gallon in September 2010 to a high of $4.68 per gallon in October 2012. These changes in gasoline prices may have influenced travel behavior, such as number of trips and mode usage, and affected the evaluation findings.

The evaluation of San Francisco UPA projects was further complicated by the nature of the projects themselves as well as other non-UPA activities occurring in the area at the same time as the evaluation. In particular, features of SF*park* and the 511 enhancements were not all implemented at the same time, thereby affecting the definition of the pre- and post-deployment evaluation periods and consideration of the potential impact of various features on the observed outcomes. Moreover, a major construction project in the Mission area noticeably impacted some evaluation results, although other local events, such as weather events, street fairs, parades and sporting events, did not appear to have an on-going effect.

Another consideration for the evaluation was the quantity and quality of the data used in the evaluation. For example, parking and roadway sensor technologies presented unexpected difficulties, such as magnetic interference and battery life, which limited some of the data used in the evaluation. SF*park* was built on state-of-the-art technologies that offered extraordinary improvements over previous technologies but also enormous challenges for collection and management of the vast amounts of data they generated. For example, the parking sensors had to be highly accurate to be used as a basis for price setting. In other cases, the challenge was how best to collect data that would capture the traveler's experience with SF*park*, such as the search for parking. Because both SF*park* and its evaluation were breaking new ground, the lessons learned from the data collection and analysis from this type of project will undoubtedly benefit those implementing similar parking systems in the future.

Major Findings of the National Evaluation

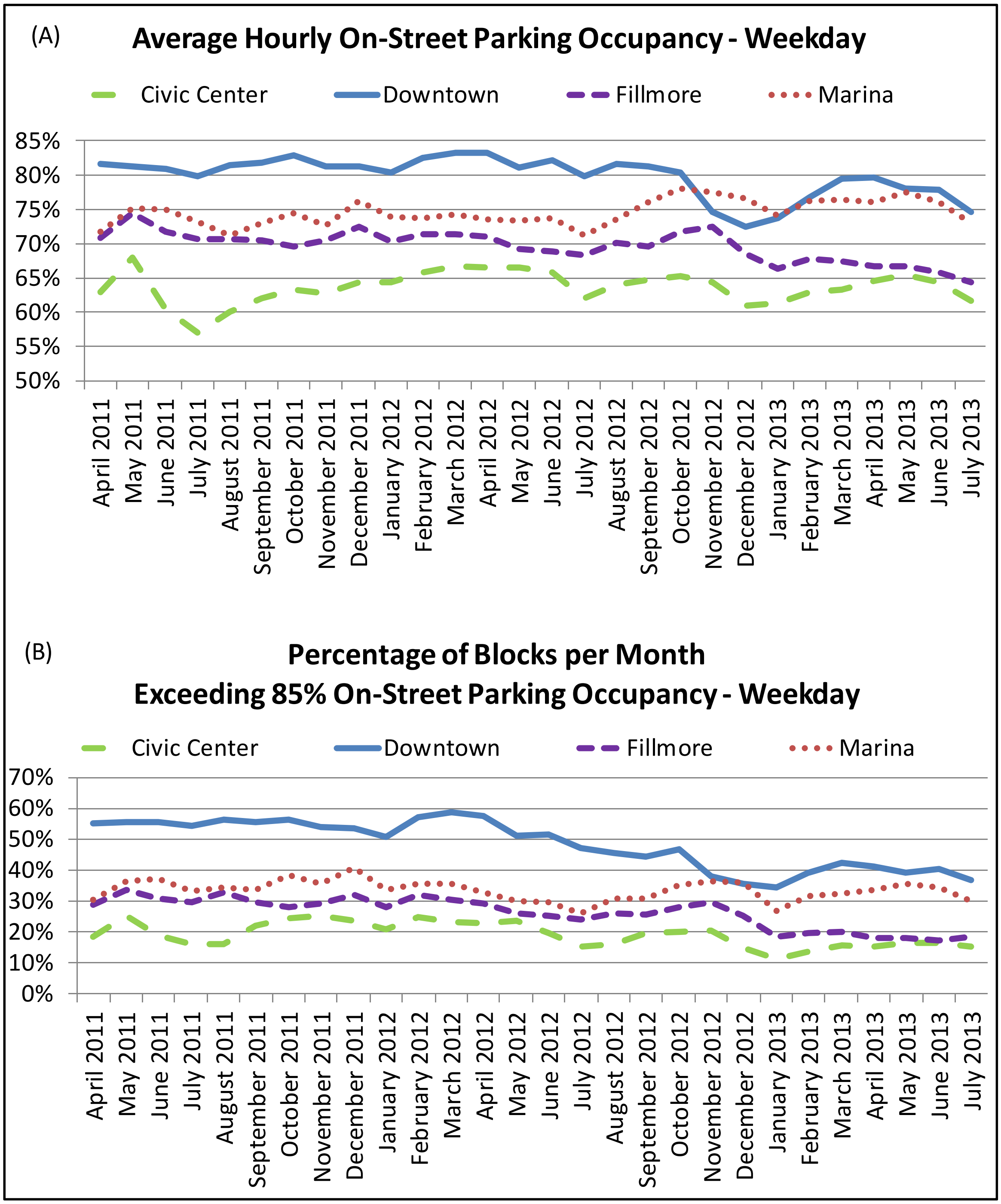
A wide range of data and analytic techniques were used in the evaluation across nine areas of analysis: congestion, pricing, technology, equity, environmental, business impacts, goods movement, non-technical success factors, and benefit cost analysis. Drawing on the results from these nine analysis areas, the following points highlight the evaluation findings of the pricing and technology projects first, followed by additional findings from some of the other analysis areas. Appendices for each analysis area provide additional findings and details.

The* SF*park Pricing Project

<u>Parking availability</u> was measured by examining trends in on-street parking occupancy, which was the percent of total time the parking sensors on a block indicated a car was in a space during a given hour between 9 a.m. and 6 p.m. when parking rates were in effect in all metered areas. Regression models showed a statistically significant negative relationship between the parking rate and occupancy for most pilot areas. That is, occupancy responded to price in the desired direction. The effect varied by pilot area and across hours of the day. For example, in the Downtown area the rate was most influential during the morning but insignificant at lunchtime in contrast to the Fisherman's Wharf area where the rate was most influential at lunchtime.

Trends in occupancy by individual parking areas showed that pricing was effective in reducing the prevalence of blocks with high occupancy. For example, Figure ES-2 shows the trend in occupancy in four pilot areas where average occupancy declined and/or the proportion of blocks exceeding

85 percent occupancy declined over time. In other pilot areas with lower initial occupancies, price reductions on under-utilized blocks resulted in gradually higher occupancies. In this manner demand-based variable pricing was found to be generally successful as a tool to better balance and distribute on-street parking utilization within the city.

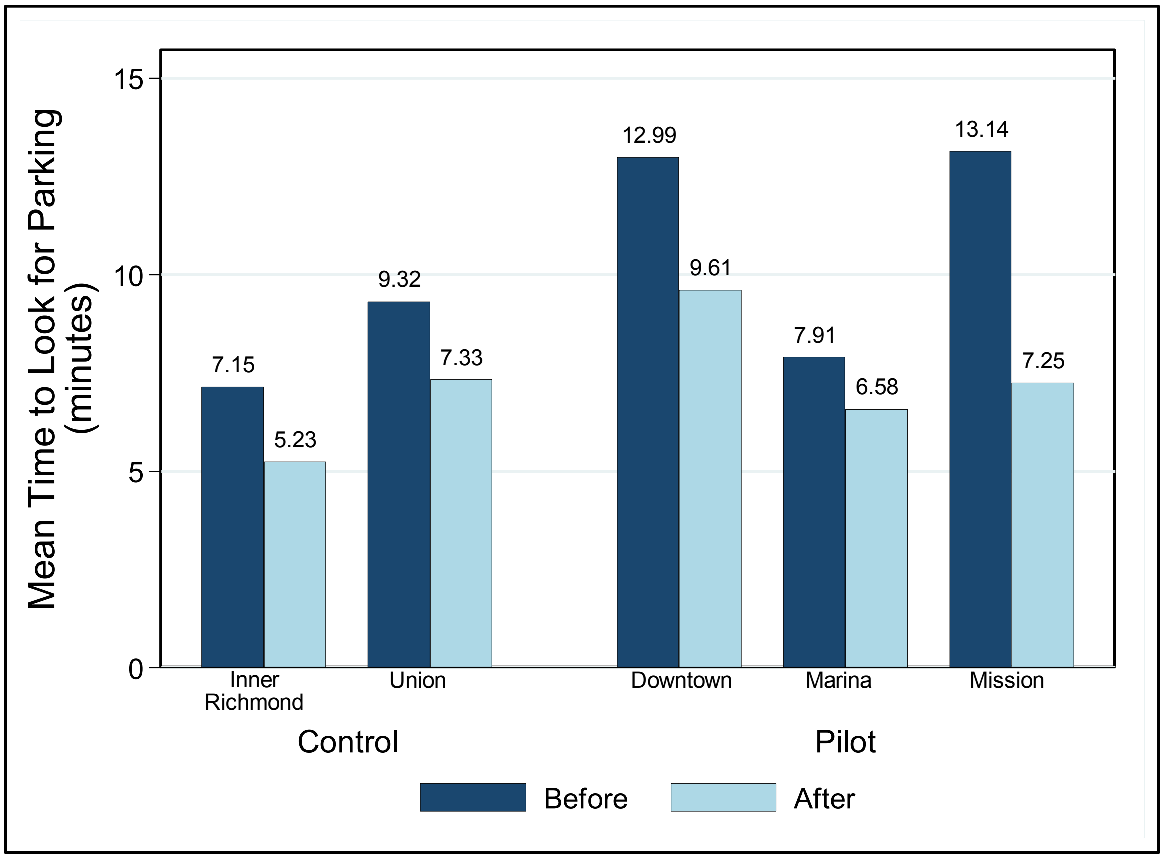


Source: Elliot Martin, 2014.

Figure ES-2. Weekday Parking Occupancy Trends in Pilot Areas with Declines in Parking Occupancy between 9 a.m. and 6 p.m.

Ease of finding parking was assessed using data from a manual field test of time and distance required to find an on-street parking space. Logit models that controlled for area (pilot versus control) and time (before and after pricing) found that average search time declined by 15 percent after pricing in the pilot compared to the control and that average search distance declined by 12 percent. Vehicles displaying a disabled placard are entitled to park at metered parking spaces for an unlimited time at no charge in San Francisco, which could have impacted the effectiveness of variable pricing on blocks where vehicles displaying the placards were prevalent. A logit model for disabled placard use showed no significant change in the rate of placard use in either the pilot or control areas from 2011 to 2013.

The model results on search time were supported by surveys of travelers to three pilot and two control areas before and after variable pricing. Figure ES-3 shows the survey results by area, indicating a drop in search time in both areas. While it took longer to find a parking space in the pilot areas (as compared to the control areas) both before and after variable pricing, the search time dropped more sharply in the pilot areas, such that the difference between pilot and control areas was reduced by a statistically significant 1.68 minutes in the after period.

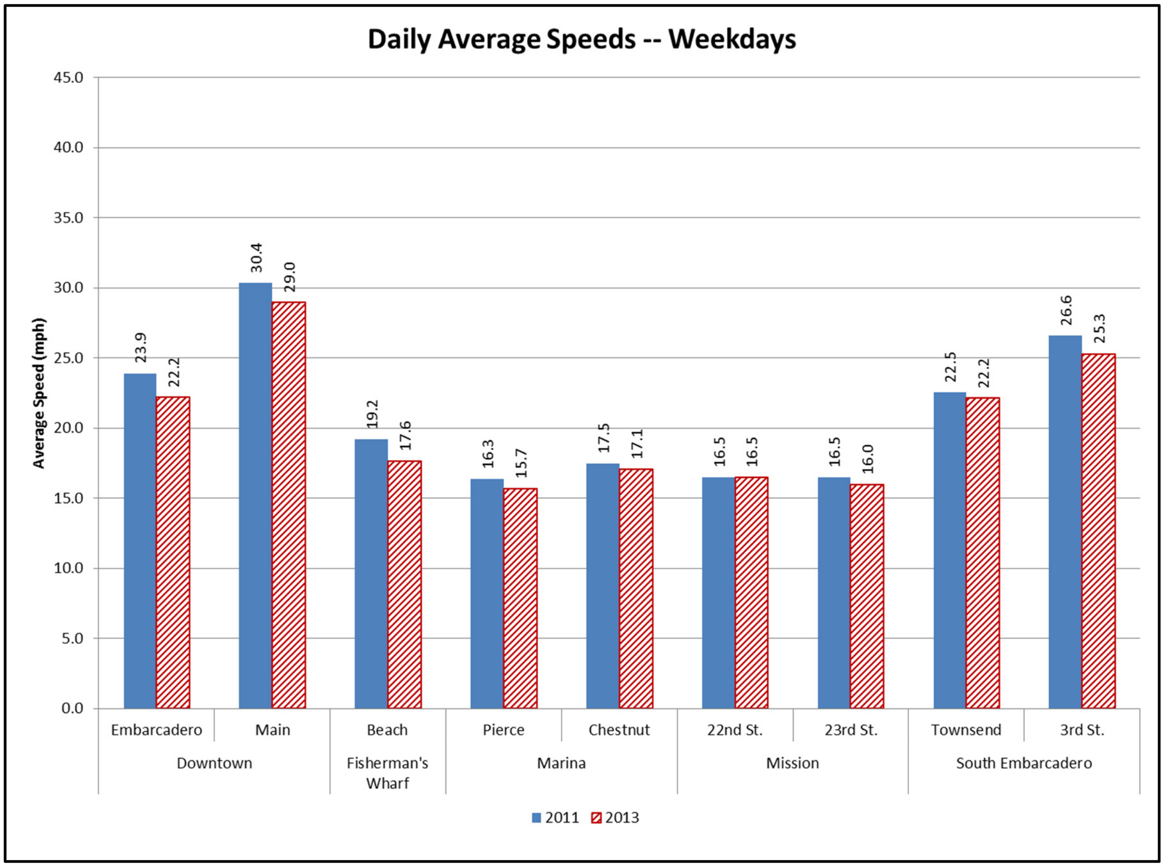


Source: Battelle based on SFMTA data, 2014.

Figure ES-3. Mean Time to Look for Parking (in Minutes) by Neighborhood and Time Period

Reduction in cruising by drivers looking for parking occurred in the pilot areas. As measured by changes in average vehicle miles traveled (VMT) to find parking among all pilot areas, an estimated 27 percent fewer miles occurred on the typical weekday and 22 percent fewer miles on Saturday with variable pricing. The reduction in cruising VMT varied by pilot area, with the reduction 30 percent or more in the Downtown and South Embarcadero areas and less than 10 percent in the Mission and Marina areas. Differences among pilot areas are attributable to the number of metered spaces and turnover rates in each area.

Reduction in traffic congestion was an important anticipated outcome of pricing, but it proved to be difficult to measure with available data. Technical difficulties with roadway sensors deployed by SFMTA resulted in a limited set of data for assessing congestion changes. Consequently, usable data for analysis of changes in traffic volumes at the aggregations employed in the national evaluation were generally not available, and usable speed data were available for only a few street segments.[1] Average daily link speeds from available roadway sensor data for spring months, shown in Figure ES-4, indicated that speeds were the same or lower in eight of the nine roadways in 2013 compared to 2011, after variable pricing had been in effect for almost two years. It is possible that higher traffic volumes due to an improving economy could have accounted for the lack of improvement in speed, but traffic count data for measuring such a change were not available from the roadway sensors.



Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

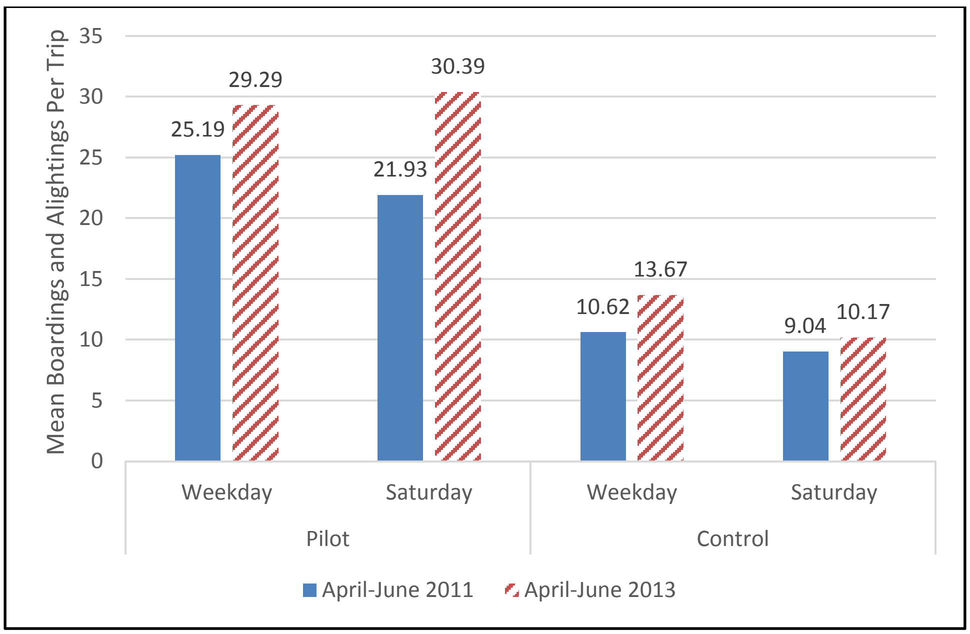
Figure ES-4. Average Daily Link Speeds from Available Roadway Sensors in SF*park* Pilot Areas, March – May of 2011 and 2013

[1] In consideration of the issues with the roadway sensor data, SFMTA employed a more granular level of analysis of roadway sensor data than the national evaluation and arrived at some limited findings with the data as published in “SF*park* Pilot Project Evaluation,” June 2014.

Automatic passenger counters (APC) on Muni buses traversing the pilot and control areas provided transit travel time and, once dwell times were removed, served as a proxy for general vehicular traffic. The data showed that average transit travel times remained relatively constant in both the control and pilot areas in 2013 relative to their 2011 pre-pilot pricing levels. In the pilot areas the travel time changed less than 0.3 minutes, with the exceptions of two bus routes in the Mission that were affected by a major construction project and a route in the Civic Center area on which travel time increased by almost two minutes by 2013, possibly due to an improving economy in that area.

Traditional measures of traffic congestion – link speeds and travel times – may not be sensitive enough to parking maneuvers. The evaluation examined data more directly related to parking maneuvers, e.g. double parking, which would directly affect traffic in the lanes in which double parking occurred. Analysis of double parking data collected by SFMTA revealed an impressive 14 percent decline for personal vehicles and a 21 percent decline by commercial vehicles with variable pricing in the pilot areas, although these differences were not statistically significant, possibly requiring a larger sample than available for statistical significance.

Mode shift was examined with questions from the before/after traveler surveys and with ridership derived from the bus APC data. Ridership, based on average boardings and alightings per trip within the pilot and control areas shown in Figure ES-5, increased in the pilot areas by 16 percent on weekdays and 39 percent on Saturdays. Statistical tests comparing pilot and control areas before and after pricing supported the potential effect of variable pricing on Saturday ridership but not on weekdays.



Source: Battelle based on SFMTA data, 2014.

Figure ES-5. Mean Boardings and Alightings per Trip by Area

In the visitor/shopper survey respondents were asked if they had changed their mode and the reason for the change. A statistically significant increase in persons changing mode was observed in the pilot areas after pricing, whereas the control areas stayed about the same: 24 percent in the pilot versus 17 percent in the control changed modes. However, among the respondents who changed modes, parking cost or availability did not figure as prominently as various other reasons for mode change, such as a new school or work location. Thus, while variable pricing may have led some travelers to change their mode when visiting pilot areas, the large increases in ridership on Muni buses is more likely attributable to other factors.

Reduction in emissions was directly related to the reduction in VMT cruising for parking. Table ES-1 shows the five major pollutants produced by private motor vehicles estimated with and without pricing in pilot areas, showing an average daily reduction of about 26 and 22 percent for weekday and Saturday, respectively. The reductions were based on the impacts of reduced parking search distance in combination with the parking turnover rates and number of metered parking spaces in each area.

Table ES-1. Summary of Daily Emission Impacts with and without Variable Pricing by Average Weekday and Saturday

Pollutant	Weekday (lbs.)		Percent Change with Pricing	Saturday (lbs.)		Percent Change with Pricing
	Without	With		Without	With	
ROG	9.25	6.79	-26.61%	10.20	7.92	-22.37%
NOx	9.39	6.89		10.36	8.04	
CO	119.15	87.44		131.38	101.99	
PM2.5	1.31	0.96		1.44	1.12	
CO2	32,746.16	24,032.16		36,107.91	28,031.21	

Source: Earth Matters, Inc., 2014.

Impact on businesses was assessed with sales tax data and data from the visitor/shopper survey. Variable pricing does not appear to have had a positive or negative impact on business. Sales (not adjusted for inflation) increased in the pilot areas judging from sales tax revenues for establishments in the “food product,” “general retail” and “miscellaneous” categories including chain stores, but sales taxes did not increase in the control areas. Survey data showed that people were visiting the area about the same amount in 2013 as the year before. While the proportion of trips for shopping purposes declined somewhat in the pilot areas (from 25 to 20 percent of trips), they were compensated by an increase in trips for dining or drinking (from 13 to 21 percent). A surprising finding was that survey respondents spent less in pilot areas in 2013 than those surveyed in 2011, but this was not attributable to the effect of pricing as the decreased spending was greater in the control areas.

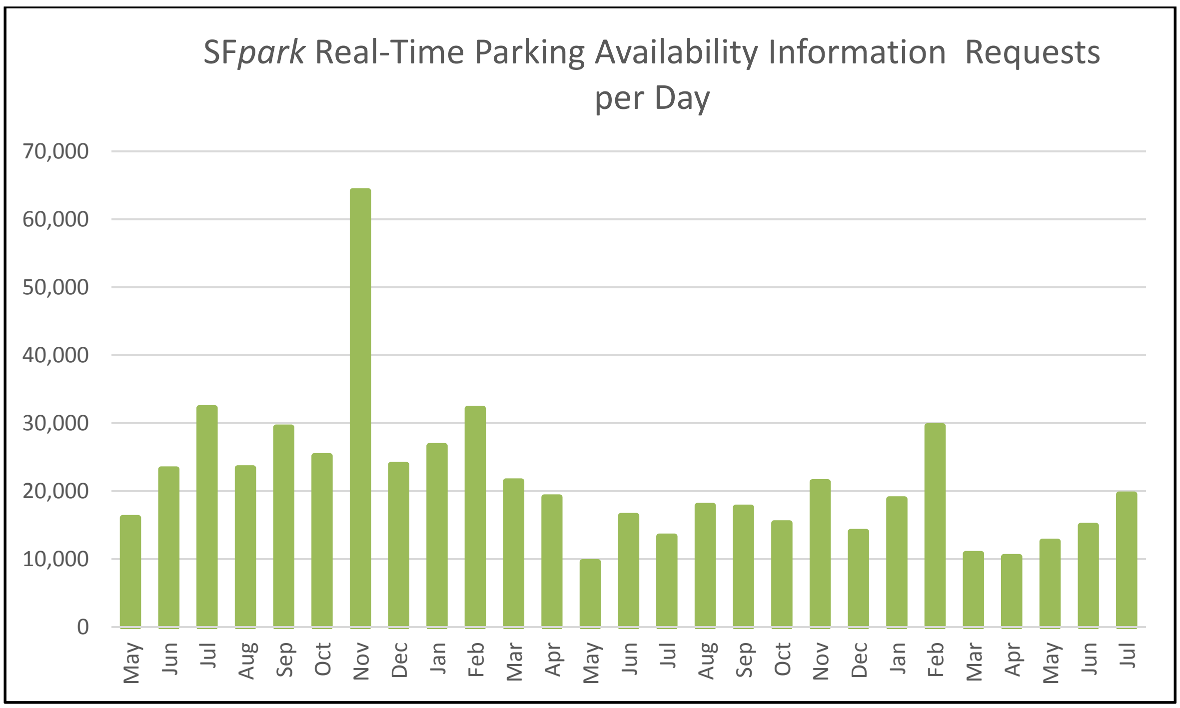
Equity impacts were assessed by income and age groups using data from the visitor/shopper survey. Questions on parking search time, distance parked from destination, perceived ease of parking, and amount paid for parking were separately examined across ten income and eight age categories. Statistical analysis using analysis of variance revealed no systematic negative or positive impact of variable pricing by income or age in any of the survey questions examined.

In conclusion, the demand-based pricing of SF*park* was effective in reducing the prevalence of blocks with high occupancy and increasing occupancy on under-utilized blocks, thereby demonstrating the approach to be a successful tool managing on-street parking within the city. For travelers, reduced parking occupancy in congested areas meant parking was more readily available and led to reduced time to find parking which meant lower vehicle miles traveled and emissions in pilot areas. The evaluation did not detect an improvement for traffic in general as measured by speed and travel times from the available data. Bus ridership increased in the pilot areas, but few travelers appeared to change mode as a direct result of parking pricing.

The Parking Information Technology Projects

Real-time information on the availability and price of SFMTA on-street and garage parking was disseminated to the public in various ways: SFMTA included the information on the SF*park* website and in smartphone applications developed for the iPhone and Android phones. MTC enhanced its 511 phone service and website service to include the real-time information received by a datafeed from SFMTA. The datafeed was also available to other product developers to disseminate information to their users.

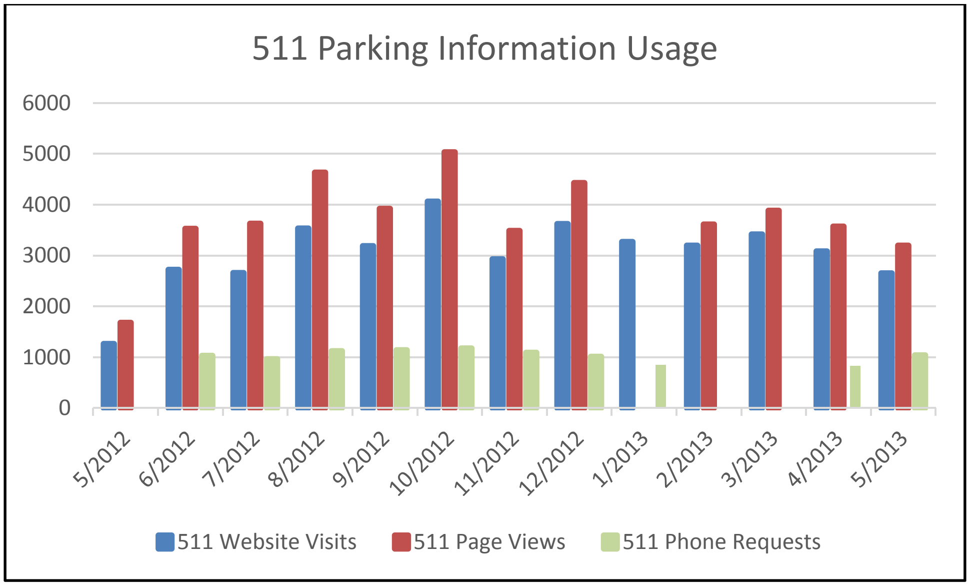
System data on usage included requests made to the SF*park* datafeed and usage of the 511 services. Figure ES-6 shows the average daily requests to the datafeed per month from May 2011, following the launch of the SF*park* iPhone app and website, through July 2013. The number of requests averaged 649,057 per month, which was an average of 21,417 requests per day. The spike in requests in November 2012 was perhaps due to media attention on the release of the Android app that month. The requests encompass all platforms for delivery of the real-time parking information, including but not limited to those of SFMTA and MTC, but the requests cannot differentiate among different platforms. Separate data on the number of downloads of SFMTA's iPhone and Android apps showed downloads totaled 70,387 through May 2013, with nearly half of the 59,512 downloads for the iPhone app occurring in the first two months following SFMTA's well-publicized launch in April 2011.



Source: Battelle based on SFMTA data, 2014.

Figure ES-6. Average Daily Requests per Month for SF*park* Real-time Parking Information per Day, May 2011 through July 2013

Monthly usage of the parking information on MTC's 511 system is shown in Figure ES-7, showing much higher website usage compared to phone. The page views indicate the number of pages visited during website visits. MTC combined its marketing of its 511 parking information with the launch of other 511 features in the fall of 2013 which was after the evaluation period. The generally low usage of both website and phone may be attributed to the absence of marketing of the parking enhancements to 511 during the evaluation period.



*Information was unavailable for 511 page views in January 2013.

Source: Battelle based on MTC data, 2014.

Figure ES-7. Usage* of Parking Information on the 511 Website and Phone

Travelers surveyed about real-time parking information revealed low awareness and usage of parking information technologies. Results of the visitor/shopper survey in 2013 showed that 15.6 percent of all respondents were aware of parking information sources. Low awareness is not surprising considering that SFMTA's promotional event had occurred two years before and MTC had not conducted any promotion prior to the survey.

Of the respondents who were aware of any way to get information to help park, only a few cited more than one source. In both the pilot and control areas, respondents were most familiar with 511.org and the SF*park* mobile application. Of the 215 individuals who were aware of ways to get information to help park, only 36 people used any source of information "sometimes" or "often."

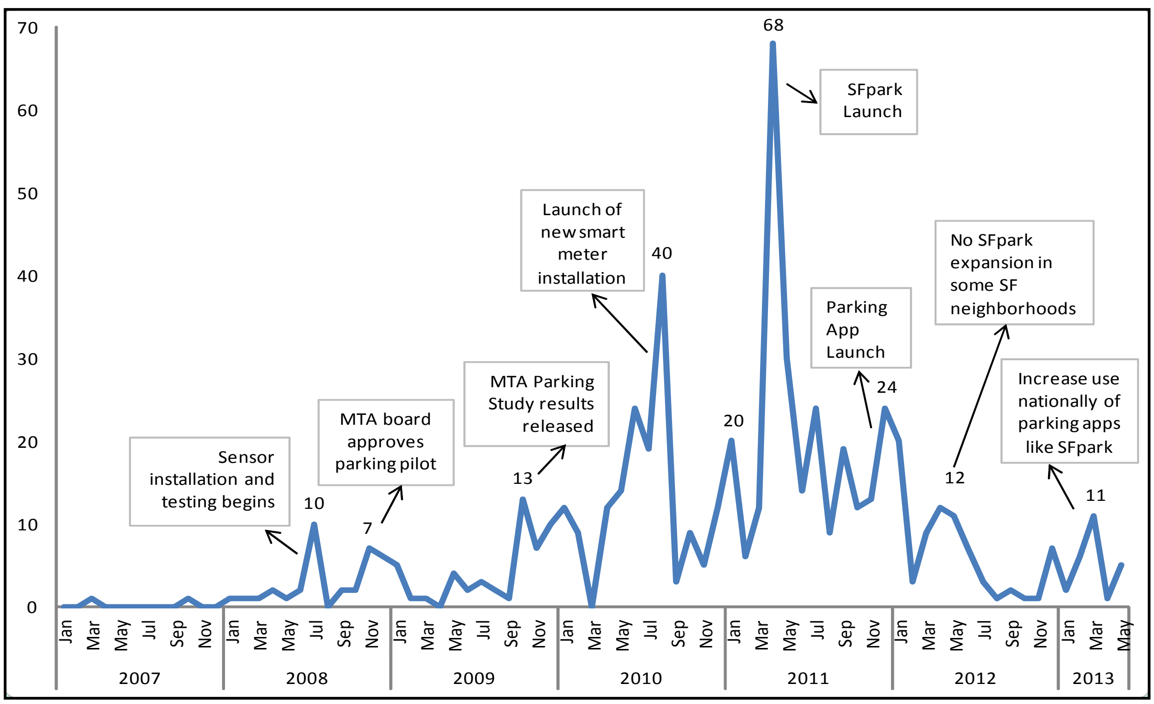
In conclusion, the real-time parking information technologies held more promise than was realized during the evaluation period. Awareness and use of those technologies did not filter down to the average person who visited the SF*park* areas, and, thus, the technologies ultimately did not appear to be effective in helping very many people with their decisions about parking during the period of the evaluation.

Additional Findings of the Evaluation

In addition to the findings discussed above, two other areas of analysis are presented below: outreach and marketing and benefit-cost analysis. The interested reader may wish to consult the main report and the report appendices which contain considerable additional details on findings.

A comprehensive SF*park* outreach and marketing plan was implemented by SFMTA to communicate the purpose and goals of the SF*park* pilot project to key stakeholders and San Francisco drivers. Through direct, one-on-one communication with community stakeholders and a widely distributed and succinct branding strategy, SFMTA worked to influence the culture of parking in San Francisco by educating people about how demand-based pricing works to create a better parking system rather than as simply a revenue producing mechanism for the city. More detail is presented in Appendix H – Non-technical Success Factors.

The marketing was successful in attracting extensive national and international news media coverage, including popular national media outlets such as The New York Times, The Los Angeles Times, The Wall Street Journal, National Public Radio, and The Huffington Post. However, most media coverage was produced locally with just over 50 percent coming from local mainstream print and television and local bloggers. The evaluation tracked the volume of coverage, and Figure ES-8 illustrates the pattern of coverage and some of the associated events over the course of the project. Analysis of a 10 percent sample of the media coverage determined that 57 percent was judged to be positive, 18 percent negative, 14 percent balanced (both positive and negative) and 11 percent neutral.



Source: University of Minnesota, 2013.

Figure ES-8. Volume of Media Coverage by Month and Associated Key Events, January 2007-May 2013

The benefit-cost analysis compared the costs of implementation and ten years of operation and maintenance with the value of ten years of benefits from the San Francisco UPA projects. The ten year post-deployment period was from 2011 through 2020. SF*park* costs for planning, design and construction in 2011 dollars was $40,653,000 and the cost of enhancements to the 511 system was $1,079,316. The addition of ten years of operations and maintenance brought the total to $43,529,299.

The ten years of benefits included the value of travel time savings ($28,082,631), reduced emissions ($579,164), reduced fuel consumption ($1,374,888), and reduced operating costs ($2,207,423) for a total of $32,244,107. While travel time savings were the biggest category of benefits, they reflected only the time savings for drivers seeking a parking space in the pilot areas on weekdays and Saturdays, because no travel time savings to other drivers or transit riders were discerned in the data available for this evaluation. Safety benefits were not measured, but if safety benefits had occurred they would have contributed additional savings not included in the analysis.

The societal benefit from the UPA projects in San Francisco was thus estimated to be a negative -$11,285,192, and the benefit to cost ratio was 0.74. It should be noted that all of the benefit estimates were based on empirical data from 2011 to 2013, and future years could yield larger net benefits. This could occur if the program is expanded to include, for example, Sundays and dinner hours, additional areas, and elimination of free parking for disabled placard users. Net benefits could also improve if costs were to be reduced by using the lower cost Sensor Independent Rate Adjustment that is not reliant on the in-ground parking sensors that were used during the evaluation period. The experimental use of sensing technology and extensive data collection to support the evaluation entailed high costs that would not be encountered by other cities. Indeed, learning from the challenges encountered with SF*park* deployment, another city could deploy a similarly functioning system for a lower cost.

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Chapter 1 Introduction

This report presents the national evaluation of the San Francisco Urban Partnership Agreement (UPA) sponsored by the U.S. Department of Transportation (U.S. DOT) UPA program. San Francisco was one of six locations selected by the U.S. DOT to implement a suite of strategies aimed at reducing congestion under the UPA and the Congestion Reduction Demonstration (CRD) programs. A cross-cutting final report that documents the UPA/CRD programs at all six locations will be generated at the conclusion of the evaluation of all the sites.

The San Francisco UPA included projects aimed at reducing congestion based on four complementary strategies based on the 4Ts: tolling, transit, telecommuting/travel demand management (TDM), and technology. U.S. DOT selected a team led by Battelle to conduct an independent evaluation of the UPA projects. This document presents the San Francisco UPA National Evaluation Final Report developed by the Battelle team in cooperation with the San Francisco UPA partners and the U.S. DOT. The report presents information from the pre- and post-deployment periods that encompass a year before SF*park* variable parking was in effect and a 21-month post-pricing period starting September 1, 2011.

This report is divided into five sections following this introduction. Chapter 2.0 summarizes the UPA and CRD programs. Chapter 3.0 highlights the San Francisco UPA local agency partners and projects. Chapter 4.0 presents the national evaluation methodology and the data used in the evaluation. Chapter 5.0 describes the various impacts from the projects and the major findings from the evaluation. Chapter 6.0 highlights the overall conclusions from the national evaluation of the San Francisco UPA projects. Appendix A through Appendix I present more detailed information on each of nine analysis areas. Appendix J contains data on exogenous factors, and Appendix K is a compilation of the hypothesis and questions guiding the San Francisco UPA national evaluation.

The evaluation report is intended to serve the needs of a variety of readers. For a reader seeking an overall understanding of the strategies used in the San Francisco UPA and the key findings about their effectiveness and impact, Chapters 3.0 and 6.0 will be most useful. Readers interested in specific types of transportation projects, such as parking systems, should consult the pertinent project descriptions in Chapter 3.0, along with the associated analysis in Chapter 5.0. For analysis of cross-cutting effects, such as equity and benefit-cost analysis (BCA), readers will find those results in Chapter 5.0. Readers interested in an in-depth understanding of the evaluation should consult the appendices, each of which focuses on a different aspect of the evaluation, along with previously-published evaluation planning documents.

The national evaluation is not the only assessment of the effectiveness of the SF*park* project. The San Francisco Municipal Transportation Agency, the agency responsible for SF*park*, published its own evaluation in June 2014,[2] and other researchers have or may in the future publish their own analyses of some of the same data used in the national evaluation. Different methodologies or criteria on what data to include in an analysis may lead to different findings than those presented in this report. Those differences are to be expected and will help to advance the collective understanding of the impacts of the San Francisco UPA projects.

[2] San Francisco Municipal Transportation Agency, "SF*park* Pilot Project Evaluation: The SFMTA's evaluation of the benefits of the SF*park* pilot project," June 2014.

Chapter 2 The UPA/CRD Programs

San Francisco was one of six sites awarded a grant by the U.S. DOT in 2007 and 2008 for implementation of congestion reduction strategies under the UPA and the CRD programs. The other areas were Atlanta, Los Angeles, Miami, Minnesota, and Seattle. A set of coordinated strategies known as the 4Ts incorporated tolling, transit, telecommuting/TDM, and technology was tailored to the needs of each site. The UPA and CRD programs sought to apply these strategies aggressively to relieve congestion in urban areas and raise revenues to support needed transportation improvements.

The national evaluation assessed the impacts of the UPA and CRD projects in a comprehensive and systematic manner across all sites. The objective was to document the extent to which congestion reduction was realized from the 4T strategies and to identify the associated impacts and contributions of each strategy. The evaluation also sought to determine the contributions of non-technical success factors – outreach, political and community support, and institutional arrangements – to the success of the projects and the overall net benefits relative to costs. Detailed documentation of the National Evaluation Framework and the evaluation planning documents specifically for the San Francisco UPA can be found at http://www.ops.fhwa.dot.gov/congestionpricing/agreements/sanfrancisco.htm.

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Chapter 3 San Francisco Urban Partnership Agreement

This chapter presents the San Francisco UPA by describing the San Francisco UPA partners, the transportation system and underlying congestion issues in the San Francisco metropolitan area, and the San Francisco UPA projects and deployment schedule.

3.1 The San Francisco UPA Partners

The San Francisco UPA partners consisted of three public agencies. Two of the partners represented the City of San Francisco – San Francisco Municipal Transportation Agency (SFMTA) and the San Francisco County Transportation Authority (SFCTA). The third partner was the Metropolitan Transportation Commission (MTC), the metropolitan planning organization (MPO) for the Bay Area.

SFMTA's role in the UPA was the deployment of SF*park,* a variable parking pricing system to improve management of the City's parking assets and reduce congestion on City streets. SFMTA is composed of the San Francisco Municipal Railway (Muni) transit system, the Division of Parking and Traffic (DPT) and the Division of Taxis and Accessible Services (DTAS). The DPT manages 19 off-street parking garages, 19 metered parking lots, and on-street parking.

SFCTA's Urban Partnership role was to plan and manage the telecommuting/TDM portion of the San Francisco UPA program. For the UPA, the SFCTA worked with the Department of Environment (SF Environment) to piggyback on its outreach to businesses and commuters by adding information on SF*park* and the 511 parking information enhancements to its regular events that promote travel options. During the course of the evaluation SF Environment revamped its outreach program and use of information on SF*park* and 511 was discontinued. With data no longer available, that part of the UPA national evaluation was not implemented.

The MTC's role was to enhance its existing 511 traveler information system by delivering real-time parking information from SF*park* to 511 users. The use of regional Clipper® smart-card payment system for parking payment was originally part of the national evaluation, but the Clipper development schedule did not align with other UPA projects and, thus, was removed from the evaluation.

3.2 The Transportation System in the San Francisco Bay Area

Bounded by the Pacific Ocean to the west and the San Francisco Bay to the north and east, the City and County of San Francisco occupy almost 50 square miles on the northern San Francisco Peninsula. The city is a leading financial, cultural, and transportation center both in California and internationally. The city and region boast a number of top-tier research centers and universities. It is also home to several Fortune 500 firms and more than 60,000 small businesses.

San Francisco is expected to continue its growth in population and employment. The estimated population for the city and county of San Francisco was 825,863 in 2012.[3] According to SFCTA, 76,000 more households and approximately 250,000 new jobs will be added by 2035.[4]

In a city and region already heavily congested with traffic,[5] this future growth could further increase traffic and travel times. Overall trip making to, from, and within the city is expected to increase by 33 percent by 2040 from 3.2 million trips per day in 2012. Nearly 68 percent of auto trips are estimated to be short-distance, internal trips less than three miles in length, as opposed to trips to and from areas outside the city.[6]

The city's dense and diverse land uses and its mature grid street system have made it very pedestrian friendly and enabled a wide variety of public transit travel options (i.e., streetcars, subways, commuter rail, trolleybuses, diesel buses, cable cars, and ferries). Nevertheless, private vehicles are still the dominant mode. According to SFCTA, the 2013 mode share for all travel was 53 percent for autos, 20 percent for transit, 24 percent for walking, and 2 percent for bike.[7] Management of the parking of vehicles is a challenge for the driver, other travelers, and city government alike. Drivers can find the search for a parking space frustrating; buses are slowed by cruising vehicles and must navigate around double-parked cars; pedestrians and bicyclists need to be cautious for drivers distracted and turning in their search for a parking space; and the city seeks the most effective means to manage its parking assets while at the same time enabling efficient travel for all modes. It is these types of challenges that the San Francisco UPA projects were meant to address.

[3] U.S. Census Bureau. http://www.census.gov/. Accessed March 14, 2014.

[4] *Congestion Management Program 2011.* Prepared by the San Francisco County Transportation Authority, December 2011.

[5] D. Schrank, B. Eisele, and T. Lomax. *2012 Urban Mobility Report.* Texas A&M Transportation Institute, The Texas A&M University System, December 2012. Available at: http://mobility.tamu.edu/ums/report/. Accessed September 27, 2013.

[6] *San Francisco Transportation Plan 2040, Appendix K: SF Travel at a Glance.* Prepared by the San Francisco County Transportation Authority, December 2013.

[7] *San Francisco Transportation Plan 2040.* Prepared by the San Francisco County Transportation Authority, December 2013.

3.3 San Francisco UPA Projects and Deployment Schedule

The national evaluation focused on two of the 4 Ts: tolling, renamed in this report as pricing, and technology. The pricing and technology projects are described in this section along with the schedule for their deployment.

3.3.1 Pricing Project

The SF*park* variable pricing system was the primary project of the San Francisco UPA. According to SFMTA:

> "Simply stated, the primary goal of SF*park* is to make it easy to find a parking space. In other words, SF*park* aims to manage demand for existing parking towards availability targets so that drivers, when they choose to drive, rarely circle to find parking or double-park. To the extent the right level of parking availability is maintained, everyone benefits."[8]

The goal was to be accomplished through the use of intelligent parking management technology and techniques to manage parking supply and demand on-street and in City-owned off-street parking. Demand-responsive pricing was complemented by extensions in times of day/week that meters were operable and the extension or elimination of limits on the length of time one could park at SF*park* meters. SFMTA expected this approach to reduce congestion and improve traffic flow, improve bus speed and reliability, reduce illegal parking, improve safety for all road users, improve air quality, and increase economic vitality and competitiveness of city businesses.

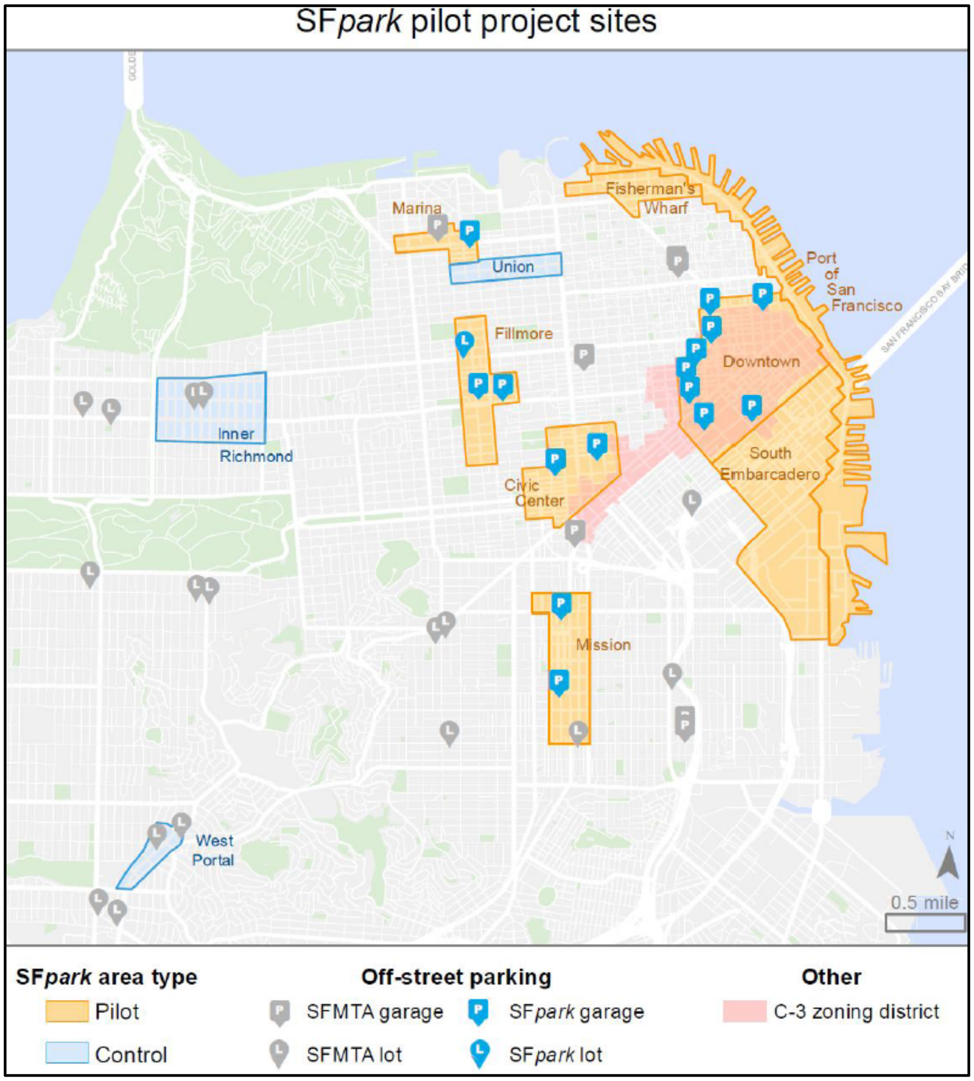
Demand-responsive pricing was achieved by periodic adjustments to rates – raising prices where and when demand was high, lowering rates where and when demand was low, and making no change where demand and supply were in balance. The following schedule was used for rate changes based on the average occupancy of general metered parking spaces for the whole block for one hour over two weeks of time:

- occupancy 80% - 100%, increase $0.25
- occupancy 60% - 80%, no rate change
- occupancy 30% - 60%, decrease $0.25
- occupancy 0% - 30%, decrease $0.50

The pilot areas for SF*park* are shown in Figure 3-1, and include Civic Center, Downtown, Fillmore, Fisherman's Wharf, Marina, Mission, Port of San Francisco, and South Embarcadero. In most pilot areas, time limits for general metered parking were relaxed to four hours, and in the rest time limits were eliminated altogether. Operating schedules in SF*park* areas remained consistent with all other parts of the city (i.e., 9 a.m. to 6 p.m.). The new system consisted of just over 7,000 metered parking spaces (about one-quarter of the city's total supply) and over 12,000 parking spaces in thirteen city-operated garages. Also shown in Figure 3-1 are three control areas – Inner Richmond, Union, and West Portal – which included approximately 1,000 spaces where variable pricing was not implemented. The use of pilot and control areas was the basis of an experimental design that would

[8] San Francisco Municipal Transportation Authority. "SF*park*: Putting Theory into Practice. Post-launch implementation summary and lessons learned," August 2011, pg. 11.

enable the evaluation to separate the impact of pricing from other changes that might occur unrelated to pricing.



Source: SFMTA, 2013.

Figure 3-1. SF*park* Parking Areas

The pilot and control areas were equipped with parking sensors for monitoring occupancy, as illustrated in Figure 3-2. However, upgraded parking meters that would accept credit- and debit-cards, as shown in Figure 3-3, were installed in the pilot areas but not in the control areas, and only pilot areas provided information on available spaces and prices in the SF*park* real-time information applications.

Source: SFMTA, 2013.

Figure 3-2. In-ground Parking Sensor

Source: SFMTA, 2013.

Figure 3-3. Advanced Parking Meters Used in San Francisco

SFMTA began variable pricing in SF*park* areas in the summer of 2011. All on-street sites were in operation by the end of August 2011. Pricing at the thirteen garages was rolled out by individual garage starting in mid-2011, with the last coming on line in May 2012.

3.3.2 Technology Projects

SF*park* relies on many technologies including but not limited to networked parking meters, parking occupancy sensors, and an extensive back-office business intelligence system. However, for the national evaluation the key technology project was the delivery of real-time parking information. SF*park* pilot areas produced data on the availability and price of parking for specific blocks and garages. These data formed the basis for parking information applications developed by SFMTA and MTC intended to assist travelers in making choices about parking pre-trip and en-route.

Source: SFMTA, 2013.

Figure 3-4. Example of SFMTA Real-time Parking Information Mobile App

SFMTA disseminated parking information in various ways. In April 2011 real-time parking information became available via SFMTA's website and Smartphone application, as illustrated in Figure 3-4. The SF*park* website (SF*park*.org) and Smartphone applications for iPhones and Androids provided an interactive map-based tool for the user to obtain information on parking availability and pricing. SFMTA made a datafeed available to third parties who wanted to develop their own applications. In September 2011 SFMTA implemented a text messaging delivery of information for parking garages, but it was discontinued after a few months due to low usage.

The 511 traveler information phone and website in the San Francisco Bay Area, operated by MTC, is one of the most advanced in the country and provides a variety of multi-modal information. MTC upgraded the static parking information on 511 (i.e., information on parking locations) to add real time parking space availability and pricing information provided by the datafeed from the SF*park* system. The user interfaces on 511 phone and website were enhanced to disseminate the parking information to 511 customers. MTC launched real-time parking information on the 511 phone system in May 2012. A beta version of the real-time parking information on the 511 website was launched in March 2012 with the final version operational in June 2013. Figure 3-5 illustrates real-time parking information for San Francisco on the 511 website available on December 20, 2013.

Source: MTC, 2013.

Figure 3-5. Example of Real-time Parking Information on 511 Website

The real-time parking information services offered by SFMTA and MTC operated during the course of the national evaluation. However, it should be noted that SFMTA eliminated real-time space availability for on-street parking from the data feed at the end of December 2013. The in-ground sensors for on-street parking began to fail as they neared the end of their battery life. SFMTA decided not to replace the sensors, but instead to use a different approach for determining demand-responsive pricing. The SF*park* data feed continued to provide on-street meter parking rates, as well as real-time space availability and rates at parking garages.

3.3.3 San Francisco UPA Project Deployment Schedule

Table 3-1 presents the deployment dates for the various San Francisco UPA projects. For on-street and garage pricing SFMTA implemented variable pricing as equipment installation was completed in each garage and on-street pilot area, and, thus, the initiation of variable pricing stretched over several months.

Table 3-1. UPA Projects and Deployment Timeline

UPA Project	Operational Start Date
SF*park* Pricing – On-street Parking	July – August, 2011
SF*park* iPhone App Launch	April, 2011
Real-time Parking Information on SFMTA Website	April, 2011
SF*park* Android App Launch	November, 2011
SF*park* Pricing – Garage Parking	June, 2011 – May, 2012
511 Website Real-time Parking Information	March, 2012
511 Phone Real-time Parking Information	May, 2012

Source: Battelle, 2014.

Chapter 4 National Evaluation Methodology and Data

This section highlights the national UPA/CRD evaluation methodology and the data used in conducting the San Francisco UPA national evaluation. An overview of the national UPA/CRD evaluation methodology is presented first in Section 4.1. The four objective questions posed by the U.S. DOT to guide the national evaluation are described, along with the associated analysis areas. The major data sources used in the San Francisco UPA national evaluation are presented in Section 4.2.

4.1 Four U.S. DOT Evaluation Questions

The national evaluation assessed the impacts of the UPA/CRD projects in a comprehensive and systematic manner across all sites. The Battelle team developed a National Evaluation Framework or NEF to provide a foundation for evaluation of the UPA/CRD sites. The NEF was based on the 4T congestion reduction strategies and the questions that the U.S. DOT sought to answer through the evaluation. The NEF defined the questions, analyses, measures of effectiveness, and associated data collection for the entire UPA/CRD evaluation. The framework was a key driver of the site-specific evaluation plans and data collection test plans and served as a touchstone throughout the project to ensure that national evaluation objectives were supported through the site-specific activities.

Table 4-1 presents the four U.S. DOT objective questions[9] and the analysis areas used in the San Francisco UPA evaluation to address these questions. As noted in the table, the analysis focused on the overall reduction in congestion, the performance of the pricing and technology strategies, and associated impacts. Elements of the analysis are presented in Sections 5.0 and 6.0. Appendix A through I present detailed information on the findings from the nine analysis areas, Appendix J summarizes information on exogenous factors that could impact the findings, and Appendix K is a compilation of all the hypotheses and questions across all nine analysis areas.

[9] “Urban Partnership Agreement Demonstration Evaluation – Statement of Work,” United States Department of Transportation, Federal Highway Administration; November 29, 2007.

Table 4-1. U.S. DOT Objective Questions and San Francisco UPA Evaluation Analyses

U.S. DOT 4 Objective Questions	Evaluation Analyses
#1 – How much was congestion reduced?	Congestion
#2 – What are the associated impacts of the congestion reduction strategies?	**Strategy Performance***
	Strategy Performance: Pricing
	Strategy Performance: Technology
	Associated Impacts
	Associated Impacts: Equity
	Associated Impacts: Environmental
	Associated Impacts: Goods Movement
	Associated Impacts: Business
#3 – What are the non-technical success factors?	Non-Technical Success Factors
#4 – What is the overall cost and benefit of the strategies?	Benefit Cost Analysis

*Not shown in this list is the telecommuting/TDM strategy, which was discontinued during the evaluation period and, thus, not included in the projects that were evaluated.

Source: Battelle, 2014.

4.2 San Francisco UPA Evaluation Process and Data

The San Francisco UPA evaluation involved several steps. Members of the national evaluation team worked closely with the local partners and U.S. DOT representatives on the following activities and products:

- Project kick-off conference call, site visit, and workshop;
- San Francisco UPA national evaluation strategy;
- San Francisco UPA National Evaluation Plan;
- 10 San Francisco UPA test plans;
- Collection of one year of pre-deployment and 21-months of post-deployment data;
- Analysis of the collected data, surveys, interviews and workshops; and
- Interim San Francisco UPA National Evaluation Report and a National Evaluation Final Report.

A wide range of data was collected and analyzed as part of the San Francisco UPA. Table 4-2 presents the data, the data sources, and related analysis areas in which the data were used in the evaluation. Each appendix presents detailed descriptions of the data sources, analysis techniques, and findings.

Members of the Battelle team worked with representatives from the San Francisco UPA partnership agencies and the U.S. DOT on all aspects of the national evaluation. This team approach included the participation of local representatives throughout the process and the use of site visits, workshops, conference calls, and e-mails to ensure ongoing communication and coordination. The local agencies were responsible for data collection and conducting surveys of travelers to the parking areas. The Battelle team was responsible for conducting the interviews and workshops with representatives of the partner agencies, who were stakeholders in the projects, and for analyzing all the data.

Table 4-2. San Francisco UPA National Evaluation Data Sources

Data	Source	Evaluation Analyses
Roadway Sensor Data	SFMTA	• Congestion Analysis • Pricing Analysis
Parking Sensor Data	SFMTA	• Pricing Analysis
Parking Meter Data	SFMTA	• Pricing Analysis
Parking Search Times and Distance	SFMTA	• Pricing Analysis • Environmental Analysis
Double-Parking and Disabled Placard Survey	SFMTA	• Pricing Analysis • Goods Movement Analysis
Automatic Passenger Counter Data (Ridership, Bus Travel Time and Speed)	SFMTA	• Congestion Analysis • Pricing Analysis • Equity Analysis
Visitor/Shopper Survey	SFMTA	• Congestion Analysis • Pricing Analysis • Equity Analysis • Business Impact Analysis
Parking Information Usage Data	SFMTA MTC	• Technology Analysis
Parking Citation Records	SFMTA	• Technology Analysis • Goods Movement
Parking and Sales Taxes	SFMTA	• Pricing Analysis • Business Impact Analysis
News and Media Coverage	SFMTA	• Non-Technical Success Factors Analysis
UPA Partnership Documents and Outreach Materials	SFMTA	• Non-Technical Success Factors Analysis
Capital, Operating, and Maintenance Costs of UPA Projects	SFMTA	• Benefit Cost Analysis

Table 4-2. San Francisco UPA National Evaluation Data Sources (Continued)

Data	Source	Evaluation Analyses
Stakeholder Interviews and Workshops	Hubert H. Humphrey School of Public Affairs	• Technology Analysis • Non-Technical Success Factors Analysis
Major Road Construction, City Events, and Weather Events	SFMTA	• Exogenous Factors
Unemployment Rates – State, and Metro Area	U.S. Department of Labor, Bureau of Labor Statistics; State of California Employee Development Department	• Exogenous Factors
Gasoline Prices	U.S. Energy Information Administration	• Exogenous Factors

Source: Battelle, 2014.

Chapter 5 Major Findings

This section highlights the major findings from the national evaluation of the San Francisco UPA projects. The contextual changes that occurred in the San Francisco metropolitan area during the evaluation period – including the decrease in the unemployment rate – are highlighted in Section 5.1. The San Francisco UPA's use of pricing and technology strategies are described in Section 5.2. Section 5.3 provides a summary of the impacts of the San Francisco UPA for each of nine evaluation analysis areas that addressed the key questions U.S. DOT had posed for the national evaluation.

5.1 Contextual Changes During the Evaluation Period

The UPA projects took place within the larger context of the City of San Francisco, the Bay Area, and the nation in general, and changes happening at these jurisdictional levels could have potentially impacted the effectiveness of the San Francisco UPA strategies. This section briefly discusses contextual changes that could have influenced the findings of the evaluation, and further details are presented in Appendix J – Exogenous Factors.

Arguably one of the most significant events that took place during the evaluation period was the major nationwide economic recession that began in late 2008. In the San Francisco region the recession was reflected in a spike to about 10 percent in the unemployment rate in early 2010. By the time SF*park* variable pricing went into effect in mid-2011, the unemployment rate had dropped below 9 percent and by the end of the evaluation period in May of 2013 it was back to a pre-recession level of 5.3 percent. As a measure of economic activity, high unemployment rates could have meant less travel and less demand for parking in the SF*park* areas of the city and just the opposite when unemployment was low. These trends could have lessened the effectiveness of pricing on reducing congestion reflected in the evaluation results.

The cost of travel could have also influenced mode choice and the demand for parking. With the price of gasoline being a major component of the cost of vehicular travel, its level during the evaluation period could have affected the evaluation findings. The price of a gallon of regular conventional gasoline in San Francisco County fluctuated during the evaluation period, reaching a low of $3.03 per gallon in September 2010 (pre-deployment phase) and a high of $4.68 per gallon in October 2012 (post-deployment phase) with considerable volatility in price during the post-deployment phase. These changes in gasoline prices may have influenced travel behavior and use of parking facilities separate from the impact of pricing.

Other types of events could have impacted travel and demand for parking in the city or region (e.g., weather, fairs and parades, sporting events, transit disruption, and construction), but they tended to be of short duration with no long-term impact that would have been detected in the evaluation findings. The one exception was a major construction project in the Mission area, which disrupted the functioning of SF*park* technology starting in March 2012. The national evaluation has sought to adjust the data to remove the effect of the Mission construction project where practical or otherwise to make note of the potential effect in presentation of the findings.

Where the data permits, the evaluation has sought to separate potential confounding effects through the use of the SF*park* control areas, which would have been subject to the same regional economic trends, for example, as the pilot areas. However, the three control areas were imperfect matches to the pilot areas in some respects (e.g., proportion of commercial versus residential uses), and, thus, caveats about the effect of exogenous factors are still warranted.

Finally, it should be noted that the UPA projects were not all synchronized in that they started at different points in time, as previously documented in Section 3.3.3. In particular, MTC's enhancements to the 511 system did not occur until mid-2012, many months after the start of SF*park* pricing and SF*park* parking information technologies launched. The later start date of the 511 enhancements could have affected their impact on travelers' awareness and use of real-time parking information.

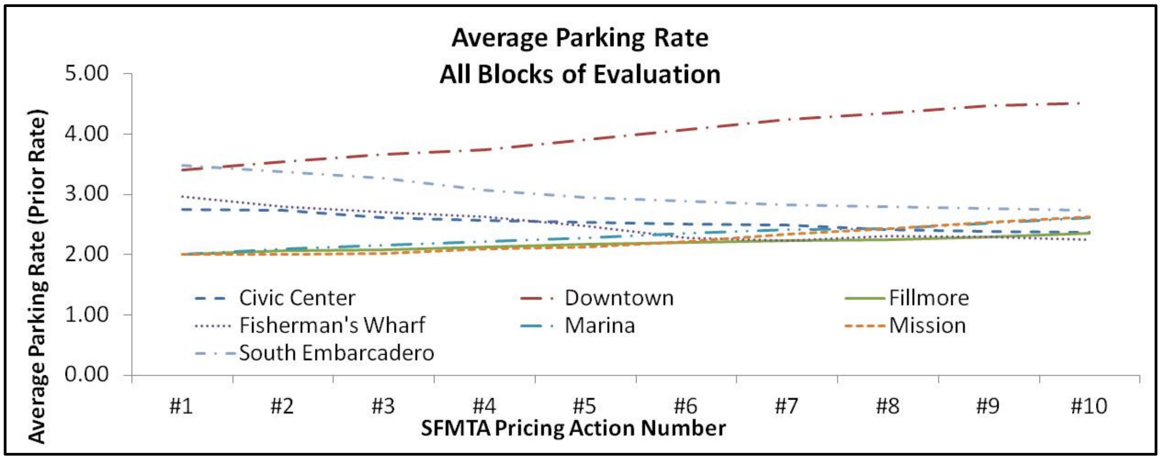
5.2 Use and Impact of the San Francisco UPA Projects

The San Francisco UPA comprised two principal strategies – pricing and technology – that were intended to affect travel in San Francisco. UPA and CRD sites were funded by U.S. DOT to test the effectiveness of some form of demand-based pricing along with supporting strategies in addressing problems of traffic congestion in metropolitan areas. In San Francisco the focus was on the use of pricing to affect parking availability so that people would spend less time cruising for a parking space and, thereby, improve travel conditions for all travelers using the same streets. The supporting strategy in San Francisco was the use of information technologies to disseminate real-time information on where parking was available and its price. That information would make parking more efficient for those choosing to drive and park, or it might help encourage use of other modes.

The following sections present evaluation results that show how well the pricing and technology projects performed in meeting their objectives. Given the vast amount of data that were analyzed for this evaluation and the desire to keep the main report relatively succinct, the selection of findings below are highlights that were judged to be the most important. However, the reader may want to consult the appendices for greater details and for additional results not presented here.

5.2.1 The SF*park* Pricing Project

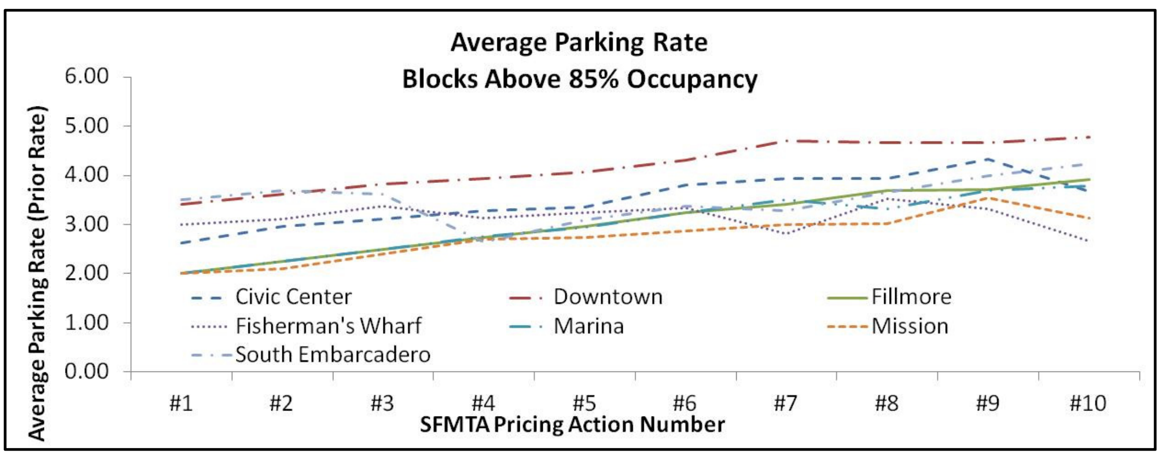
Demand-based pricing was implemented incrementally with no increase greater than $0.25 at a time, no decrease greater than $0.50 at a time, and with price changes no more frequently than every six weeks to give people an opportunity to become aware of prices and adjust their behavior accordingly. Given the small incremental size of the price changes and limitations on their frequency, the impact was expected to take many months to become apparent. Figure 5-1 shows the average parking rates on blocks in the pilot areas over the course of the 21-month post-implementation evaluation period. For consistency in the analysis, data were used only for blocks in a parking area in which SFMTA subjected them to at least seven out of the ten price changes (including instances where occupany data dictated that no price change was warranted). Prior rate was the average hourly charge for those blocks prior to the new rate determined with each pricing action. Average prices rose in four of the seven pilot areas, including Downtown, Fillmore, Marina, and Mission. Average prices fell in the Civic Center, Fisherman's Wharf, and South Embarcadero.



Source: Elliot Martin, 2014.

Figure 5-1. Average Parking Rate of All Blocks with Seven or More Pricing Actions

Since a key objective was to use higher prices to make parking more available on the most congested blocks, Figure 5-2 shows the average parking rates of the same set of blocks used in Figure 5-1 but filtered for those with more than 85 percent occupancy in any one period. For these blocks, the trend in average parking rates ended higher in all pilot areas except one, Fisherman's Wharf. However, as parking rates changed, so too did the sample of blocks with high occupancies, resulting in a shifting pattern over time as pricing moved toward equilibrium.



Source: Elliot Martin, 2014.

Figure 5-2. Average Parking Rate of Blocks with Occupancy of 85 Percent or More

The question to be examined here is how well did the pricing work in changing parking behavior and improving traffic? In addition, did the pricing have any negative consequences for businesses and individuals?

Parking Availability

Parking availability was measured by examination of trends in occupancy, which is a reasonable surrogate for the likelihood of finding a parking space, and hence a measure of availability. Occupancy was the percent of total time the parking sensors on a block indicated a car was in a space during a given hour between 9 a.m. and 6 p.m. when parking rates were in effect in all metered areas.

Regression models (described in Appendix B – Parking Analysis) for each of seven pilot areas by time of day showed a negative and statistically significant relationship between parking rate and occupancy in most cases, as illustrated in Table 5-1. One pilot area was an exception, the Mission district, in which the parking rate variable was most often insignificant and was most likely due to the major construction in the area that disrupted parking and other traffic. The coefficients are the average percentage change in occupancy that resulted from a $1 increase in parking rate. For example, the coefficient for 9 a.m. to 10 a.m. in the Civic Center indicates that on average, each additional dollar in the parking rate charged reduced the average parking occupancy by 4.2 percent within that pilot area. The reverse is also true, in that a reduction in the parking rate by $1 would have increased parking occupancy by 4.2 percent (in the case of the Civic Center during 9 a.m. to 10 a.m.). Other coefficients have the same interpretation for their respective values.

The impact of parking rate on parking occupancy naturally varied by pilot area and across the hours of the day. For example, the parking rate appeared to have the greatest average influence on blocks within the Marina district during all hours of metered parking. On the other hand, in the Downtown pilot area, the rate was most influential during the morning hours and statistically insignificant (i.e., not different from a zero effect) during lunch time. In contrast, the parking rate was most influential during the lunch hour in the Fisherman's Wharf tourist area and statistically significant during other hours.

Table 5-1 also shows unweighted averages of the coefficients within each hour and across all pilot areas. The hourly averages show that, on balance, parking pricing was slightly more influential on occupancy during the morning hours than during the afternoon. The generalization of this effect is, however, nuanced by the fact that the influence of the parking rate in the Fillmore and Fisherman's Wharf pilot areas was slightly stronger in the afternoon hours. The pilot area averages show that, as mentioned above, the parking rate was most influential on occupancy in the Marina and least influential in the Mission. For the other areas, the effect of a $1 increase in parking rate would, on average, reduce occupancy between 2.5 to 4.2 percent. The average across all coefficients was -0.0363, and this generally implies that across all blocks and across all hours, the average effect of a $1 increase in parking rate would reduce average parking occupancy by about 3.6 percent.

Table 5-1. Parking Rate Coefficients for All Pilot Areas by Time of Day[10]

Parking Rate Model	Civic Center	Downtown	Fillmore	Fisherman's Wharf	Marina	Mission	South Embarcadero	Hourly Average
9 a.m. to 10 a.m.	-0.042***	-0.089***	-0.035***	-0.022***	-0.114***	-0.005[NS]	-0.024***	-0.047
10 a.m. to 11 a.m.	-0.043***	-0.081***	-0.041***	-0.022*	-0.113***	-0.031**	-0.031***	-0.052
11 a.m. to 12 p.m.	-0.041***	-0.051***	-0.042***	-0.025**	-0.107***	-0.022*	-0.033***	-0.046
12 p.m. to 1 p.m.	-0.045***	-0.012[NS]	-0.031***	-0.045***	-0.063***	-0.01[NS]	-0.023***	-0.033
1 p.m. to 2 p.m.	-0.041***	-0.011[NS]	-0.032***	-0.049***	-0.063***	-0.001[NS]	-0.022***	-0.031
2 p.m. to 3 p.m.	-0.032***	-0.015[NS]	-0.036***	-0.044***	-0.065***	0.002[NS]	-0.021***	-0.030
3 p.m. to 4 p.m.	-0.018**	-0.024*	-0.05***	-0.024**	-0.068***	0.001[NS]	-0.026***	-0.030
4 p.m. to 5 p.m.	-0.009[NS]	-0.03**	-0.053***	-0.029**	-0.072***	0[NS]	-0.028***	-0.032
5 p.m. to 6 p.m.	-0.004[NS]	-0.02*	-0.055***	-0.03***	-0.057***	-0.003[NS]	-0.014*	-0.026
Pilot Area Average	-0.031	-0.037	-0.042	-0.032	-0.080	-0.008	-0.025	-0.0363

*** p-value < 0.001, ** p-value < 0.01, * p-value < 0.05

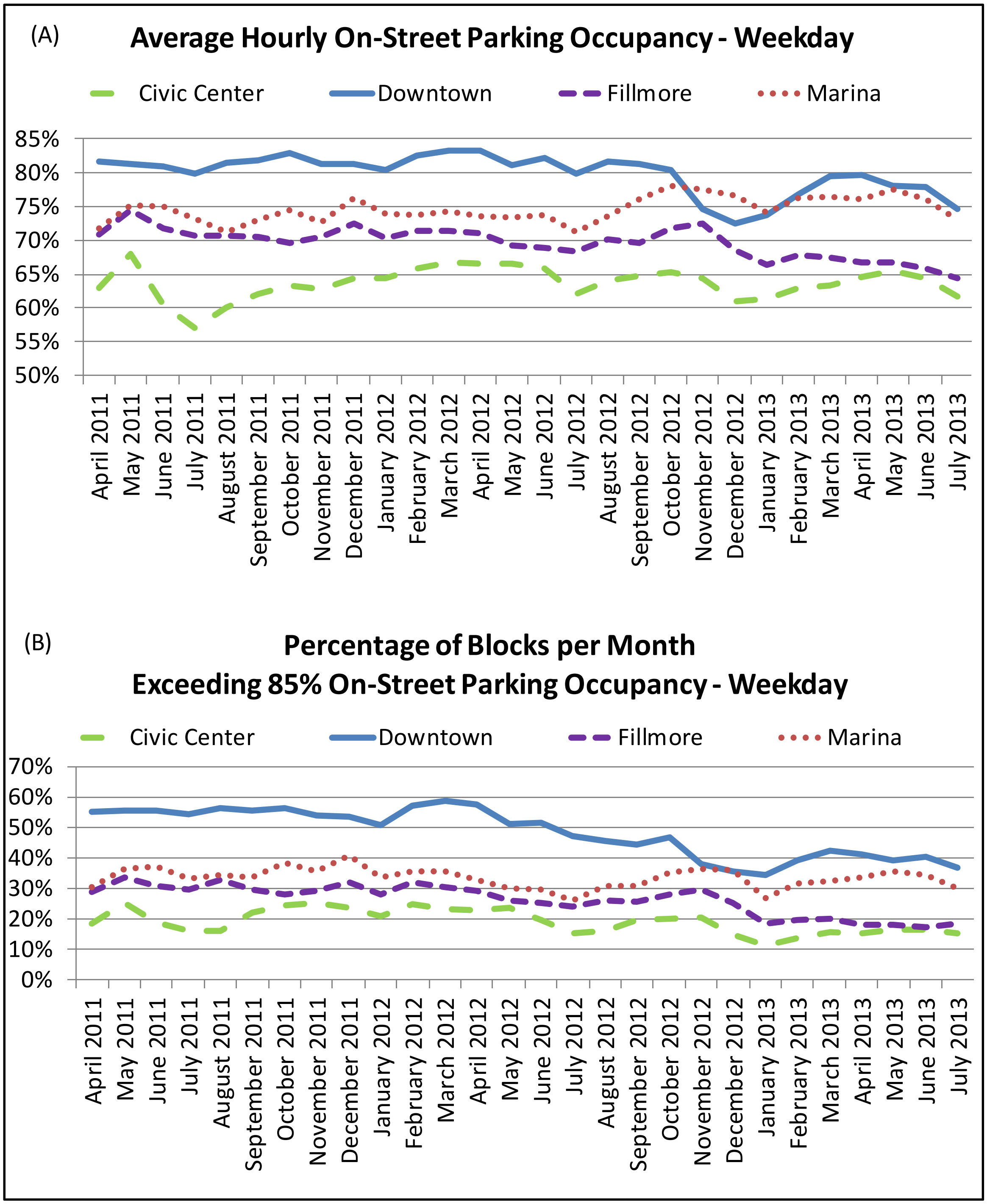
NS = Not Significant

Source: Elliot Martin, 2014.

[10] The coefficients are the average percentage change in occupancy that resulted from a $1 increase in parking rate. The Pilot Area Average and the Hourly Average are simply unweighted row and column averages, and as such no test for statistical significance is available.

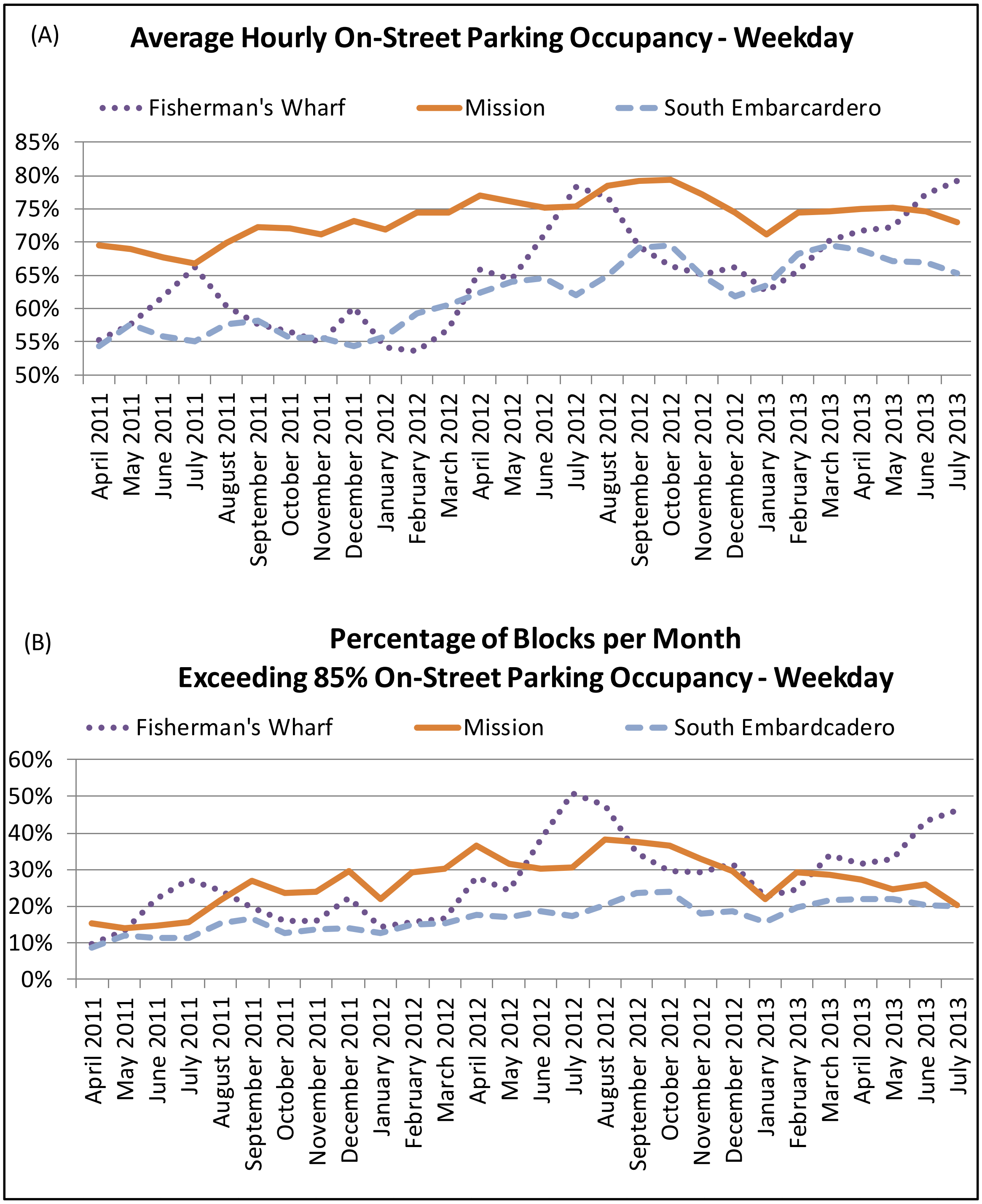
Examination of trends in occupancy by individual parking areas showed that pricing was effective in reducing the prevalence of blocks with high occupancy. Figure 5-3 shows that in the Civic Center, Downtown, Fillmore, and Marina pilot areas, parking occupancy averaged across the hours from 9 a.m. to 6 p.m. remained relatively flat, but the proportion of blocks exceeding 85 percent occupancy declined. Average occupancy also declined in some of these areas, or remained level. The pilot area that saw the most reduction in parking occupancy (and, thus, the greatest increase in average availability), was the Downtown, in which there was a noticeable decline in both average occupancy and the proportion of blocks exceeding the 85 percent threshold. The Fillmore also exhibited a decline in both trends. The Civic Center exhibited a relatively constant average occupancy over the evaluation period but a drop in the proportion of blocks exceeding 85 percent occupancy. The changes observed in the Marina were notably slight at this level of aggregation. This was due to the fact that in the morning, parking occupancies rose in the Marina area as SFMTA lowered prices within this period. In the afternoon hours, the Marina experienced modest declines in parking occupancy. When aggregated together, the overall impact on the Marina appeared negligible and unseen unless disaggregated by hour.

Figure 5-4 shows the same trends for the three other pilot areas. Fisherman's Wharf and South Embarcadero exhibited a clear increasing trend in the average hourly parking occupancy and the percentage of blocks exceeding 85 percent. Both of these areas were more vacant than the other five pilot areas, as average hourly occupancies began at 55 percent and stayed below 60 percent for much of the first year. (The spike in occupancy of blocks exceeding 85 percent in the Fisherman's Wharf area in summer of 2012 could be related to the America's Cup racing that summer.) A gradual and steady increase in parking occupancy then occurred in both areas during the second year of the evaluation. The Mission area was more of an anomaly, as parking occupancies started at 70 percent, but did not follow the expected pattern. A major construction project starting in March 2012 led to removal of sensors for 9 of the 28 blocks in the pilot area, thereby disrupting the pricing actions taken in Mission. Thus, Mission's occupancies did not move with pricing and in fact increased slightly.



Source: Elliot Martin, 2014.

Figure 5-3. Weekday Parking Occupancy Trends in Pilot Areas with Declines in Parking Occupancy



Source: Elliot Martin, 2014.

Figure 5-4. Weekday Parking Occupancy Trends in Pilot Areas with Increases in Parking Occupancy

Occupancy data for two control areas, Inner Richmond and Union, where no pricing actions were taken, exhibited no consistent pattern over time. Occupancies exceeding 85 percent decreased in Union but increased in Inner Richmond. Dynamics other than pricing appear to have been at work in changes in occupancies in these parts of the city.

Overall, the evidence suggests that the parking pricing actions taken by SFMTA in the SF*park* project were effective in reducing parking occupancies in the pilot areas with congested parking, thereby increasing the availability of parking. Pilot areas with higher initial parking occupancies experienced reductions in occupancy over time, whereas the pilot areas with lower initial occupancies experienced increases over time. Thus, lowering prices on under-utilized blocks, where parking had been readily available, was gradually effective in producing higher utilization of existing on-street capacity. In sum, demand-based variable pricing was demonstrated to be generally successful as a tool to better balance and distribute on-street parking utilization within the city.

Ease of Finding Parking

While analysis of occupancy provides a general picture of availability, the ease with which someone looking for parking finds it provides a more concrete indication of the parking experience from the traveler's viewpoint. Data for this area of the evaluation came from a manual field test on time and distance to find an on-street parking space, a manual field survey on the use of spaces by vehicles with disabled placards, and surveys of travelers (the visitor/shopper survey) in the pilot and control areas.

A logit model (described in Appendix B) applied to the field test on average parking search time and distance measured the effect of variable pricing by controlling for the area (pilot and control) and time before and after pricing began (2011 and 2013). The model statistically controlled for confounding effects of time of day and day of week (i.e., weekend vs. weekday). Specially trained surveyors on bicycles followed preset routes to locate the first available space. Data were collected by days of week and times of day in all pilot and control areas. A model was also developed for the data on use of disabled placards to assess their impact on parking availability, as drivers with disabled placards in San Francisco are permitted to park for an unlimited time without a charge at metered parking. A local concern in implementing SF*park* was that on blocks with a high prevalence of disabled placards at metered parking spaces the effectiveness of variable pricing could be diminished.

The results of the models are shown in Table 5-2. The exponents of the model coefficients show the before/after difference for the pilot and control areas and the difference between them. The difference between the pilot and control parameters can be interpreted as statistically significant when only the pilot time effect is significant or when both the pilot and the control effects are significant. The interpretation of the results is that there was a significant before/after difference in both the pilot and control areas, and that pricing exerted a statistically significant effect in the pilot areas compared to the control. On the other hand, there was no significant change from 2011 to 2013 in the rate of disabled-placard parking in either the pilot or the control areas.

Table 5-2. Logit Model Results for Parking Search Time and Distance and Disabled Placard Use Predicted by Pricing and Time Period

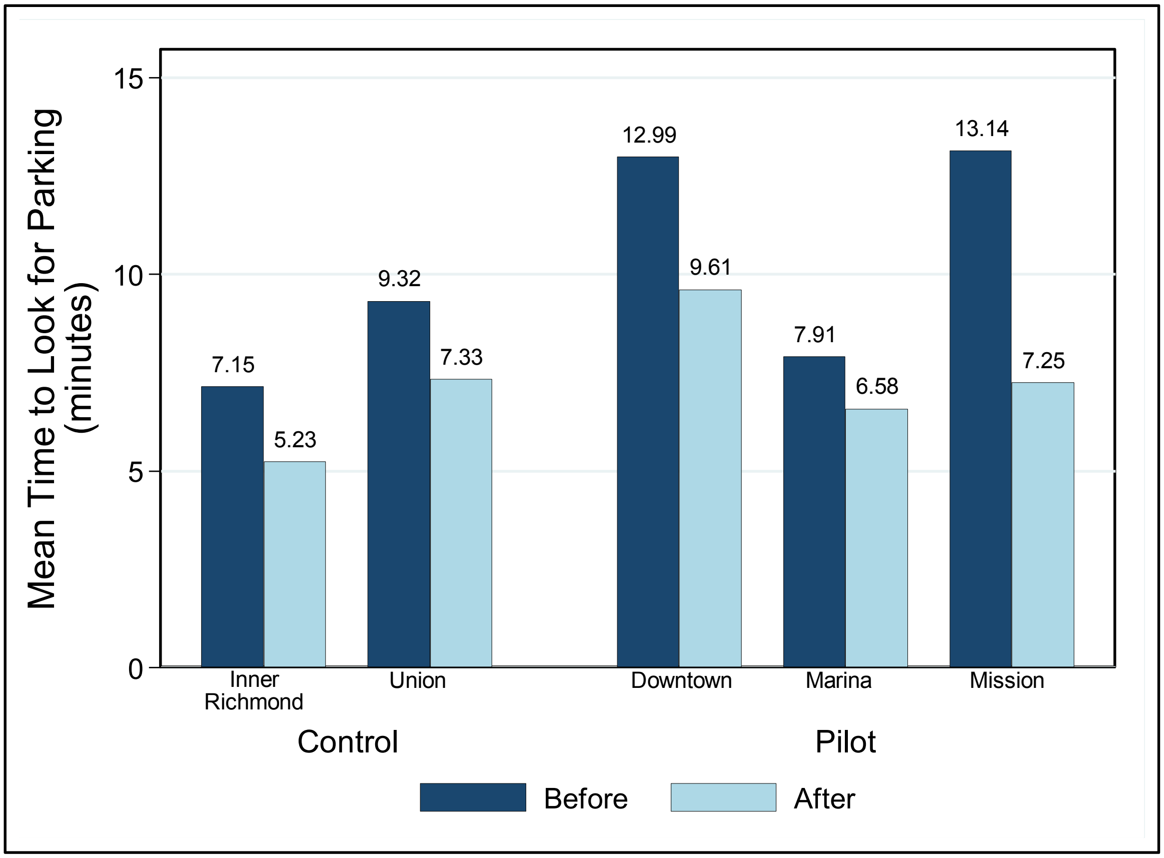
Mean	Exponent of Coefficient for Pilot and Control Areas			N
	$EXP(Pilot)$	$EXP(Control)$	$EXP(Pilot - Control)$	
Search Time (seconds) per Parking Space	0.71 **(0.001)**	0.83 **(0.000)**	0.85	221
Search Distance (feet) per Parking Space	0.73 **(0.000)**	0.83 **(0.000)**	0.88	221
Disabled Placard Parking per Available Spaces	0.99 (0.782)*	1.04 (0.495)	0.96	322

* P-values are in parentheses, and those in bold are statistically significant at the .05 probability level or less.

Source: Caroline Rodier, 2014.

Percent changes in search time and search distance in the post-pilot pricing period were calculated using the model results. A 15 percent reduction (calculated with coefficient 1 – 0.85 * 100) in parking search time (total search time divided by total number of parking spots found for each time period for each survey day) was estimated for the pilot relative to the control. For parking distance (total search distance divided by total number of parking spots found in each time band for each survey day) a decrease of about 12 percent in the pilot relative to the control was estimated. The rate of disabled placard parking was 4 percent less in the pilot relative to control areas, but not statistically significant (i.e., not different from zero change).

The cross-sectional visitor/shopper surveys in the pilot and control areas in the spring of 2011 and 2013 asked how long it took to find parking. The respondents had either driven and parked that day or had done so within the last year. As shown in Figure 5-5 respondents generally found parking in fewer minutes in control areas than in the pilot areas prior to the start of variable pricing in 2011, perhaps owing to different characteristics of the control districts (e.g., more residential relative to the pilot areas) reducing the demand for parking. The before/after comparison showed a post-deployment reduction in minutes in both the control and pilot areas.



Source: Battelle based on SFMTA data, 2014.

Figure 5-5. Mean Time to Look for Parking (in Minutes) Reported by Survey Respondent by Neighborhood and Time Period

To gain further insight into the nature of the change, an analysis of variance (ANOVA) model was fitted to the data with fixed effects for time period and area with an interaction term added to test whether the difference between control and pilot areas was different between time periods. The results of the ANOVA model, shown in Table 5-3, indicate that there was a significant difference in the time spent looking for parking between time periods (p-value<0.0001). There was also a significant difference in the amount of time respondents spent looking for parking in the control districts compared to the pilot districts (p-value<0.0001). The interaction effect was also significant (p-value=0.0251), which indicates that the mean difference between the time spent looking for parking in the control versus pilot districts depended on the time period. For the before period, respondents in the pilot districts reported spending an average 3.27 minutes longer finding parking than in the control districts. In the after period, the difference between pilot and control districts was reduced to 1.59 minutes (a reduction of 1.68 minutes). These finding suggest that SF*park* pricing was effective in making it faster to find a place to park in the pilot relative to the control districts.

Table 5-3. Results from ANOVA Model Testing for Significant Differences in Time to Find Parking by Parking Area and Time Period

Comparison	Difference in Time (Minutes)	P-Value
Before (Pilot Area – Control Area)	3.27	<0.0001*
After (Pilot Area – Control Area)	1.59	0.0022*
After (Pilot Area – Control Area) – Before (Pilot Area – Control Area)	1.68	0.0251*

*Comparison significant at the 0.05 level.

Source: Battelle based on SFMTA data, 2014.

The survey data were also analyzed with logit models, one for those who drove the day of the survey and a separate model for those who had driven to the area previously but not that day to see whether there was a difference among the two sets of respondents. The models controlled for confounding effects, or covariates, such as income, age, gender, home ZIP code, time of day, and day of week. For respondents who drove to the area on the day of the survey the model suggested greater reduced search time in the pilot areas; however, the reduction was not statistically significant. The results for those who had not driven that day suggested the opposite but, again, there was a lack of statistical significance. The opposite results for those who had not driven that day may be due to recall bias and/or could indicate the possibility that those who decided not to drive to the pilot area that day had had a particularly bad experience parking there in the past.

Although the different analytic methods produced some differences in results, a conclusion that can be drawn is that respondents, in particular those who drove the day of the survey, found parking more readily in the pilot areas after variable pricing was implemented than before.

It is important to note, nonetheless, that the national evaluation team viewed the absolute values in search times and distance derived from the manual field test as unrealistically low, which can be attributed to the survey design, although the relative differences (before/after and pilot/control) are believable. The visitor/shopper survey, on the other hand, was based on travelers reported search times, and the average differences in before/after and pilot/control comparisons are considered to be realistic based on experience of SFMTA staff and the national evaluation team. However, the visitor/shopper survey was limited by not having been administered in all pilot and control areas and by a much smaller sample than the manual field test. Consequently, the national evaluation used both sets of survey data to “scale-up” the parking search times and distances from the manual field test data with the data from the visitor/shopper survey to achieve a best estimate of the true impact of variable pricing. The results of the use of the data in this way are shown in the estimates of miles of cruising presented below.

Reduction in Cruising

An important expected by-product of variable pricing, as it made it easier for drivers to find parking, was that the amount of cruising for parking would decrease. The evaluation measured the change in cruising by the miles driven in the search for parking spots with and without variable pricing. Estimates of vehicle miles traveled (VMT) cruising for parking from 9 a.m. to 6 p.m. on weekdays and Saturdays were developed using results of the logit model based on parking search time field data, search time in the visitor/shopper survey, and parking duration and turnover from parking meter data.

VMT estimates were not possible for the Fisherman's Wharf pilot area as no parking search time data were collected there. Saturdays represented weekend VMT as no parking rates were in effect on Sundays during most of the evaluation period, nor was the visitor/shopper survey conducted on Sundays. VMT were estimated with and without variable pricing in pilot areas. (Details of the methodology are presented in Appendix E – Environmental and Energy Analysis.)

Table 5-4 shows the estimated parking cruise VMT by the average weekday and Saturday. The results show that on weekdays across all the pilot areas without variable pricing the cruise VMT would have been 12,431 miles and with pricing it was 9,123 miles. This represents 0.18 – 0.25 percent of all VMT in San Francisco County, which is substantial given the relatively small geographic area represented by the parking pilot areas.[11] On Saturdays without variable pricing an estimated 13,707 miles of travel occurred between 9 a.m. and 6 p.m. in the pilot neighborhoods. (Only the Marina area showed a slight but negligible increase in VMT on Saturdays.) With pricing, this value decreased by 22.37 percent to 10,641 miles, or 0.21 percent of all VMT in San Francisco. The overall conclusion from these estimates is that variable pricing resulted in less cruising for parking.

Table 5-4. Daily Parking Cruise VMT with and without Variable Pricing in Pilot Areas by Weekday and Saturday

Pilot Area	Variable Pricing	Weekday VMT Average		Saturday VMT Average	
		9 a.m. – 6 p.m.	Percent Change (With Pricing)	9 a.m. – 6 p.m.	Percent Change (With Pricing)
Civic Center	Without	2,295	-28.84%	2,576	-25.68%
	With	1,633		1,915	
Downtown	Without	1,570	-38.55%	1,683	-31.34%
	With	965		1,155	
Fillmore	Without	1,784	-30.01%	1,960	-24.43%
	With	1,249		1,482	
Marina	Without	1,125	-7.17%	1,152	+0.28%
	With	1,044		1,155	
Mission	Without	2,373	-9.72%	2,735	-5.07%
	With	2,142		2,597	
S. Embarcadero	Without	3,283	-36.37%	3,601	-35.07%
	With	2,089		2,338	
Total	Without	12,431	-26.61%	13,707	-22.37%
	With	9,123		10,641	

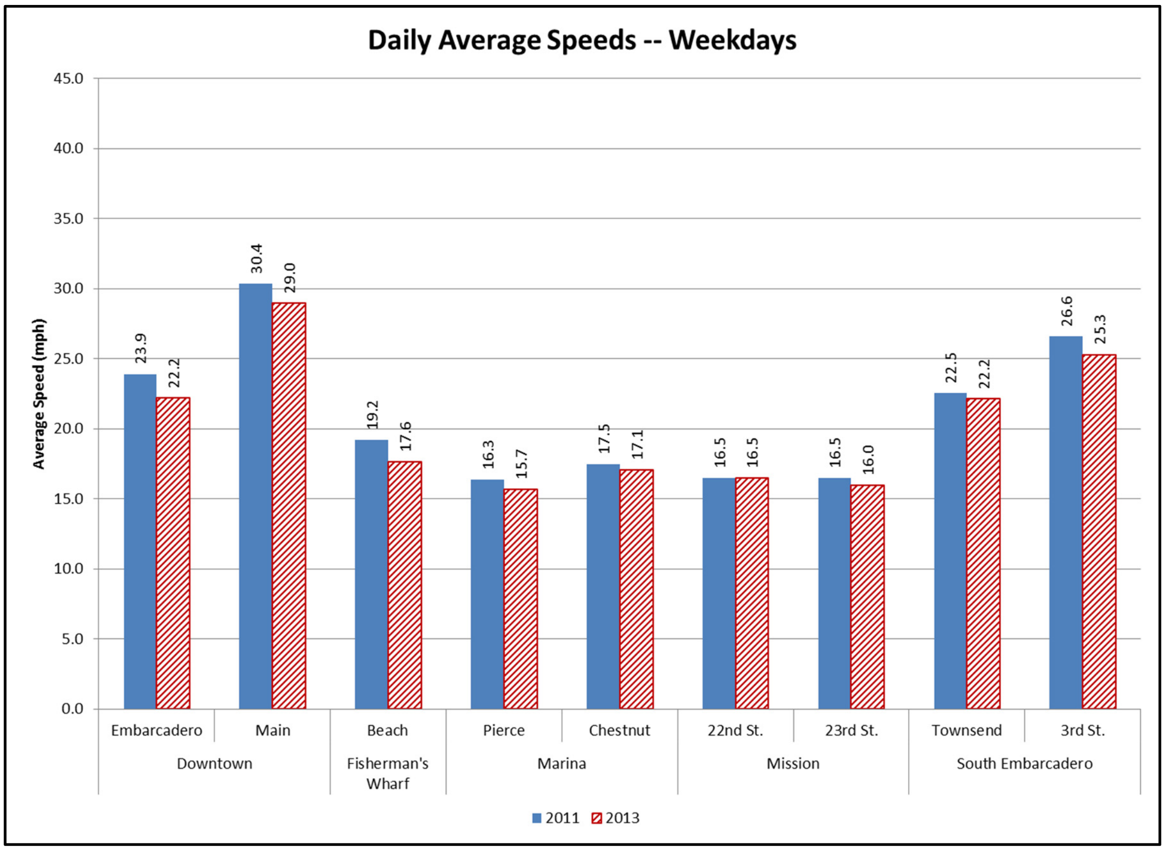
Source: Earth Matters, Inc., 2014.

[11] The EMFAC2011 run for San Francisco County shows 13,311,000 miles of travel daily (passenger vehicles only). Taken as an average this is 554,625 miles of travel per hour, or approximately 4,991,625 miles per 9 hour period. EMFAC reports VMT on freeways, arterials, and some surface streets.

Reduction in Traffic Congestion

The U.S. DOT's UPA program was intended to test the effectiveness of demand-based pricing in combating traffic congestion in metropolitan areas. In the San Francisco UPA, measurements of traffic congestion proved to be the most problematic for the evaluation. Roadway sensors deployed by SFMTA to measure traffic in pilot areas were plagued with technical problems that resulted in a limited set of data for assessing congestion changes. Consequently usable measures of changes in traffic volumes were generally not available and reliable speed data were available for only a few street segments. Automatic passenger counters (APC) on approximately 30 percent of Muni buses traversing the pilot and control areas provided another source of data for the congestion analysis. Transit travel time and speed served as a proxy for general vehicular traffic once dwell times were removed from the data. (Details on the data are presented in Appendix A – Congestion Analysis.)

Despite the limitations in the roadway sensor data, calculations of average speeds were derived for nine streets in five of the seven pilot areas as shown in Figure 5-6. Link speeds were collected in 15-minute intervals from March 2011 through May 2013, covering multiple price changes. The data analyzed for the evaluation were for the spring months (March – May) of each year. The figure shows that average weekday travel speeds were the same or lower in eight of the nine roadways in the pilot districts in 2013 compared to 2011.



Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure 5-6. Average Daily Link Speeds from Available Roadway Sensors in SF*park* Pilot Areas

Traffic speeds during the morning and evening peak periods were also examined and are shown in Table 5-5. For this analysis, the a.m. peak period has been defined as the interval between 7:00 a.m. and 9:00 a.m. and the p.m. peak period has been defined to be the interval between 3:00 p.m. and 6:00 p.m. It should be noted that in the Marina, Mission, and South Embarcadero pilot areas metering is not in effect until 9:00 a.m., and thus averages in the a.m. speeds are not shown for those areas, as they could not be affected by variable pricing. For all districts, metering is in effect through 6 p.m. during the p.m. peak.

The table shows that average travel speeds in both the a.m. and p.m. peak period declined or remained relatively unchanged after variable pricing was implemented. The findings suggest that variable pricing did not result in an increase in travel speeds in the pilot areas. In most of the pilot areas (where data were available), average travel speed remained constant or even declined slightly after variable pricing policies were implemented.

Table 5-5. Change in Average Weekday Peak Periods Travel Speeds (mph) from Available Sensors in SF*park* Pilot Areas

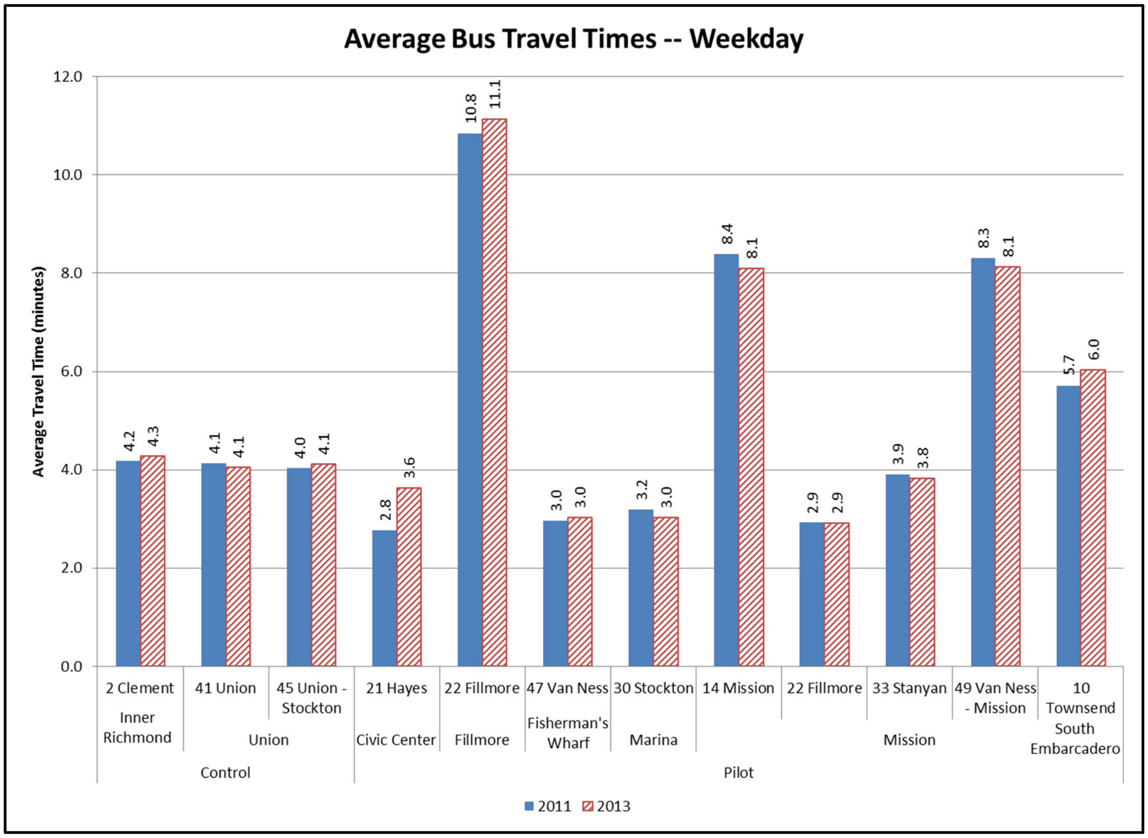
Pilot Management District	Roadway	A.M. Peak (07:00-09:00)			P.M. Peak (15:00-18:00)		
		2011	2013	Net Change	2011	2013	Net Change
Downtown	Embarcadero	26.2	22.9	-3.3	22.9	20.6	-2.3
	Main	28.3	28.4	+0.1	29.7	28.0	-1.7
Fisherman's Wharf	Beach	20.4	19.7	-0.6	18.7	17.1	-1.6
Marina	Pierce	NA	NA	NA	16.6	15.8	-0.8
	Chestnut	NA	NA	NA	16.6	17.2	+0.6
Mission	22nd St.	NA	NA	NA	16.0	16.4	0.4
	23rd St.	NA	NA	NA	15.0	14.9	-0.1
South Embarcadero	Townsend	NA	NA	NA	21.2	21.8	+0.6
	3rd St.	NA	NA	NA	26.6	24.2	-2.4

NA: Not applicable, as metering was not in effect during between 7:00 a.m. and 9:00 a.m.

Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

As roadway sensor data from the control areas were not available for comparison, it is difficult to determine if any of the changes in average travel speeds that were observed were directly attributable to the changes in parking pricing or due to other causes. For example, as the economy was in recovery from the recession in the two years after variable pricing, the lack of improvement in travel speeds could have reflected higher volumes of traffic due to favorable economic conditions.

Bus travel time served as another measure of congestion after time spent picking up and dropping off passengers was removed from the APC data. Figure 5-7 presents the average travel times of transit vehicles traveling through the pilot and control areas on weekdays, indicating that average transit travel times on the routes in the pilot and control areas changed little following variable pricing. In the control areas, because parking pricing was not varied over the course of the evaluation period, any changes in transit travel times that might have occurred would have been due to other reasons. For the three routes in the control areas travel times remained fairly constant at about four minutes, suggesting that the background level of congestion affecting travel times with which the pilot areas would be compared remained the same over the duration of the evaluation period.



Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure 5-7. Weekday Average Transit Travel Times by Routes in Pilot and Control Areas

Figure 5-7 shows that average transit travel times remained relatively constant on all the routes through the pilot areas – never changing more than 0.3 minutes – except for the #21-Hayes route in the Civic Center pilot parking management district. For the #21-Hayes route in the Civic Center pilot area, travel times increased between 2011 and 2013, but the overall change in travel times was less than a minute. Although traffic volume data are lacking, a possible explanation for increased travel times around the Civic Center was more congestion due to an improving economy.

The travel speed of transit vehicles was assessed using the APC data. Table 5-6 shows the results of the statistical analysis of average travel speed of transit vehicles by parking area. The shaded cells in the table represent statistically significant differences at a 95 percent confidence level. The negative values shaded in red represent reductions in average speeds, while the positive values shaded in green represent increases in average speed compared to 2011 averages. The results show that average transit travel speeds in the control parking areas were approximately 0.1 mph lower in 2013 compared to 2011. This suggests that overall average transit travel speeds were declining only slightly over time. It should be noted, however, most of the changes in travel speeds were relatively minor (less than 0.20 mph) and well within the margin of error.

Table 5-6. Statistical Comparison* of the Change in Average Transit Speeds by Parking Management District

Parking Management Districts		Change in Average Speed (mph) of Transit Vehicles Between Spring 2011 to Spring 2013		
		ΔSpeed	Std. Error	t value
Control	Inner Richmond	-0.07	0.066	-1.06
	Union	-0.15	0.042	-3.60
	Total	-0.13	0.035	-3.66
Pilot	Civic Center	-0.29	0.063	-4.61
	Fillmore	-0.18	0.040	-4.37
	Fisherman's Wharf	0.06	0.056	1.18
	Marina	0.10	0.052	1.83
	Mission**	0.13	0.024	5.30
	South Embarcadero	-0.82	0.074	-11.12
	Total	-0.02	0.017	-0.95

*T-test for significant before/after difference in average speeds was performed. Shaded cells indicate t-values that are statistically significant at 95 percent level of confidence.

**Data for Mission routes 14 and 49 for 2012 not included due to impact of construction.

Source: Texas A&M Transportation Institute, 2014.

Measures of congestion based on travel speeds and travel times did not indicate that variable pricing had an impact; however, the results should be judged as inconclusive owing to the limitations of the data that were available for the analysis. Moreover, the traditional measures of congestion (link travel speeds and travel times) might lack sensitivity to changes caused by parking maneuvers that are not in the immediate vicinity of the traffic sensors. For example, SFMTA examined both the roadway sensor data and the transit travel data at a more granular level than the national evaluation.[12]

Given these issues with measuring congestion with roadway and transit data, a measure directly related to parking may provide insight on potential congestion reduction. SFMTA performed field data collection of double parking on a sample of blocks in the pilot and control areas in 2011 and 2013. They also collected occupancy of legal parking spaces to provide a reference point for the double parking. Logit modeling of the data produced the results shown for personal vehicles and commercial vehicles in Table 5-7. Based on the results from the model, double parking was estimated to have declined by about 14 percent for personal vehicles and by about 21 percent for commercial vehicles in the pilot versus the control areas, although the differences between pilot and control areas were not

[12] Personal communication with SFMTA in April 2014. SFMTA's analysis looked at corridors by the side of streets where there was a decrease in double parking and the inbound/outbound direction of buses. Their analysis found that a relationship may exist between decreased double parking (which has a loose relationship with decreased occupancy) and transit performance, but they ultimately concluded that the data were insufficient to draw significant general conclusions about the degree to which variable pricing of parking impacted overall congestion in the pilot areas.

statistically significant, possibly requiring a larger sample size owing to the high variation in the rate of double parking. Since double parking can result in slower speeds and travel times for other vehicles in the lane, the decrease in double parking in the blocks that were surveyed is important and an indication of the potential improvement in congestion closer to the parking maneuver than the other traffic data were able to detect.

Table 5-7. Logit Model Results for Double Parking by Parking Area and Time Period

Mean	Exponent of Coefficient for Pilot and Control Areas			N
	$EXP(Pilot)$	$EXP(Control)$	$EXP(Pilot - Control)$	
Personal Vehicle Double Parking per Available Spaces	0.56 (0.001)*	0.65 (0.134)	0.86 (0.650)	322
Commercial Vehicle Double Parking per Available Spaces	0.86 (0.020)*	0.68 (0.540)	0.79 (0.425)	322

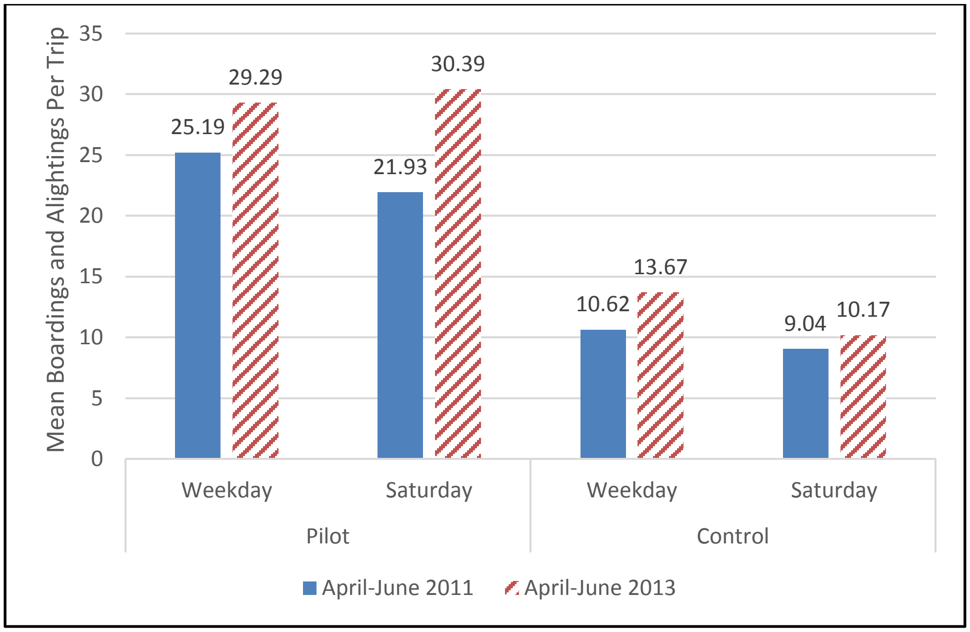
* p-values in parentheses that are less than or equal to .05 are considered statistically significant.

Source: Caroline Rodier, 2014.

Mode Shift

SF*park* had the potential to affect mode decisions through parking pricing based on demand and enhancing transit performance to attract more usage. Mode shift was examined with data on transit ridership and survey data. The APC data provided counts of boardings and alightings from Muni bus routes that traversed the pilot and control areas. Respondents in the visitor/shopper survey were asked about their mode and, if they made a change, the reason for making a change.

Figure 5-8 compares the average boardings and alightings per trip by day of week and area in the spring of 2011 and 2013. For pilot areas, weekday transit ridership showed an overall increase of 16.2 percent and an increase of 38.6 percent on Saturdays. Comparison of the pilot and control areas showed a bigger before/after difference in the pilot areas than the control areas, with a much larger difference on Saturdays.



Source: Battelle based on SFMTA data, 2014.

Figure 5-8. Mean Boardings and Alightings per Trip by Area

An ANOVA model with fixed effects for time period (before/after) and area (pilot/control) was used to test the statistical significance of the differences observed. An interaction term was added to test whether the difference between control and pilot areas changed between spring 2011 and spring 2013. A significant interaction effect would support the notion that variable pricing in the pilot areas could account for the observed difference. Table 5-8 presents the ANOVA results. The data on boardings and alightings showed higher ridership in the spring of 2013 compared to 2011 in both pilot and control areas. The pilot areas showed a bigger before/after difference than the control areas, with a much larger difference on Saturdays. With regard to the impact of variable pricing, the evidence (significance of the interaction effect in the ANOVA model) supports variable pricing as an explanation for Saturday increases in ridership in the pilot areas, but not the weekday increases in ridership.

Table 5-8. Results from ANOVA Model Testing for Significant Differences in Boardings and Alightings (per trip) between Pilot and Control Area by Time Period

Day of Week	Comparison	Difference in Average Boardings and Alightings	P-Value
Weekdays	Pilot Area (Spring 2013 – Spring 2011)	**4.09**	**<0.0001***
	Control Area (Spring 2013 – Spring 2011)	**3.06**	**<0.0001***
	[Pilot Area (Spring 2013 – Spring 2011)] – [Control Area (Spring 2013 – Spring 2011)]	1.03	0.1116
Saturday	Pilot Area (Spring 2013 – Spring 2011)	**8.46**	**<0.0001***
	Control Area (Spring 2013 – Spring 2011)	1.13	0.4791
	[Pilot Area (Spring 2013 – Spring 2011)] – [Control Area (Spring 2013 – Spring 2011)]	**7.33**	**<0.0001***

*Values in bold indicate the comparison was significant at the 0.05 level

Source: Battelle based on SFMTA data, 2014.

The visitor/shopper survey included questions on mode shift and the reasons a shift was made when it occurred. For the question "Compared to a year ago, have you changed your transportation mode to get to the area?" Table 5-9 shows that about one in four (or N=179) respondents to the "after" survey said they had changed their mode of travel to the area compared to a year before and the difference was statistically significant (chi-square test <.05).

Table 5-9. Summary Statistics (N and Percent) for "Compared to a year ago, have you changed your transportation mode to get to the area?" by Area and Time Period

Area	Compared to a year ago, have you changed your transportation mode to get to the area?	Before N (Percent)	After N (Percent)
Control	1 – Yes	117 (18.48%)	115 (16.76%)
	2 – No	516 (81.52%)	571 (83.24%)
	Total	**633 (100.00%)**	**686 (100.00%)**
Pilot	1 – Yes	109 (16.37%)	179 (24.32%)
	2 – No	557 (83.63%)	557 (75.68%)
	Total	**666 (100.00%)**	**736 (100.00%)**

Source: Battelle based on SFMTA data, 2014.

However, when respondents in the pilot areas were asked about the reason for their mode change, parking availability or cost did not figure as prominently as a new school or work location (19 percent), move to or from the area (10 percent), or other reasons (27 percent). Fifteen percent cited more difficulty in finding parking as their reason for a mode change, and 10 percent said more expensive parking was the reason. These data suggest that variable pricing was not strongly linked to mode shift in the post-pilot pricing period.

Of the 179 mode "changers" in the pilot areas 149 reported using a mode more often, and of those 149 about half (53 percent) said they used public transit more, 32 percent used a car more, and a smaller proportion said that they bicycled (7 percent) or walked (15 percent) more. Of the 78 respondents in pilot areas who said they used a mode less, 67 percent used a car less and 26 percent used less public transit, with other mode reductions of 5 percent or smaller. Thus, on balance the survey data indicated that pilot areas had a few more transit riders after variable pricing was in effect but not many, and most of the mode changes were not related to parking.

Thus, it would appear that the increase in ridership noted in the APC data appears to have been due more to factors other than pricing, perhaps improving economic conditions in the pilot areas. Perceptions of parking's high cost or lack of availability encouraged some to change mode, but negative aspects of parking were not the main reason for mode changes that occurred in the post-pilot pricing period. Nevertheless, the extent to which parking availability and price encouraged even a small percent to use alternative transportation is a positive impact in a high-density city such as San Francisco.

Reduction in Emissions

As cruising for parking was reduced with variable pricing, so too were emissions of pollutants in areas where variable pricing was implemented. The evaluation of impacts on air quality used motor vehicle emission factors from the EMFAC2011[13] model, the tool used by the California Air Resources Board for estimating emissions from on-road vehicles in California. The model was used to estimate emission factors for San Francisco County for 2012. That year represented the mid-point between pre-deployment 2011 and post-deployment 2013, and allowed comparison of pre- and post-deployment emissions from parking searches using the same emission rates. Consequently any difference in emissions would be due to changes in parking search cruising and the speed of the searches.

Five types of emissions were estimated in the national evaluation. ROG represents reactive organic compounds; CO is carbon monoxide; NOx is nitrogen oxides; CO_2 is carbon dioxide, a principal greenhouse gas, and $PM_{2.5}$ is fine particle matter less than 25 microns in width. ROG and NOx are the primary precursors to ozone, the compound which, at breathing zone level, can damage the lungs and respiratory system. CO can be dangerous or even fatal when inhaled in large concentrations, and $PM_{2.5}$ also has significant health consequences. CO_2, as a principal component of greenhouse gases, does not cause direct health effects, but is the most commonly used metric for the concept of a carbon footprint.

Table 5-10 summarizes the impact of SF*park* on emissions across all six pilot areas. (No parking search data were collected in the seventh pilot area, Fisherman's Wharf, and, therefore, estimation of emissions for that area was not possible.) Overall there was a significant reduction in emissions both on weekdays and Saturdays. The "without" columns represent emissions in the absence of variable pricing and the "with" represents emissions with variable pricing in pilot areas.

[13] EMFAC stands for EMission FACtor.

Table 5-10. Summary of Daily Emission Impacts of Variable Pricing by Average Weekday and Saturday

Pollutant	Weekday (lbs.)		Percent Change with Pricing	Saturday (lbs.)		Percent Change with Pricing
	Without	With		Without	With	
ROG	9.25	6.79	-26.61%	10.20	7.92	-22.37%
NOx	9.39	6.89		10.36	8.04	
CO	119.15	87.44		131.38	101.99	
$PM_{2.5}$	1.31	0.96		1.44	1.12	
CO2	32,746.16	24,032.16		36,107.91	28,031.21	

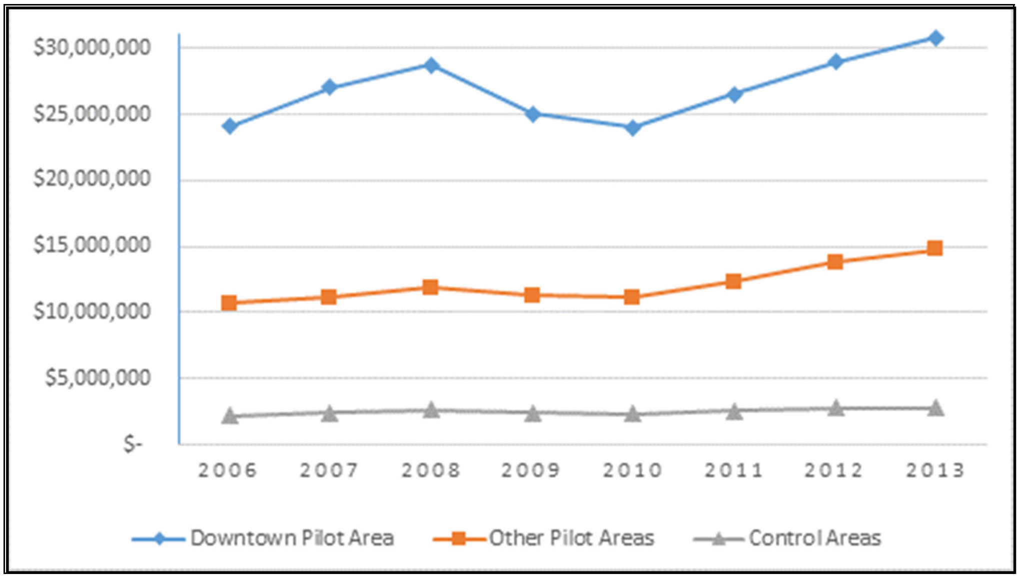
Source: Earth Matters, Inc., 2014.

The percentage change is the same for all pollutants because the estimated speed of parking cruise travel with and without variable pricing did not vary enough to require the use of different emission factors for different speeds. Therefore, the emissions changed linearly with respect to the change in VMT. Had speeds been available at a finer scale the emission changes would likely not have been linear. The changes on the neighborhood level are identical, in percentage terms, to the VMT changes presented earlier.

Potential Impact on Businesses and Social Segments

Availability and price of parking can affect the ability of the public to patronize businesses in an area and may impact some segments of society more than others, inviting concerns about equity of how parking is managed with pricing. Data from the visitor/shopper survey and sales tax revenues were used to examine these potential impacts.

To assess economic vitality in the SF*park* pilot and control areas sales taxes from establishments in the "food product," "general retail" and "miscellaneous" categories including chain stores were examined for the second quarter (April through June) for each year from 2006 through 2013. Figure 5-9 presents the data summed by pilot and control areas, with the Downtown pilot area shown separately due to scale. (One caution with the sales tax data is that it was not possible to adjust them for inflation owing to differences between the components of the consumer price index and the sales tax categories used in the evaluation.) The figure demonstrates an uptick in the pilot areas starting in 2011, before variable pricing but continuing afterward. The control areas, on the other hand, did not experience the increase. While variable pricing in the pilot areas might not have been the cause of sales growth as reflected in sales tax revenues, the data certainly show no negative impact of SF*park* pricing on business.



Source: Battelle based on data from the Controller's Office, City and County of San Francisco, 2014.

Figure 5-9. Second Quarter Sales Tax Revenues by Pilot and Control Areas, 2006 through 2013

Another measure of variable pricing's business impact is the purpose for which people travel to an area. Some purposes have more potential for revenue generation and, thus, might be seen as more valuable for businesses. Among the responses to the question on trip purpose in the visitor/shopper survey shown in Table 5-11, shopping, dining or drinking, personal errand or appointment, and entertainment probably have the most direct potential for revenue generation. A chi-square test indicated significant differences (at 0.05 level) in response distributions between the pilot and control areas in both periods. The pilot areas tended to be work destinations, with a greater proportion of respondents (around 33 percent) coming to the areas for work compared to the control areas (about 13 percent). A smaller proportion of respondents in the pilot came to the area for shopping, dining or drinking, and personal errand or appointment. Entertainment was a minor purpose for trips in both areas, although somewhat greater in the pilot than control areas.

Table 5-11. Summary Statistics (N and Percent) for "What was the reason* you came to the area today?" by Area and Time Period

Area	What was the reason you came to the area today?	Before N (Percent)	After N (Percent)
Control	1. Shopping	213 (33.13%)	187 (27.26%)
	2. Working	81 (12.60%)	95 (13.85%)
	3. Dining or drinking	144 (22.40%)	209 (30.47%)
	4. Personal errand or appointment	172 (26.75%)	191 (27.84%)
	5. Visiting friends in this area	44 (6.84%)	45 (6.56%)
	6. Gym or other Exercise	34 (5.29%)	43 (6.27%)
	7. Entertainment	5 (0.78%)	1 (0.15%)
	8. Site-seeing/Tourist attractions	12 (1.87%)	11 (1.60%)
	9. I live in this area	30 (4.67%)	30 (4.37%)
	10. School or Education	3 (0.47%)	4 (0.58%)
	11. Other	1 (0.16%)	1 (0.15%)
	Total	**738 (114.96%)**	**817 (119.10%)**
Pilot	1. Shopping	172 (25.63%)	149 (20.24%)
	2. Working	216 (32.19%)	252 (34.24%)
	3. Dining or drinking	89 (13.26%)	157 (21.33%)
	4. Personal Errand or appointment	136 (20.27%)	143 (19.43%)
	5. Visiting friends in this area	48 (7.15%)	42 (5.71%)
	6. Gym or other Exercise	25 (3.73%)	24 (3.26%)
	7. Entertainment	21 (3.13%)	9 (1.22%)
	8. Site-seeing/Tourist attractions	33 (4.92%)	18 (2.45%)
	9. I live in this area	25 (3.73%)	31 (4.21%)
	10. School or Education	10 (1.49%)	28 (3.80%)
	11. Other	7 (1.04%)	1 (0.14%)
	Total	**782 (116.54%)**	**854 (116.03%)**

*The respondent could give more than one reason for trip.

Source: Battelle based on SFMTA data, 2014.

Given the basic differences in the pilot and control areas, the issue is whether there was an increase in trip purposes of interest to businesses in the pilot areas. The results show that the pilot areas had significant differences in the response distribution between the two periods whereas the control area differences between periods were not significant. More pilot area respondents after pricing came for dining and drinking (up from 13 percent to 21 percent) than before. On the other hand, a lesser percentage of respondents came to the pilot area afterward for shopping (20 percent) compared to before (25 percent). Personal errand or appointment was unchanged. Based on data on trip purpose in the pilot areas, no overall impact on businesses, positive or negative, can be attributed to variable pricing. Although shopping trips experienced a relative decline, they were compensated by an increase in trips for dining or drinking. It should also be noted that the analysis does not account for potential changes in the businesses themselves, such as more restaurants and fewer retail establishments.

Another measure of potential business impact was whether the change in parking pricing affected how frequently people visited the area. In the visitor/shopper survey, after variable pricing was in effect, over three-fourths of the respondents said they visited about the same amount, 15 percent said they visited the area more, and less than 10 percent said they visited the pilot areas less often. These findings suggest that people continued to visit areas where variable pricing was in effect at least to the extent that they had been visiting and were not discouraged by the change in parking prices.

According to respondents in the visitor/shopper survey, there was a significant drop in the amount of money that was spent in the before versus the after period in the control area (p-value=0.0007) as reflected in the ratio in Table 5-12. In the control area, respondents said they had or planned to spend about 38 percent more in the before period compared to respondents in the after period. Despite the apparent drop in spending in the pilot area shown in the table, there was no statistically significant difference in money spent between the two periods in the pilot area. An interaction term was added to test whether the difference between control and pilot areas was different between the before and after periods. The interaction effect was not significant (p-value=0.1541), which indicates that the mean difference in the money spent during the visit in the control versus pilot areas did not depend on the time period. That is, spending was fundamentally different between pilot and control areas regardless of the change in parking pricing. Nevertheless, it is surprising that the respondents in the pilot areas did not show the increase in spending that might have been expected based on the trends in tax revenues.

Table 5-12. Results of ANOVA Test for Significant Differences in "How much money will (did) you spend in the area on your visit?" across Time Periods for Pilot and Control Areas

(Results are Ratios of Geometric Means between Time Periods)

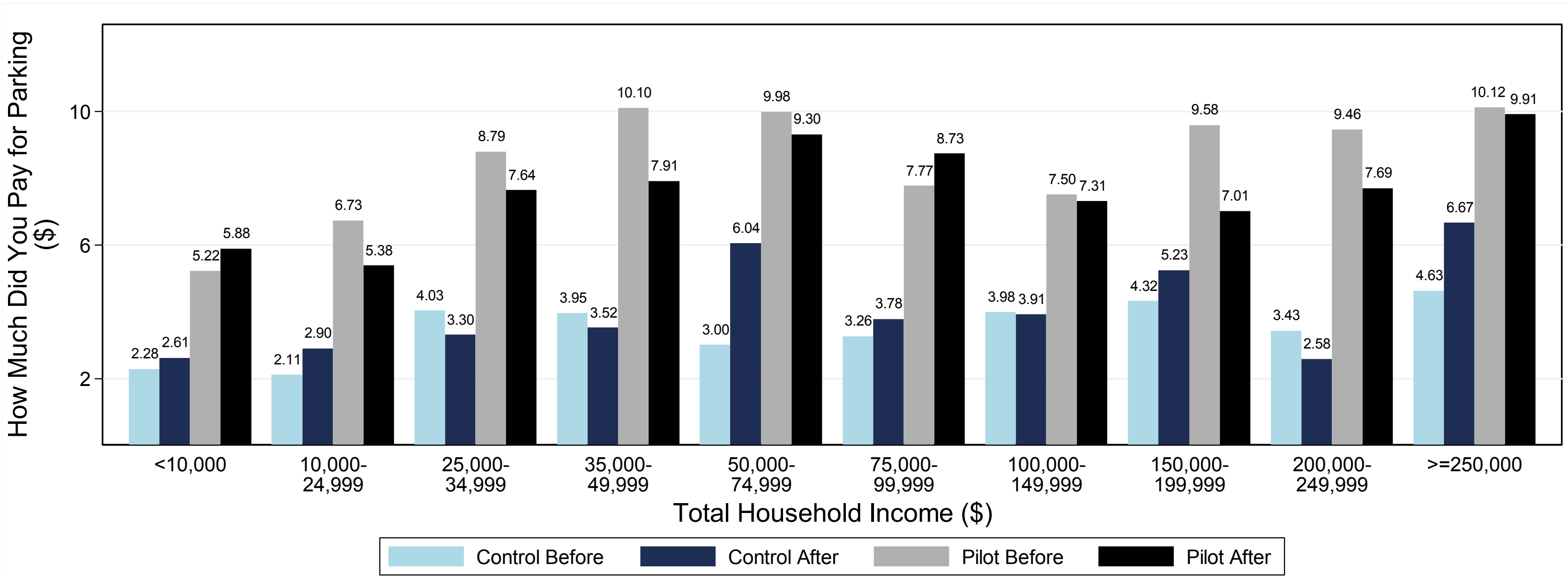
Comparison	Ratio of Money Spent	P-Value
Control Area (Before/After)	1.38	0.0007*
Pilot Area (Before/After)	1.14	0.1480
Control Area (Before/After)/Pilot Area (Before/After)	1.21	0.1541

*Comparison significant at the 0.05 level.

Source: Battelle based on SFMTA data, 2014.

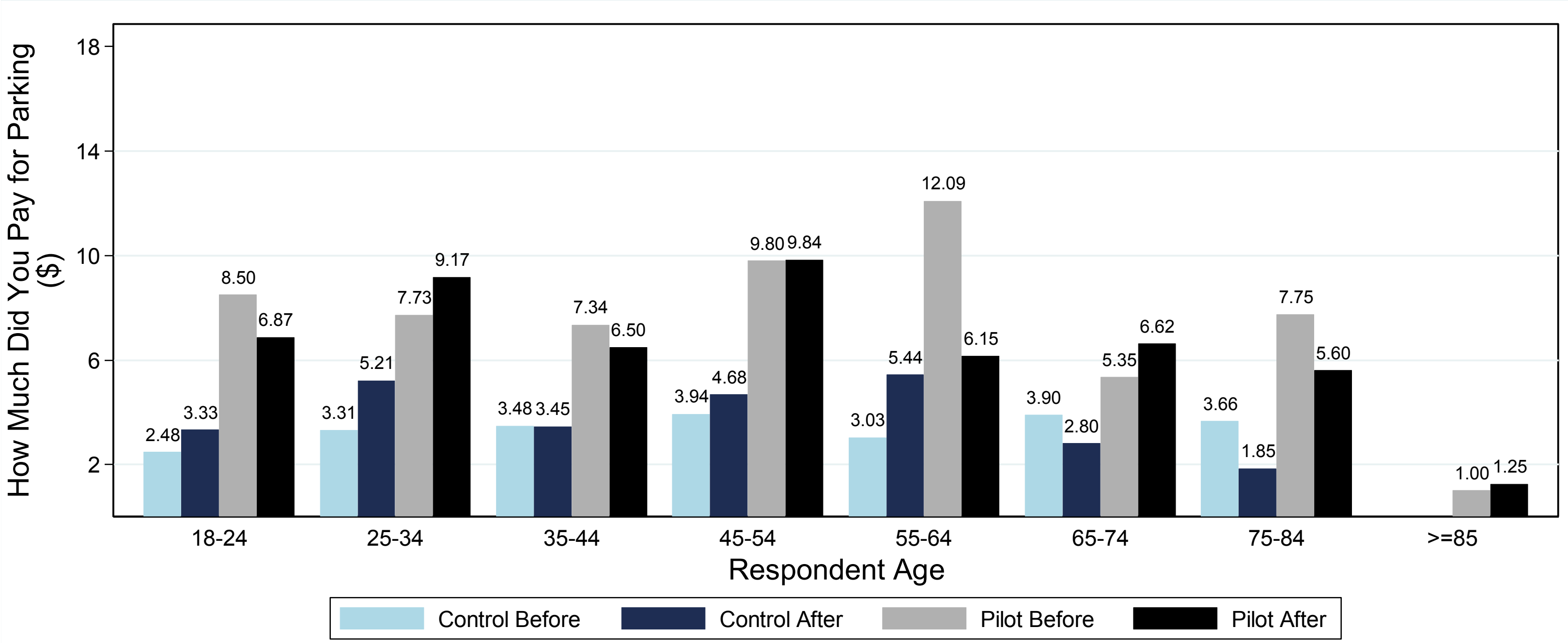
Variable pricing does not appear to have had a positive or negative impact on business. Sales (not adjusted for inflation) increased in the pilot areas judging from sales tax revenues, and survey respondents said they were visiting the area about the same amount in 2013. While the proportion of trips for shopping purposes declined somewhat in the pilot areas, they were compensated for by an increase in trips for dining or drinking. A surprising finding was that respondents said they spent less in pilot areas in 2013 than those surveyed in 2011, but this was not attributable to the effect of pricing as the decreased spending was greater in the control areas.

Potential equity impacts were examined by income and age groups using data from the visitor/shopper survey. Questions on parking search time, distance parked from destination, perceived ease of parking, and amount paid for parking were separately examined using ANOVA models with ten income categories and eight age categories. Respondents' income was based on ten self-identified categories between less than $10,000 and more than $250,000. Age of respondents was based on eight self-identified categories between 18 and 85 or more. There were differences between the pilot and control areas on some questions, as seen in the responses to amount paid for parking by income and age category in Figure 5-10 and Figure 5-11. However, the effect of time, i.e., difference after variable pricing, was not significant. The ANOVA results taken as a whole (and reported in detail in Appendix D – Equity Analysis) revealed no systematic negative or positive impact by income or age in any of the survey questions examined.



Source: Battelle based on data provided by SFMTA, 2014.

Figure 5-10. How Much Did You Pay for Parking (Average) by Area, Total Household Income, and Time Period



Source: Battelle based on data provided by SFMTA, 2014.

Figure 5-11. Average Amount Paid for Parking by Area, Age, and Time Period

5.2.2 The Parking Information Technology Projects

The San Francisco UPA launched several parking information technology projects, shown in Table 5-13, over the course of the evaluation period, with all of them driven by the SF*park* data feed of real-time parking availability and price data for SFMTA's on-street and garage parking. Although it was outside of the national evaluation time frame, in January, 2014 SFMTA discontinued usage of in-ground parking sensors and no longer disseminated real-time on-street parking availability data. Parking pricing data remained available.

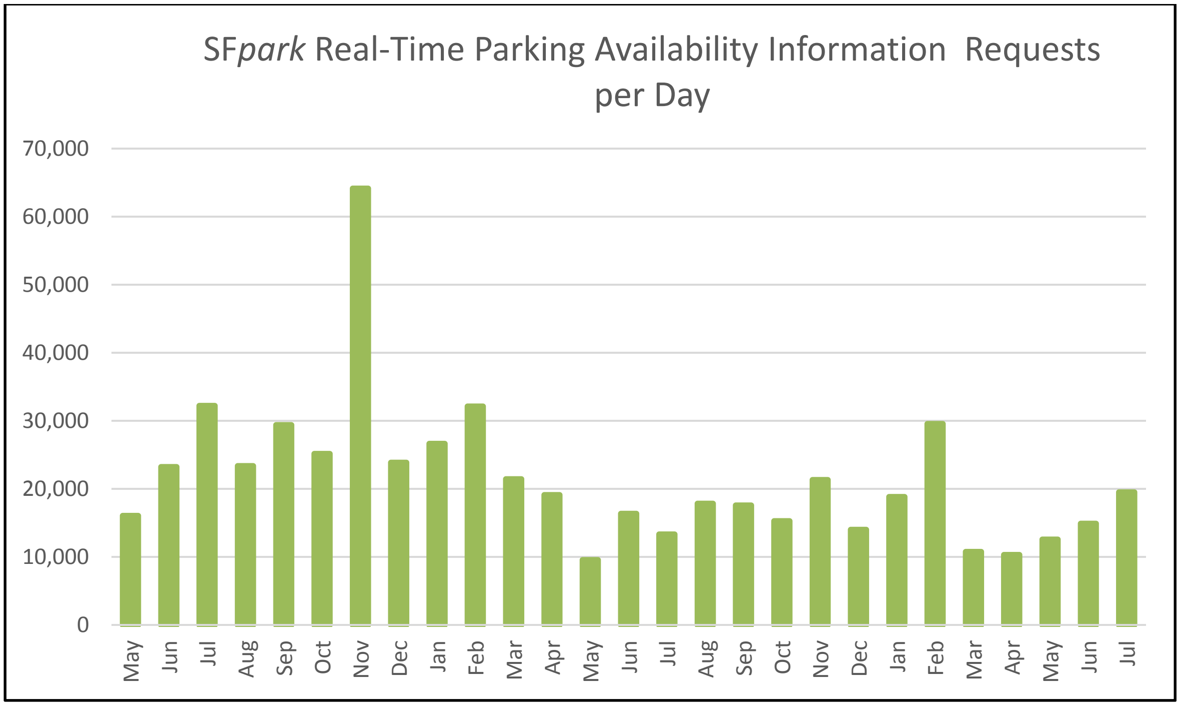
SFMTA launched its iPhone app and real-time parking information website at a widely publicized media event in April of 2011. MTC launched parking information on its 511 phone service and website between March and May of 2012, although they delayed a marketing campaign until the fall of 2013 to coordinate the parking information with other upgrades to its 511 services. Consequently, there was no outreach to raise the public's awareness of 511's parking information enhancements until after the end of the evaluation period.

Table 5-13. Parking Information Technology Projects

Parking Information Technology Project	Go Live Date
SF*park* iPhone App Launch	April 24, 2011
Real-time Parking Information on SFMTA Website	April 24, 2011
Real-time Parking Information via Text Messaging	September 15, 2011-June 1, 2012
SF*park* Android App Launch	November 7, 2011
Real-time Parking Information on Dynamic Message Signs	December, 2011
Real-time Parking on 511 Website	March, 2012
511 Phone Real-time Parking Information	May, 2012

Source: Battelle, 2014.

Figure 5-12 shows the daily average number of requests made to the SF*park* data feed by month from May 2011 through July 2013. Although the number of requests fluctuated throughout the evaluation period, they averaged 649,057 per month, which is equivalent to an average 21,417 per day. The spike in requests in November 2012 may be related to media coverage around the time of the launch of the Android app.

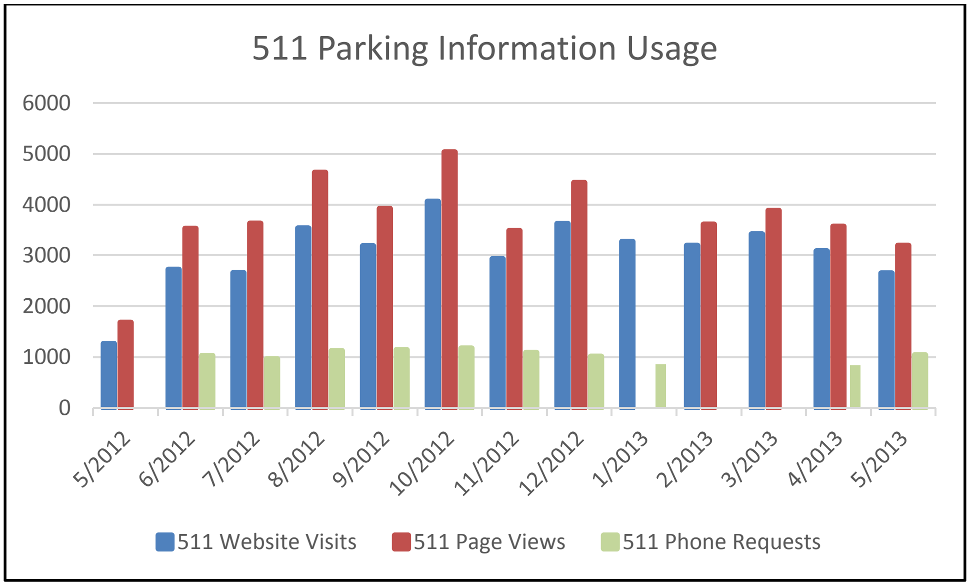


Source: Battelle based on SFMTA data, 2014.

Figure 5-12. Average Number of Requests for SF*park* Real-time Parking Information per Day, May 2011 through July 2013

SFMTA collected data on the number of SF*park* app downloads for iPhone and Android. A total of 70,387 downloads of the apps occurred by May 2013. Of these 59,512 were for the iPhone app with nearly half occurring in the first two months following SFMTA's media event in April 2011. The extent to which people who downloaded the apps made use of them is not known.

Figure 5-13 presents usage information for parking information on 511, showing much higher website usage compared to phone. Page views are the number of webpages viewed during the site visits. The generally low usage of both website and phone isn't surprising given the absence of marketing of the parking enhancements to 511 during the evaluation period.



*Information was unavailable for 511 page views in January 2013.

Source: Battelle based on MTC data, 2014.

Figure 5-13. Usage* of Parking Information on the 511 Website and Phone

The visitor/shopper survey in 2013 included questions about awareness and usage of parking information technologies. As shown in Table 5-14 only 215 (99 plus 116) respondents, or 15.6 percent of all respondents, were aware of parking information sources. Low awareness is not surprising considering that SFMTA's promotional event had occurred two years before and MTC had not conducted any promotion prior to the survey.

Table 5-14. Awareness of Parking Information Sources: Summary Statistics (N and Percent) for "Are you aware of ways to get information to help you park in the area?" by Area*

Area	Are you aware of ways to get information to help you park in the area?	After Period N (Percent)
Control	1. Yes	99 (14.86%)
	2. No	567 (85.14%)
	Total	666 (100.00%)
Pilot	1. Yes	116 (16.32%)
	2. No	595 (83.68%)
	Total	711 (100.00%)

*Chi-square test had a P-value of 0.4588, indicating there was no significant difference between the pilot and control areas at the 0.05 level of significance.

Source: Battelle based on SFMTA data, 2014.

Of the 215 respondents who were aware of any way to get information to help park, they collectively identified a total of 240 sources (most of which were the same). Respondents could identify multiple sources, but almost none did. In both the pilot and control areas, respondents were most familiar with 511.org and the SF*park* mobile application. Of the individuals who were aware of ways to get information to help park, only 36 people used any source of information “sometimes” or “often.”

In conclusion, the real-time parking information technologies held more promise than was realized during the evaluation period. SFMTA launched its iPhone parking app with great fanfare and garnered considerable media coverage. Despite that attention, the awareness and use of those technologies did not filter down to the average person who visited the SF*park* areas. Thus, the technologies ultimately did not appear to be effective in helping very many people with their decisions about parking during the period of the evaluation.

5.3 Assessment of U.S. DOT Four Objective Questions

The preceding section presented the major evaluation findings of the pricing project and the use of technology as a supporting strategy. This section breaks down the findings by the nine analysis areas used in the San Francisco UPA evaluation. These nine areas are derived from the four U.S. DOT objective questions originally posed for the national evaluation and discussed in Section 4 of this report. Given the broad scope and amount of information to convey, this section attempts only to summarize the findings for the hypotheses and questions for each of the nine analysis areas. Complete details on findings, data and methods used in each analysis are presented in Appendices A through I.

5.3.1 Summary of Congestion Impacts

Two hypotheses formed the basis for the analysis of the impact of the UPA projects on congestion. The first hypothesized effect was that the projects would reduce traffic congestion on selected routes in the areas where they were implemented. The second hypothesis was that travelers would perceive the reduced congestion. To test these hypotheses a variety of data were analyzed, including roadway sensors installed in the SF*park* pilot and control areas, data from Muni buses equipped with APC devices, and before/after surveys with travelers to the parking areas.

Table 5-15 summarizes the findings for these two hypotheses. Overall, the findings on the hypothesized congestion effects were inconclusive or not supported by the data. The traditional measures of congestion (link travel speeds and travel times) did not change substantially after SFMTA implemented variable pricing in the pilot areas. One possible explanation might be the lack of sensitivity of the data and the measures used to assess changes caused by parking maneuvers. The type of sensors used in this evaluation provides point estimates of speeds, and could not measure perturbations (such as those caused by parking maneuvers) unless they occurred in the immediate vicinity of the sensor. Furthermore, performance issues associated with the traffic sensors resulted in less than the desired quantity of data necessary for evaluating the congestion impacts of pricing.

Measuring the effects of parking maneuvers on congestion required speed derived from travel times (i.e., space mean speeds) or travel times to have been measured directly. Because traditional means of measuring travel times were not available from the roadway sensors, an attempt was made to use travel times from transit vehicles as a surrogate. The results suggest, however, that travel times available from transit vehicles were not sensitive enough to detect the impacts of parking maneuvers on congestion level. Only a limited number of vehicles in SFMTA’s fleet is equipped with the APC devices to collect transit travel times including only a small portion of the transit vehicles traveling through each parking area. In addition, the portions of the routes passing through individual parking areas are relatively short in distance, making the likelihood of a parking maneuver impacting a bus' travel time relatively small. Moreover, other factors such as traffic signal operations and schedule adherence criteria may have impacted transit travel times in the corridors where the buses traveled, thereby reducing the ability to quantify the impacts of parking maneuvers on transit travel times.

Travelers' perception of congestion was based on changes in survey responses prior to and after variable pricing. Two survey questions dealt with perception—one on traffic congestion and the other on parking availability. For both questions the results showed that visitors and shoppers did not perceive an improvement in the districts where variable pricing was implemented compared to the control areas. While only a minority of respondents felt that traffic was heavy in the area in which they parked, that percentage increased in the pilot districts from 32 percent before to 35 percent after variable parking pricing was implemented. Forty-one percent of respondents in pilot areas also thought parking availability had worsened compared to 31 percent in control areas. While SF*park* did not appear to influence perception of improved conditions where variable pricing was implemented, respondents did report an improvement in actual parking experience. The time they reported it took to find parking went down after variable pricing was in effect, and it went down more sharply (by an average of 1.68 minutes) in the pilot than control districts. Moreover, respondents in both pilot and control districts were able to park closer to their destination based on the number of blocks they reported than in the baseline period.

Table 5-15. Summary of Conclusions from Congestion Analysis by the National Evaluation Team

Hypotheses	Result	Evidence
The deployment of SF*park* and the 511 improvements will reduce traffic congestion on selected travel routes in the areas in which they were implemented.	Inconclusive	Major reductions in transit travel times or in travel time reliability measures, such as 95th percentile and buffer indices, were not observed in those portions of the transit routes passing through the SF*park* pilot parking management districts.
	Unknown	Traffic sensor issues did not permit the vehicle throughput or person throughput measures to be collected.
	Inconclusive	Implementing the UPA improvements had little to no impact on the ratio or average peak period to off-peak period speeds, which remained at approximately the same levels from 2011 to 2013. The speed in the peak period was expected to have been relatively constant, as most of the drivers would not have been looking for a parking space. In the off-peak period, when there were fewer vehicles, speeds would have been more sensitive to drivers searching for parking with an improvement expected in the off-peak speed after price changes. Thus, a drop in the ratio might have indicated that parking pricing had had an effect.
Travelers will perceive that congestion has been reduced	Not supported	Survey respondents in pilot districts did not perceive a reduction in traffic, as the percentage who thought traffic was heavy increased slightly after variable pricing was implemented. Respondents in pilot districts also thought parking availability had worsened. The results were in the opposite direction for reported parking experience. Respondents in pilot districts reported less time to find parking and the decrease was larger than in the control districts. Respondents were generally able to park closer to their destination in both pilot and control districts than in the baseline period.

Source: Battelle, 2014.

5.3.2 Summary of Pricing Impacts

The pricing analysis posed six hypotheses for the impact of variable pricing: parking availability would increase; parking search time would be reduced; double parking would be curtailed; the duration of on-street parking would go down; transit reliability and speed would improve; and there would be a shift to other modes and parking garages. The following sources of data were used to test the pricing hypotheses: the visitor/shopper survey, parking search time survey, disabled placard/double parking survey, parking sensors and meters, parking tax receipts, and transit APC data.

Table 5-16 presents a summary of the pricing analysis across the six hypotheses showing that three of the hypotheses were supported by the data and three were not. Analysis of parking sensor data supported the first hypothesis that parking pricing increased parking availability. The impact of parking pricing on parking availability was primarily measured by 1) the trend in average on-street occupancy, 2) the trend of the percentage of blocks exceeding 85 percent occupancy, and 3) a regression analysis of parking price on parking occupancy. The regression analysis almost universally showed that average block occupancy had a negative and statistically significant relationship with parking price. That is, when price went up occupancy went down and vice versa.

Table 5-16. Summary of Pricing Analysis across Hypotheses

Hypotheses	Result	Evidence
Parking pricing will increase parking availability.	Mostly supported	A regression analysis of parking price on parking occupancy almost universally showed that average block occupancy had a negative and statistically significant relationship with parking price. Average occupancy and the percentage of blocks exceeding 85 percent occupancy differed depending on the pilot area. In highly congested areas (i.e., Civic Center, Downtown, Fillmore, and Marina), average occupancy stayed flat while the proportion of blocks exceeding 85 percent declined. In the Fisherman's Wharf and South Embarcadero, both metrics increased over time, likely due to increased economic activity in Fisherman's Wharf and in both South Embarcadero and Fisherman's Wharf a broad reduction in on-street parking price meant to raise occupancy levels. Regarding the evaluation of disabled placards, a separate modeling analysis for the field data indicated that there was no significant change from 2011 to 2013 in the rate of disabled placard parking in both the pilot and the control areas.
Parking pricing will lead to reduced search time.	Supported	The models using the parking search time field data indicate a 15% reduction in parking search time in the pilot relative to the control.

Table 5-16. Summary of Pricing Analysis across Hypotheses (Continued)

Hypotheses	Result	Evidence
Parking pricing will reduce double parking.	Somewhat supported	Model results for field data indicate that double parking for personal vehicles may have been reduced by about 14% and for commercial vehicles by about 21% in the pilot versus the control. However, due to the variability in the double parking rate data, the sample size may not have been large enough to conclude that the differences observed in the control and pilot areas were significantly different.
Parking pricing will shorten the duration of the average on-street parking session.	Not supported	Payment data were used to evaluate session length given the absence of session data from sensors. Analysis showed that payment duration for on-street parking rose or stayed flat in most every pilot area during weekdays and weekends. In Civic Center, Fisherman's Wharf, and South Embarcadero average parking session length rose from 0.8 hours to between 1.4 and 2.0 hours (depending on location and time of day). In the Downtown, Fillmore, Marina, and Mission, parking session length remained mostly flat following an initial increase. This result was not solely influenced by pricing. Installation of smart meters eliminated the need for coinage, making longer sessions easier to purchase. In addition, SFMTA reduced prices on many blocks, making longer sessions more affordable. Also, allowable time at meters went up substantially (to at least four hours), which allowed people to stay longer. These factors produced trends that were counter to the initial expectations of the evaluation.
Parking pricing will improve the reliability and speed of public transit.	Not supported	Reliability measured by schedule adherence of Muni buses improved between 2 and 3 percent, but the difference between pilot and control areas was not statistically different. Changes in transit speed were minimal and were not in a consistent direction among pilot areas, indicating no impact from variable pricing.
Parking pricing will cause a shift to other modes and parking garages.	Somewhat supported	The models using data from the visitor/shopper survey indicate no significant change between control and pilot areas in terms of mode or type of parking. However, several of the pilot areas exhibited increased utilization of SFMTA and non-SFMTA garages and off-street lots. Upward trends in off-street parking were not shared across all pilot areas. But increases of transient entrances to SFMTA garages were as high as 45% in the Civic Center, 15% in Downtown and 32% in the Marina. These increases, alongside the general upward trend in parking tax receipts in most areas, support the hypothesis that some shift to off-street parking did occur.

Source: Battelle, 2014.

The direction of trends in average occupancy and the percentage of blocks exceeding 85 percent occupancy differed depending on the pilot area. In highly congested areas such as the Civic Center, Downtown, Fillmore, and the Marina, average occupancy stayed flat while the proportion of blocks exceeding 85 percent occupancy declined. This pointed to a desirable spatial spreading of parking availability in the face of constant overall average parking occupancy. In the Fisherman's Wharf and South Embarcadero, both occupancy metrics increased over time, but with low baseline occupancies this was not a negative result. This likely resulted from increased economic activity in tourist-heavy Fisherman's Wharf and in both Fisherman's Wharf and South Embarcadero a broad reduction in on-street parking price meant to raise low occupancy levels.

The analysis supported the second hypothesis that parking pricing would reduce parking search time. Models using the parking search time survey data indicated a 15 percent reduction in parking search time in the pilot areas relative to the control areas.

The analysis somewhat supported the third hypothesis on double parking. Models using field data showed that that double parking for personal vehicles was reduced by about 14 percent and for commercial vehicles by about 21 percent in the pilot versus the control areas, but the reduction was not statistically significant, possibly indicative of the need for a larger sample size.

To assess the fourth hypothesis, parking duration was analyzed by evaluating the time duration of on-street parking sessions purchased through payment data. Sensor reported sessions turned out not to be useful for reporting discrete session times, and instead payment data were applied to evaluate parking duration. Payment duration was considered a viable proxy as it signaled "expected or intended session length" on the part of the paying user. The evidence from analysis of the payment session data broadly suggests that the average parking session length increased or did not change, but it did not go down as was hypothesized. The results showed that the duration of parking length rose or stayed flat in every pilot area during both weekdays and weekends. In the Civic Center, Fisherman's Wharf, and South Embarcadero parking areas, average parking session length rose steadily from 0.8 hours to between 1.4 and 2.0 hours. In the Downtown, Fillmore, Marina, and Mission parking areas, parking session length remained mostly flat following an initial increase at the beginning of the evaluation period. The observed increase in session length was likely in part due to the installation of smart meters that made advanced payment methods available for on-street parking during the project, which eliminated the need for coins to pay the meter. In addition, some blocks (particularly in the Fisherman's Wharf and South Embarcadero) experienced considerable price declines, making longer parking sessions more affordable. Also, allowable time at meters went up substantially (to at least four hours), which allowed people to stay longer. These factors produced trends that were counter to the initial expectations of the evaluation.

In the fifth hypothesis parking pricing was expected to improve the reliability and speed of public transit, but that was not supported by the data. Transit reliability was measured by schedule adherence for buses arriving either early or on-time. Data on Muni buses traversing the pilot and control areas showed an improvement in schedule adherence of 2.9 percent for the pilot areas and 2.3 percent for the control areas, but the difference between the pilot and control areas was not statistically significant, and thus variable parking pricing appeared not to have made a difference. Data on average transit speeds showed a decline, no change, or an increase, depending upon the particular pilot area. However, across all the pilot areas the observed changes were less than 0.5 mph – except for a 0.8 mph decrease in the South Embarcadero pilot area. The two control areas in the analysis showed a decline of an average 0.1 mph. These modest differences over time and between pilot and control areas suggest minimal change, if any, on transit speeds due to variable pricing.

The expectation in the sixth hypothesis was that pricing would cause a change in modes and use of parking garages. Statistical analyses of the visitor/shopper survey indicated no significant change in the respondents' travel modes after variable pricing went into effect and no change in use of parking garages between the pilot and control areas. In some of the pilot regions, particularly the Civic Center, Downtown, and Marina, the trend in transient (non-monthly) entrances to several SFMTA parking garages did exhibit a notable increase. From the start to end of the evaluation period, transient parking entrances ended 45 percent higher in the Civic Center, 15 percent higher in the Downtown, and 32 percent higher in the Marina. The Fillmore and Mission also had SFMTA garages, but exhibited only a 5 percent and -2 percent change in entrances respectively. Because there were no SFMTA garages in the control areas, a pilot and control comparison on public garages could not be made. A comparison of the normalized trends in parking tax receipts from private garages across all regions (pilot and control) showed that all regions exhibited an upward trend in parking tax receipts, though some regions more than others. Thus, while the visitor/shopper survey showed no significant change in garage activity, a general increase in garage utilization was observed in the data within select areas.

5.3.3 Summary of Technology Analysis

Although many intelligent transportation technologies were embedded in the San Francisco UPA projects, the evaluation team did not attempt to look at them all. Instead, the analysis narrowed the scope to two. The first hypothesis was that implementing advanced parking technology would improve the SFMTA's ability to manage parking. The second hypothesis was that having a variety of methods for disseminating real-time parking information would reduce parking search times. Data used in the technology analysis included interviews with parking management staff, parking citation data, data from the visitor/shopper survey, and trends in usage of the various information dissemination methods deployed by local partners MTC and SFMTA.

The results of the technology analysis are summarized in Table 5-17 and show that the first hypothesis was supported but not the second hypothesis. The first hypothesis – implementing advanced parking technology will improve SFMTA's ability to manage parking – was supported by the results from the post-deployment interviews and workshop, and, to a lesser degree, the analysis of the parking citation data. The results from the post-deployment interviews and workshop indicated that SFMTA personnel perceived improvements in the agency's ability to manage parking in the SF*park* pilot sites through the use of the parking occupancy sensors and parking meter technologies.

Table 5-17. Summary of Impacts across Technology Hypotheses

Hypotheses	Result	Evidence
Implementing advanced parking technology will improve the local agency's ability to manage parking.	Supported	SFMTA personnel who were interviewed perceived improvements in the agency's ability to manage parking in the SF*park* pilot sites as a result of the technology. Parking sensors and meter technology provided accurate data and enhanced the ability of SFMTA to manage parking at the pilot sites. The analysis of the parking citation data indicated a statistically significant reduction in the number of citations in the pilot and control districts from the pre-deployment period to the initial post deployment period, with a slightly larger percent change in the pilot districts (when Downtown was included). However, the differences in percent changes between the pilot and control districts were not significant whether or not Downtown was included. The limitations in the parking citation dataset may influence the ability of the analysis to detect and attribute changes in citations to advanced parking technology and variable pricing.
Improving the dissemination of parking information via the 511 phone system, websites, and text messaging, will reduce parking search times.	Not supported	Parking information was widely disseminated. Usage of 511 remained constant and SF*park* apps continued to be downloaded through the deployment period. Text messaging was less successful and was discontinued. Among surveyed respondents awareness of information sources was low (15.6%) and regular usage even lower. Thus, parking information was not shown to be effective at helping users make decisions about parking, which might have reduced parking search times.

Source: Texas A&M Transportation Institute and Battelle, 2014.

The analysis of the parking citation data in the pilot and the control districts showed a statistically significant reduction in the number of citations from the pre-to-post deployment periods, with a slightly larger percent change in the pilot districts. However, the reductions in citations in the pilot districts may be influenced by other factors, and may not be attributed solely to the deployment of the advanced parking technology. The limitations within the citation dataset described in the SFMTA Meter-Related Citation Data Guide[14] may also hinder the ability to detect and attribute to any specific causes the changes in citations in the pilot and control districts.

Real-time parking information was provided to the public via a number of sources. However, the visitor/shopper survey found that awareness and use were too low to have a measureable impact on parking search times. Thus, the second hypothesis is not supported.

[14] Meter-Related Citations Guide, San Francisco Municipal Transportation Agency, November 22, 2013.

5.3.4 Summary of Equity Analysis

The equity effects of the San Francisco UPA projects were assessed with four questions shown in Table 5-18, which presents a summary of the findings. The questions were addressed with data from the visitor/shopper survey, traffic and transit data, data on parking prices and availability, and from communications with SFMTA staff.

Table 5-18. Summary of Equity Impacts across Evaluation Questions

Questions	Result	Evidence
What are the direct social effects (parking fees, travel times, adaptation costs) for various transportation system user groups?	No equity impact	Respondents to the 2011 and 2013 visitor/shopper survey reported parking cost; parking search time and distance from destination; and perception of ease of parking. Differences by age and income categories in pilot and control areas in the pre- and post-pricing periods revealed no systematic impact by age or income that could be characterized as an equity issue, except that the highest income categories tended not to see reductions in search time like the other income categories. They had the lowest search times both before and after variable pricing.
What is the spatial distribution of aggregate out-of-pocket and inconvenience costs, and travel-time and mobility benefits?	Mixed effect	Geographic equity of variable pricing was examined with three types of data. Congestion measures of speed and travel time using data from roadway sensors and buses showed no before/after differences in pilot areas. Parking occupancy data showed before/after differences among pilot areas. Residents and visitors to neighborhoods with high parking congestion would have seen availability improve but higher prices. In neighborhoods with lower starting occupancies, people benefited from lower parking prices but had slightly higher parking occupancies. Reduced emissions and energy usage from less cruising for parking benefited all the pilot areas, but Downtown and South Embarcadero saw the greatest reductions and Marina and Mission the least.
Are there any differential impacts on certain socioeconomic groups?	No equity impact	Available data on socioeconomic groups were restricted to income and age categories from the visitor/shopper survey. No systematic equity impacts by income or age were discerned in the survey findings.
How does reinvestment of parking pricing revenues impact various transportation system users?	Positive impact	By statute, SFMTA parking-related revenues are to be used to support transit, thereby serving a wider range of travelers than those who use parking facilities.

Source: Battelle, 2014.

For the first question the visitor/shopper survey provided data to examine direct costs in terms of parking fees and parking convenience as reported by user groups defined by income and age categories. Survey respondents reported how much they paid for parking, how long they looked for parking, how far away they parked from their destination, and their overall perception of how easy it was to find parking. Based on summary statistics, such as averages and percentages by income or age category, and on analysis of variance models, the findings revealed no systematic differences by income or age that indicate an equity impact from variable pricing in the pilot areas.

The second question examined geographic equity using data on traffic congestion measures, parking availability, and environmental and energy impacts. Congestion measures of travel speed and travel time based on data from roadway sensors and Muni buses showed little to no change, and thus, no discernible impact of variable pricing. Changes in parking availability varied among the pilot areas. Those pilot areas with the highest parking congestion, such as Downtown, saw the percentage of highly congested blocks decline as higher parking prices began to enhance availability of spaces. Pilot areas starting with lower occupancies saw an increase resulting from price reductions, but parking availability was still within an acceptable range. Thus, SF*park* pricing resulted in different outcomes for different neighborhoods depending upon their original levels of parking availability and the direction of price changes. The effect on people living in or coming to congested areas was that they would realize a benefit of greater parking availability during high-demand periods, but at a greater price. People in other neighborhoods would benefit from lower parking prices but they might experience less parking availability than before. Environmental and energy usage due to less cruising for parking after variable pricing benefited all the pilot areas, but some more than others. Downtown and South Embarcadero saw the greatest reductions, while Marina and Mission saw the least. Thus, people living in or driving to those areas would have been similarly impacted.

The third question addressed whether any user groups were positively or negatively impacted by the UPA projects. The data available to address this question were the same as used for the first question. No additional data on race or ethnicity was available in the visitor/shopper survey to further explore impacts on minority groups, and, therefore, the focus was on impact on user groups defined by income and age. Based on income and age no systematic impacts of variable pricing, positive or negative, were identified among the respondents in the visitor/shopper survey.

In the fourth question, the impact of reinvestment of parking revenues was examined. San Francisco's City Charter requires that parking-related revenues be used to support capital and operating expenses of SFMTA's transit services. Thus, from an equity standpoint, parking revenues are used to benefit a broader set of travelers than those who drive and park in SFMTA facilities, and, therefore, the equity effect is positive.

5.3.5 Summary of Environmental Analysis

Environmental impacts of the SF*park* were evaluated with two hypotheses: an improvement in air quality due to reduced cruising for parking and a shift to transit, and reduced fuel consumption would result for the same reasons. A third hypothesis dealing with the perception that air quality had improved could not be tested due to lack of data.

Table 5-19 presents the results from the analysis and shows that SF*park* resulted in significant reductions in emissions of air pollutants and greenhouse gases, as well as in fuel use. The data support a conclusion that parking pricing is an effective way to reduce the amount of time and distance individuals must search to find parking, and that this benefit translates to quantifiable emission and energy benefits. More specifically, the SF*park* program resulted in greater than

22 percent reduction in mileage from cruising for parking spots, and associated emissions and energy use on Saturdays, and greater than 26 percent on weekdays.

Table 5-19. Summary of Environmental Impacts across Hypotheses

Hypotheses	Result	Evidence
SF*park* will improve air quality by reducing parking search times and shifting trips from car to transit.	Supported for parking search time reduction	Reductions of 26.61% in weekday and 22.37% in Saturday emissions of ozone precursors, particulate matter, carbon monoxide and greenhouse gases. Shift to transit was modest and not clearly linked to the impact of variable pricing, and thus not included in emission estimates.
The public will perceive an improvement in air quality resulting from SF*park*.	Not evaluated	Data were not available.
SF*park* will reduce fuel consumption by reducing parking search times and shifting trips from car to transit.	Supported for parking search time reduction	Reduction in fuel use of 26.61% on weekdays and 22.37% on Saturdays. Shift to transit was modest and not clearly linked to the impact of variable pricing, and thus not included in energy estimates.

Source: Battelle, 2014.

Summing across the pilot neighborhoods, without SF*park*, the estimated 9 a.m. – 6 p.m. VMT from cruising for parking spots on an average weekday was 12,431 miles and with the program it decreased to 9,123 miles. This represents 0.18 – 0.2 percent of all VMT in San Francisco County, which is substantial given the relatively small geographic area represented by the parking pilot zones.

On Saturdays, the amounts were somewhat greater, as is the demand for parking spots. On Saturdays, cruising for parking in the six of the seven pilot neighborhoods (for which parking search time was available) represents nearly 0.3 percent of total travel in San Francisco without SF*park* and 0.21 percent with. Without SF*park* 13,707 miles of travel by cruising for parking spots occurred between 9 a.m. and 6 p.m. in the pilot neighborhoods, on the average Saturday. With the program, this value decreased by 22.37 percent to 10,641 miles of cruising.

Emissions of the ozone precursors NOx and ROG declined from 9.25 (without pricing) to 6.74 (weekdays) and 9.4 to 6.9 (Saturdays) pounds per day. Emissions of fine particulate matter declined from 1.3 to .96 pounds per day on weekdays and 1.44 to 1.12 on Saturdays. Fuel consumption declined by the same percentages as VMT: 26.61 percent on weekdays and 22.37 percent on Saturdays. The data indicated only a very modest shift to transit that could not be directly linked to variable pricing, and, therefore, transit was not included in the quantitative impact reported here.

5.3.6 Summary of Goods Movement

The impact of the UPA projects on goods movement was examined with four hypotheses about the effect of SF*park*: double parking by commercial vehicle operators (CVO) would decrease; fines from CVO double parking would decrease; parking availability for CVOs would increase; and travel times would decrease. Sources of data to test the hypotheses included the double parking survey, parking citation data, parking sensors, and bus APC data.

Table 5-20 summarizes the findings for the four goods movement hypotheses. With available data, support was found for two of the four hypotheses but not for the other two. The evidence supports the first hypothesis on double parking. Based on modeling of field surveys of double occupancy in 2011 and 2013, double parking by commercial vehicles fell by 21 percent after variable pricing and other SF*park* enhancements had been made.

The second hypothesis was not supported. Data on the number of parking citations, instead of the amount of parking fines collected which were not available, did not exhibit a statistically significant difference in the before/after changes between control and pilot areas. The average monthly changes within the pilot areas over time are suggestive of a potential impact of the SF*park* enhancements, but the differences between control and pilot areas were not statistically significant, and thus the hypothesized effect was not supported.

The third hypothesis on parking availability was not supported at a statistically significant level. Analysis of parking sensor data indicated that demand-based pricing began to have its expected effect in the later stages of the evaluation period by making space more available for all vehicles on the most popular blocks where parking was most congested. For commercial vehicles the implication is that potential conflict for parking between commercial vehicles and passenger vehicles would have been reduced, thereby making it easier for commercial vehicles to find parking. A decline in double parking by commercial vehicles in pilot areas lent some support to the hypothesized decrease, but the finding was not statistically significant.

The fourth hypothesis was not supported. Bus travel times changed very little after variable pricing was deployed (less than 0.3 minutes per route) and this change was not statistically significant.

Table 5-20. Summary of Goods Movement Analysis Across Hypotheses

Hypotheses	Result	Evidence
CVOs double parking will decrease in the SF*park* pilot areas.	Somewhat supported, but not at a statistically significant level	Double parking by commercial vehicles dropped by 21% in pilot relative to the control areas at the end of the evaluation period in 2013. The findings used data from before and after field surveys and were based on modeling techniques that controlled for other variables. However, the difference between the pilot and control areas was not statistically significant and may require a larger sample size owing to the high variability in the observed double parking rates.
CVO double parking fines will decrease in the SF*park* pilot areas.	Not supported	Among the three types of citations for truck parking there were no statistically significant differences between control and pilot areas, although the citations in the pilot areas were fewer in the period after smart meters were installed and parking time limits were relaxed. Citations in the pilot areas continued to fall after variable pricing was implemented for yellow zones but not for truck loading zones, although the changes were not statistically significant.
Parking availability, including loading and freight zones, will increase in the SF*park* pilot areas.	Somewhat supported, but not at a statistically significant level	The analysis of parking sensor data showed that demand-based pricing made space more available for all vehicles on the most popular blocks where parking was most congested. This may have reduced conflict between commercial vehicles and passenger vehicles, thereby making it easier for commercial vehicles to find parking.
Travel times will decrease in the SF*park* pilot areas for CVOs and other vehicles.	Not supported	Using travel times for buses on streets through pilot and control areas as a proxy for all vehicles, travel times in pilot areas changed very little after variable pricing – less than 0.3 minutes per route – not an appreciable amount for CVOs or other drivers.

Source: Battelle, 2014.

5.3.7 Summary of Business Impacts

The impact of the UPA projects on businesses was evaluated with two hypotheses: sales would increase and travel to access retail and similar businesses would increase. Data used to assess business impacts included sales tax revenues and data from the visitor/shopper survey.

Table 5-21 presents a summary of the business impact analysis for the two hypotheses. The analysis of the data revealed a neutral to positive impact of demand-based parking pricing on businesses in the pilot areas. The hypothesis on sales increasing in the SF*park* pilot areas was supported, based on the analysis of sales tax revenues from establishments in the “food product,” “general retail” and “miscellaneous” categories. Tax revenues increased in the pilot areas but remained relatively flat in the control areas after the implementation of the variable pricing in pilot areas. While the parking changes in the pilot areas may not have caused the sales growth, they clearly did not hurt business. Before/after spending reported by survey respondents on the day they were interviewed dropped in both pilot and control areas, but the drop was statistically significant only in the control areas. Still, respondents in the pilot areas did not indicate the increase in spending that might have been expected based on the trends in tax revenues.

The second hypothesis dealing with travel to access businesses was analyzed using multiple questions from the visitor/shopper survey. SF*park* appeared to have minimal impact on access in either a positive or negative way. Trip purposes changed somewhat in the pilot areas, but the changes appeared to be small shifts between types of businesses visited (more dining and drinking, and less shopping). Perhaps the most important finding was that the frequency of trips to both the pilot and control areas had not been reduced: over 75 percent of survey respondents reported they visited at about the same frequency as a year ago and a greater proportion of respondents reported more visits than fewer. Among respondents who reported mode changes in pilot areas, increased transit use was the primary response, which can be viewed as a positive impact of SF*park*. Negative aspects of parking were not the primary reasons for mode change, but 10 percent in pilot areas gave that reason. On the other hand, half as many respondents in the pilot areas as the control areas cited difficulty finding parking in the after period. SF*park* did not appear to lead to changes in the type of parking used or in the timing of trips, given that responses in control and pilot areas were similar.

Table 5-21. Summary of Business Impact Analysis across Hypotheses

Hypotheses	Result	Evidence
• Sales will increase in the SF*park* pilot areas.	Somewhat supported	Pilot areas, where variable pricing was in effect, showed growth in sales tax revenues following the price changes. Although the trend in the pilot areas started in the year prior to price changes, it continued into the after period, whereas in the control areas sales tax revenues remained relatively flat. Survey respondents in the after period indicated a drop in spending compared to the before period in pilot areas, but it was not statistically significant. Control areas saw a significant before/after decrease in spending.
• Overall travel to access retail and similar businesses will increase in the SF*park* pilot areas as measured by:		
- Change in trip purposes	Neutral	In pilot areas shopping trips declined by 5% but dining and drinking trips increased by 8%.
- Change in frequency of visits	Neutral	Changes in the frequency of visits were similar for the pilot and control areas. Variable pricing itself did not lead to more frequent visits to the pilot areas but neither did it lead to fewer visits. In the after period, the percentage visiting at about the same frequency as the previous year in both the pilot and control areas was over 75%; the percentage visiting less was 10% or below; the percentage visiting more often was about 15%.
- Change in mode used and reason for change	Positive shift to transit in pilot areas, but mixed in terms of attributable to variable pricing	More changed modes in pilot areas (24%) than control areas (17%) in the after period. Those who used a mode more frequently changed to a greater degree to transit in the pilot areas (53%) compared to the control areas (40%). In the after period, fewer in the pilot (15%) cited difficulty finding parking as their reason for mode change than in the control (29%), but 10% in the pilot cited more expensive parking versus the 5% in the control. Still, the negative aspects of parking were not the primary reasons for mode change.
- Change in parking type and reason for change	Not supported	Fewer than 10% in both pilot and control areas changed the type of parking, and the reasons cited for the change were generally unrelated to parking.
- Change in trip timing	Neutral	No significant difference between control and pilot areas, with 14% and 11%, respectively, saying they changed the time of trip to find cheaper parking.

Source: Battelle, 2014.

5.3.8 Summary of Non-Technical Success Factors

The San Francisco UPA projects were evaluated on the role that non-technical factors played in project implementation and operation. These factors included organizational structures and processes, staffing and the role of the media. Sources of data were interviews and workshops with agency personnel, agency documents, and archives of coverage of the projects by the media.

As highlighted in Table 5-22, people, process, structures, the media, and competencies all played supporting roles in the implementation, deployment, and operation of the San Francisco UPA projects. For the most part, the San Francisco UPA projects did not require a strong multi-organizational structure and SFMTA did not promote collaboration among partners while developing SF*park*. But this was not a deterrent to the agency's ability to deliver an innovative, customer-centric parking pricing pilot in a city that is traditionally skeptical of the motives of local government. SFMTA deployed an ambitious communications and outreach plan, recognizing their responsibility in effectively communicating to the public a project that would significantly change the culture of parking in the city. The media often served in a complementary way to the messaging produced by SFMTA on the project's purpose and goals. In a mostly positive or balanced way (based on a small sample of the coverage), the media was able to describe the effects SF*park* would have on traffic congestion and it fueled excitement around the innovative technologies developed for the project. Interviewees expressed a desire to continue to develop a comprehensive congestion reduction plan for the City of San Francisco and for the Bay Area, citing the UPA as benefitting the region's ability to move forward with these goals.

Table 5-22. Non-Technical Success Factors' Questions

Questions	Result	Evidence
What role did the following areas play in the success of the San Francisco UPA projects? 1. People 2. Processes 3. Structures 4. Media 5. Competencies	1. Effective 2. Problematic 3. Adequate 4. Effective 5. Effective	1. & 5. Agency staff held technical expertise and project management skills needed to successfully implement the projects. 1. & 5. Agency leadership influenced policy and process to keep projects on track. 2. Communication and information sharing among agency partners were minimal. Once SF*park* launched, it became easier for project partners to access needed information. 3. SFMTA did not promote a multi-agency organizational structure; however, this did not impede their ability to deliver a successful project. 4. Media kept the projects in the public eye, and their contribution to public opinion remained mostly positive before, during, and after project deployment, based on the sampled coverage.

Source: University of Minnesota, 2013.

5.3.9 Summary of Benefit Cost Analysis

This analysis examined the net societal costs and benefits of the San Francisco UPA projects for a period extending ten years. To summarize, the benefits of the San Francisco UPA projects including travel time savings, reduced emissions and reduced fuel use totaled $32,244,107. The cost of the UPA projects, in 2011 dollars, was $43,529,299.

As presented in Table 5-23, the benefit-to-cost ratio for the San Francisco UPA projects was 0.74 and the net societal benefit was -$11,285,192. This BCA examined the net societal costs and benefits of the San Francisco UPA projects.

The analysis had several limitations and required numerous assumptions. For example, data on possible reduction in fuel used by buses were not available. Potential reductions (or increases) in crashes were not measured. An important goal of SF*park* was to enhance bicycle and pedestrian safety, and, if that did occur, it would have added significant project benefits. However, the evaluation period was considered too brief for national evaluation to include safety benefits, which typically take several years of data for a trend to be reliably measured.

All of the benefit estimates were based on 2011 and 2013 empirical data. Future years will likely yield larger benefits than what was measured in 2013 versus 2011. This is particularly true if the program is expanded to additional areas of the city using the Sensor Independent Rate Adjustment method to price parking. This will keep costs low while benefits from parking pricing should increase in a similar manner to what was found in this analysis. In addition, the use of parking sensors in a large scale deployment such as this was experimental and the first of its kind, resulting in higher costs than what future implementations should experience. Moreover, the extensive data collection and storage for the evaluation added to the cost of the project. On the benefits' side, shutting off meters after 6 p.m., prior to dinner and when some neighborhoods experience their greatest parking shortfalls, providing free parking all day on Sundays, and complying with California state law prohibiting charging parking patrons with disabled placards, clearly reduced benefits.The future year costs and benefits represented the best estimates available, but they are only estimates, and the actual costs and benefits could vary substantially.

Table 5-23. Question for the BCA

Questions	Result	Evidence	
What are the overall benefits, costs, and net benefits from the Atlanta CRD projects?	Negative societal benefits*	Benefits:	$32,244,107
		Costs:	$43,529,299
		Net Benefits:	-$11,285,192
		Benefit-to-cost ratio:	0.74

*Over 10-year period following deployment.

Source: Texas A&M Transportation Institute.

Chapter 6 Summary and Conclusions

This report has presented the results from the national evaluation of the San Francisco UPA projects. The report included a summary of the UPA and CRD programs, the San Francisco UPA partners and projects, and the evaluation process and data. The major findings from the evaluation were presented. Appendices A through I contain more detailed descriptions of the 9 analysis areas. This section summarizes the major findings from the evaluation and presents overall conclusions on the San Francisco UPA project.

6.1 Summary of Major Findings

Table 6-1 highlights the key findings from the national evaluation of the San Francisco UPA projects based on the U.S. DOT's four objective questions.

Table 6-1. U.S. DOT Objective Questions and San Francisco UPA Impacts

U.S. DOT 4 Objective Questions Evaluation Analyses
How much was congestion reduced?
Congestion. Limited data showed no impact on congestion in the SF*park* pilot areas from variable pricing when measured by traffic speeds or travel times. However, traditional congestion metrics may not be sensitive enough to pick up changes from parking maneuvers. Other parking-based measures showed improvements. Miles traveled by vehicles cruising for parking declined by an estimated 27 percent on weekdays and 22 percent on Saturdays. Although not statistically significant, double parking also declined – 14 percent for personal vehicles and 21 percent for commercial vehicles in the pilot areas – which would have improved traffic conditions.
Pricing. Demand-based pricing of on-street parking showed a consistent negative relationship with occupancy. In highly congested pilot areas the proportion of blocks exceeding 85 percent occupancy went down as prices rose. Lowering prices on under-utilized blocks gradually produced more occupancy, demonstrating variable pricing's effectiveness as a tool to better balance and distribute on-street parking. Parking search time declined by 15 percent and distance by 12 percent in pilot compared to control areas. Blocks with extensive use of disabled placards were not sensitive to price changes.
Transit. Transit performance was not affected by the parking pricing project. Transit speeds, travel times, and schedule adherence were unchanged or below their levels prior to variable pricing. Ridership in the pilot areas increased, but little of that increase if any represented a mode shift that could be attributed to variable pricing.
Technology. Real-time parking availability and pricing information in the pilot areas was available to travelers over multiple platforms, but awareness was low and consequently had minimal impact on travel and parking decisions.

Table 6-1. U.S. DOT Objective Questions and San Francisco UPA Impacts (Continued)

U.S. DOT 4 Objective Questions Evaluation Analyses
What are the associated impacts of the congestion reduction strategies? Equity. Variable parking pricing had no systematic equity impact by income or age group. Geographically, some pilot areas appeared to benefit more than others from variable pricing, depending upon their original level of congestion and the direction of price changes. Reduced cruising and associated emission reductions were the highest in Downtown and South Embarcadero and were the least in Marina and Mission. Environmental. Tied to the reduction in vehicle miles traveled by vehicles cruising for parking, emissions and fuel usage were estimated to have declined by 27 percent on weekdays and 22 percent on Saturdays. Business. Parking pricing had no noticeable impact on business-related activity. Sales tax revenues increased in the pilot areas, despite survey respondents in 2013 reporting somewhat lower average spending. Respondents reported traveling to the pilot areas with about the same frequency as in the previous year, with a slight shift in trip purposes focused more on dining and drinking and less on shopping. Goods Movement. Double parking by commercial vehicles declined by 21 percent in pilot areas relative to control areas, possibly a result of less competition from non-commercial vehicles due to better availability of parking in previously congestion areas but the differences were not statistically significant. Citations for truck parking did not show a significant change.
What are the non-technical success factors? Non-Technical Success Factors. Ambitious and effective communications and outreach to the public and other stakeholders was instrumental in communicating an approach to parking management that was a marked departure from the past. Extensive media coverage locally and beyond helped with communications and, through various industry awards and recognition, provided validation of the innovative experiment with parking pricing.
What is the overall cost and benefit of the strategies? Benefit Cost Analysis. The San Francisco UPA projects had a benefit-to-cost ratio of 0.74 when benefits were projected for the first ten years. The net societal benefit was negative due in part to travel time savings accruing only to those who directly benefited from reduced search time to find parking.

Source: Battelle

6.2 Conclusions

The San Francisco UPA projects were designed to demonstrate the effectiveness of innovative strategies to reduce congestion problems caused by parking. This report documents the impacts of the projects of the national evaluation sponsored by U.S. DOT. The following conclusions can be drawn from the experience in deployment of the UPA projects and their use by the public:

- To make a major change in addressing transportation problems requires imagination and courage on the part of public agencies. SF*park*'s innovative approach to parking pricing and its state-of-the art application of technologies entailed risks from which SFMTA and other agencies can learn. Lessons learned include but are not limited to the practical limits of some technologies and challenges related to measurement and analysis of parking behavior.
- Massive amounts of data were collected and analyzed in the course of the demonstration and evaluation of SF*park*. Other metropolitan areas without the resources to replicate the project can determine what data and analytic approaches are most essential to use in their own areas. For example, advanced parking meter data may be a more cost-effective source of data for measuring occupancy and setting prices than in-ground sensors, a direction that SFMTA itself is now going.
- Traditional measures of congestion used in transportation research and operations may not be effective when applied to parking. Parking maneuvers may be too discrete to be detected in general area metrics such as link speed or travel time. Innovative approaches to measurement and analysis are needed for assessing the effect of parking maneuvers on traffic conditions.
- Unlike the multi-agency collaborations required at other UPA and CRD sites, SF*park* was implemented by a single agency and required minimal contact with other partner agencies over the course of the deployment. The project benefited from a simplified reporting and decision-making structure that facilitated various aspects of the project ranging from technology purchases to marketing plans. However, the minimal collaboration may have overlooked opportunities for sharing expertise among agencies, such as increasing the effectiveness of real-time parking information dissemination to the public and incorporation of variable parking pricing in regional models.
- Some technologies failed to perform and as a result limited some of the analysis. A high percentage of roadway sensors deployed at key locations within the pilot and control areas failed to provide data of sufficient quality and quantity for use in the national evaluation. For example, useable one-hour traffic count data from the roadway sensors were too limited for analyzing changes, and parking sensors degraded over time due to battery life and other problems. Some of these data issues may have affected the results of the evaluation. They are also instructive to other cities, which will want to learn more about the problems when considering similar technologies.
- SF*park* represented a cultural shift in how the public would experience parking in San Francisco. Demand-based pricing, smart meters, expanded time limits on parking, and real-time parking information all occurred in a short time frame and required an effective marketing plan to inform the public what was coming and to instruct them on how to use the new system. SFMTA did not shortchange this

element of the project, but instead adopted a bold approach to rebrand parking that mirrored the innovativeness of SF*park*.

Appendix A. Congestion Analysis

This appendix presents the congestion analysis of the San Francisco UPA projects. The analysis focused on assessing the extent to which traffic congestion was reduced in the parking management districts in San Francisco in which the UPA projects were deployed. These included the demand-based parking system SF*park* and the parking information systems that used SF*park* real-time data on parking availability and data.

Table A-1 presents the two hypotheses for the congestion analysis. The first hypothesis focused on reduction in congestion on selected routes in the areas of San Francisco in which the SF*park* demand-based parking pricing system operated for which traffic data were collected. The second hypothesis focused on the perception of travelers that congestion had been reduced in the areas in which the UPA projects were implemented.

Table A-1. National Evaluation Congestion Analysis Hypotheses

Hypotheses
• The deployment of SF*park* and the 511 improvements will reduce traffic congestion on selected travel routes in the area in which they were implemented.
• Travelers will perceive that congestion has been reduced.

Source: Battelle, 2014.

The remainder of this appendix is divided into five sections. The data sources used in the analysis are described next in Section A.1. In Section A.2 the findings based on roadway sensor data are presented. Findings from analysis of transit data are presented in Section 0. Section A.4 summarizes the results from congestion-related questions included in the survey conducted on visitors and shoppers to the parking management districts covered by the UPA projects. Section A.5 presents a summary of the congestion analysis in relation to the hypotheses.

A.1 Data Sources

Three sources of data provided by the San Francisco Metropolitan Transit Authority (SFMTA) were used in the congestion analysis. Roadway traffic data were obtained from automated data collection equipment deployed specifically for this project by SFMTA at strategic locations in each parking management district to collect traffic performance data. A second source of data was the travel time of SFMTA’s transit vehicles which served as a surrogate for travel time data that could not be obtained via traditional sensors. The third source of data for the congestion analysis was the survey of travelers in which they were asked questions that revealed their perception of traffic congestion in San Francisco. The following sections provide details on the data sources and availability used in the congestion analysis.

A.1.1 Roadway Sensor Data

SMFTA deployed a series of traffic sensors to collect traffic performance data in and around the SF*park* pilot and control parking management districts. The sensors used to collect traffic data were manufactured by Sensys and were the same sensors that were used to monitor the parking space activity. The sensors were wireless, self-powered magnetometers embedded in each travel lane at strategic locations within each parking management district. The sensors transmitted measured data from the traffic stream via roadside wireless access points back to the Sensys sensor management system. Access points were mounted on poles with direct lines of sight to roadway sensors. Repeaters were used in locations where direct communication between the roadway sensors and the access points was deemed unreliable because of environmental conditions.

Sensors were installed at a total of 56 locations throughout the city and captured four standard traffic performance metrics: vehicle count, average speed, median speed, and sensor occupancy (a surrogate measure for traffic density). Figure A-1 shows the locations of sensor deployments in each parking management district.

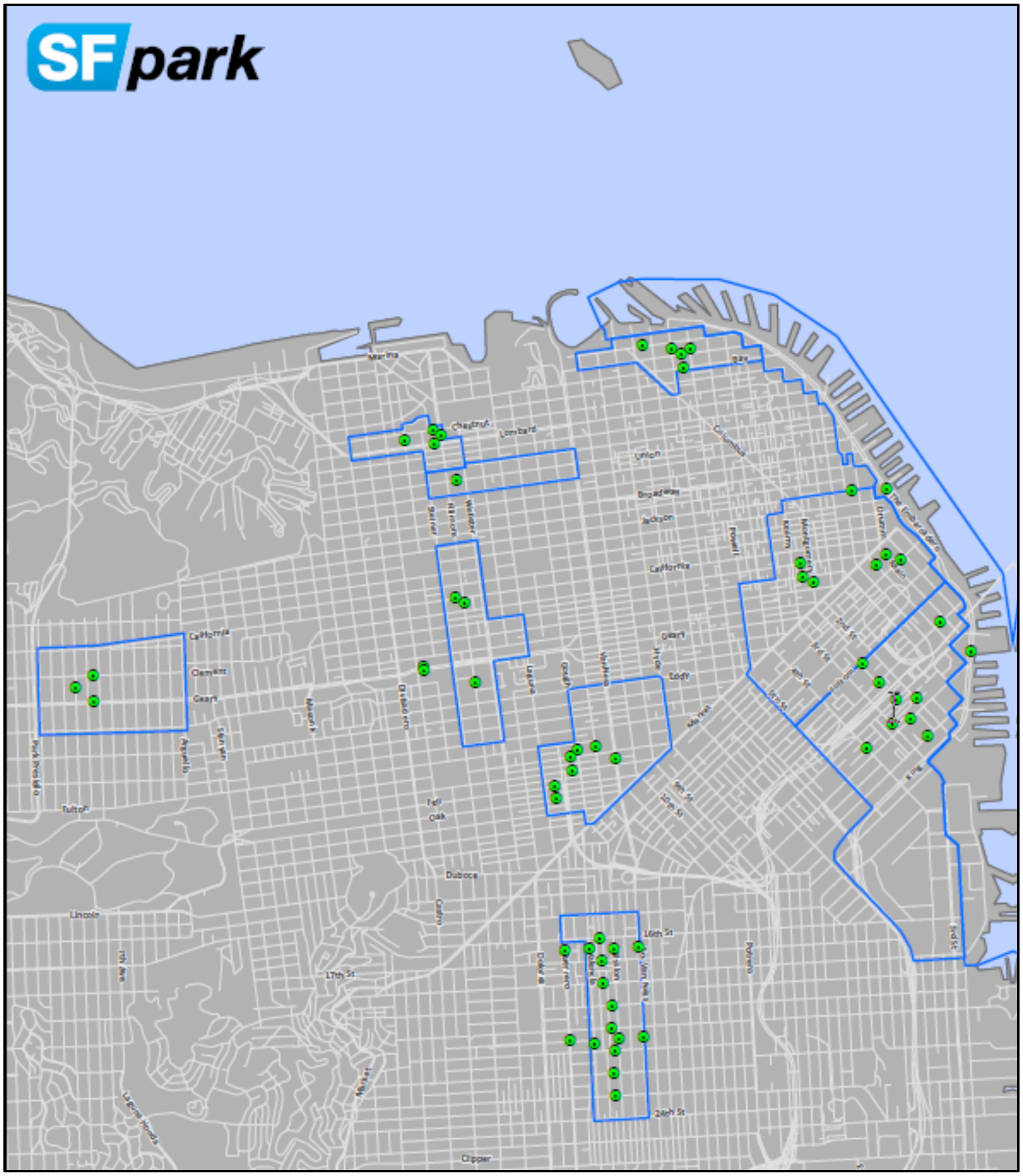
SFMTA originally planned to provide a continuous data stream that could be analyzed throughout the evaluation process; however, various outages, as well as technology and environmental issues did not permit the continuous data streaming to occur. Instead, traffic volume reports were uploaded daily to the SF*park* Data Warehouse. The traffic sensor data were aggregated to hourly intervals and stored in the SF*park* Data Warehouse. SFMTA used the following rules for data aggregation:

- 15-minute traffic count data were summed to provide hourly counts.
- 15-minute average speeds were averaged to provide an hourly average speed.
- Hourly median speed was set equal to the median of the four 15-minute median speeds.
- 15-minute average occupancy was averaged across the hour to provide average hourly occupancy.

Once the data were loaded into the SF*park* Data Warehouse, SFMTA conducted an assessment of the completeness of the entire dataset. This analysis showed the following major gaps and issues associated with the traffic sensor data:

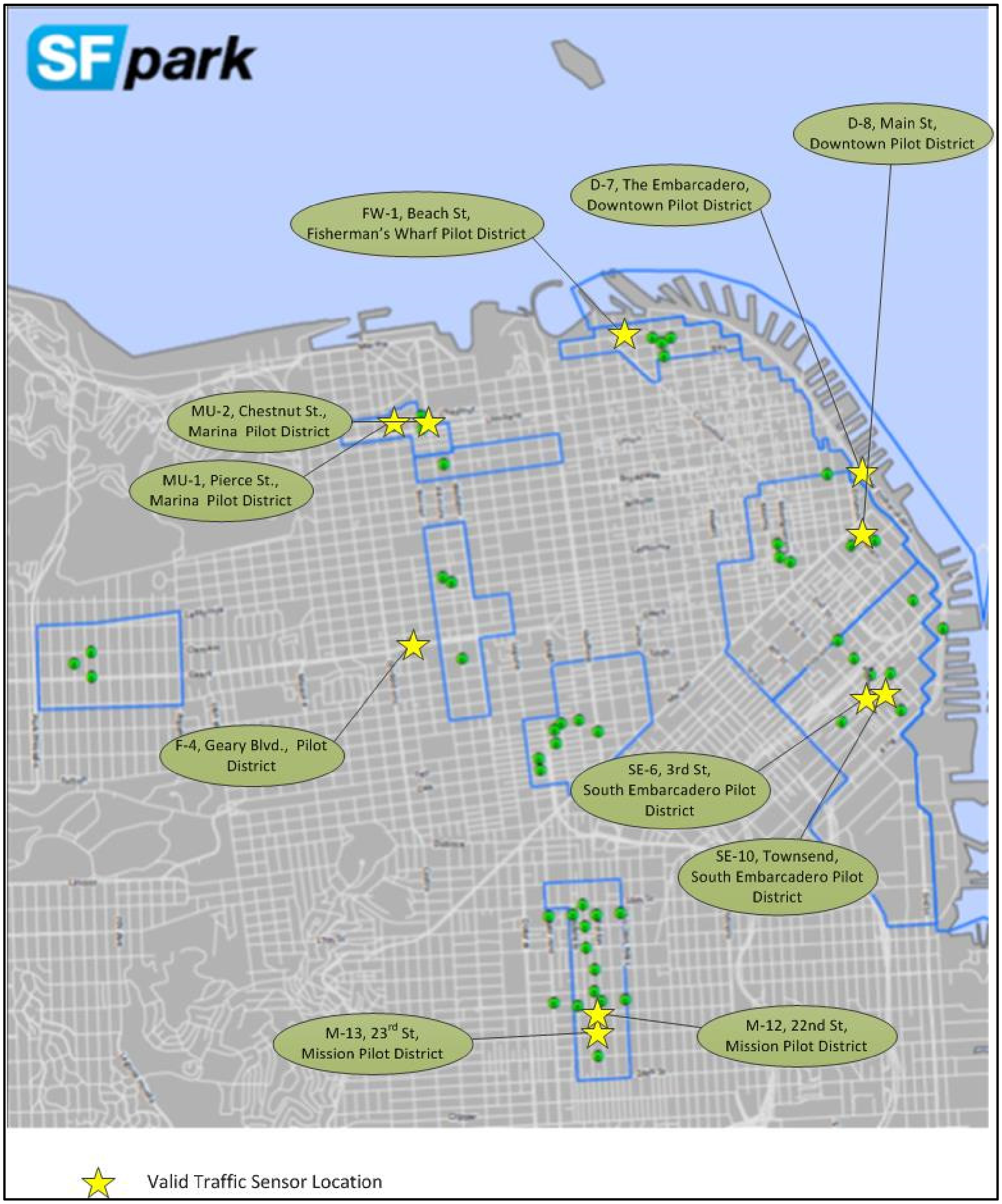
- Missing data: Across the entire dataset, 40 percent of all records for both traffic counts and speeds were missing.
- Error codes: SFMTA reported a high number of error codes in the data. Between 15 and 18 percent of all average speed data contained error codes.

After accounting for missing data and error codes, SFMTA determined the proportion of potentially usable average speed and traffic records to be 43 percent and 45 percent, respectively. SFMTA then applied further data quality checks to ensure the validity of the data. For the speed data, SFMTA required that a sensor exceed a 30 percent reporting threshold, similar to that used by SFMTA for their automatic passenger count data on Muni buses, for all lanes to be considered in the analysis. After applying the threshold, SFMTA retained only 10 of the original 56 sensor locations. The locations of the sensors used in the analysis are shown in Figure A-2. All the valid sensors were in the pilot districts and none were in the control districts, thus preventing a comparison of changes between pilot and control parking management districts. In addition, the valid sensor on Geary Blvd. was near but outside the Fillmore pilot area and measured eastbound traffic only (away from the pilot area) and, therefore, it was excluded from the analysis.



Source: SFMTA, 2013.

Figure A-1. Locations of Deployed Roadway Sensors in each SF*park* Parking Management District



Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure A-2. Location of Valid Traffic Sensors Used in UPA Congestion Analysis

In addition to use of speed measurements, the national evaluation originally planned to use traffic volume data from the roadway sensors in the congestion analysis. However, SFMTA determined that the traffic count data was not reliable because of the inconsistent nature of issues encountered in that data.

A.1.2 Transit Vehicle Data

In addition to data from traffic sensors, the congestion analysis used data from SFMTA's Muni buses as a surrogate measure for vehicle travel times. The hypothesis was that as transit vehicles were impacted similarly as other vehicles by parking maneuvers, improvements in parking performance and reductions in overall congestion would be observable in changes in transit travel times through the SF*park* pilot parking management districts.

To acquire these data, SF*park* staff utilized data from automatic passenger counter (APC) systems, which measure the following performance measures for each equipped vehicle:

- Stop-to-stop travel time;
- Stop-to-stop travel distance;
- The number of passenger boardings and alightings associated with each stop; and
- The vehicle load (in terms of number of passengers onboard) after each stop.

Speeds were calculated using the change in distance over change in time formula (excluding the dwell time of the transit vehicle).

Data from selected routes were downloaded from the APC server, processed, and stored at the SF*park* Data Warehouse. SFMTA used the following criteria to define the route segments analyzed for the national evaluation:

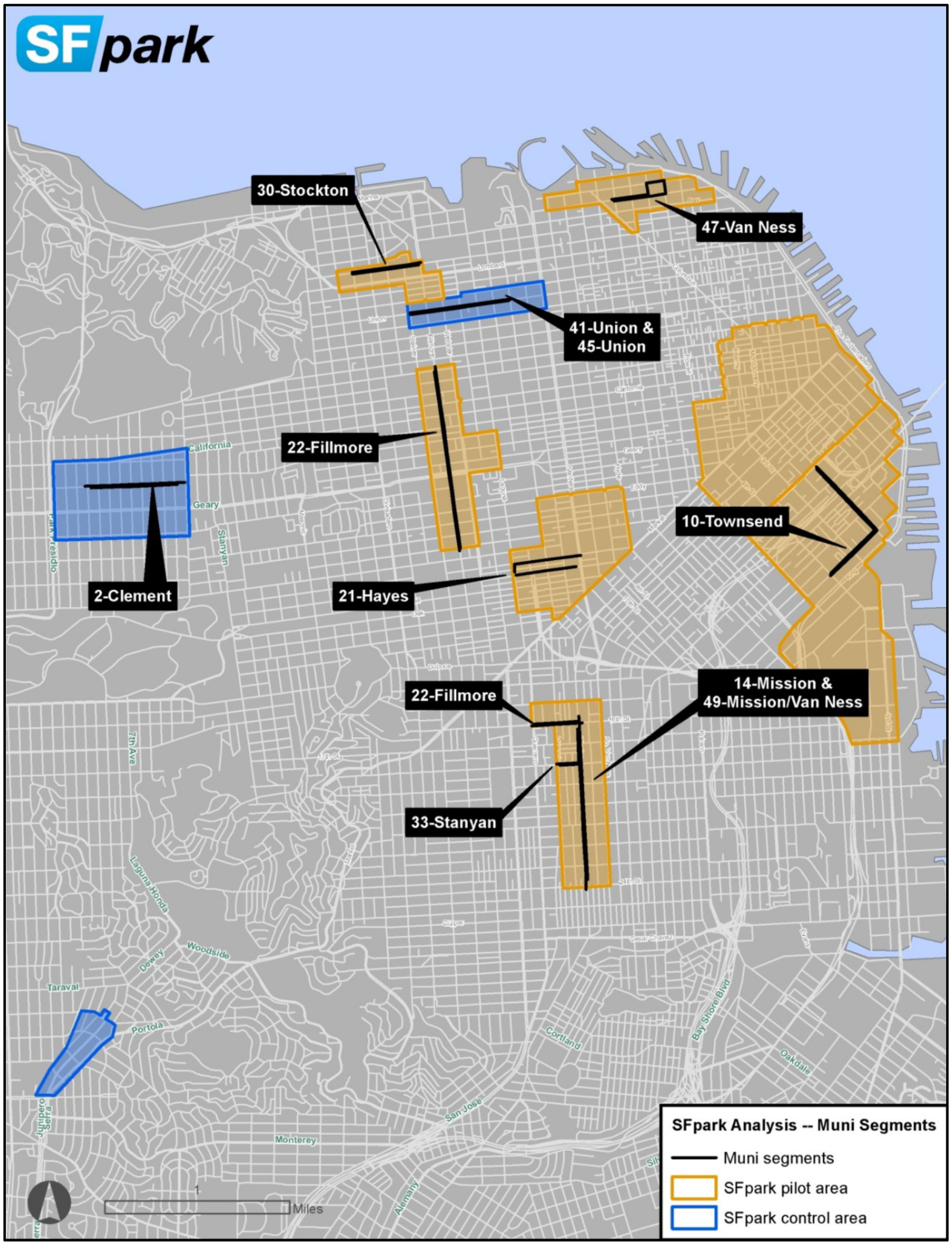
- Transit lines that fall within a pilot or control parking management district where parking sensors were installed for at least 3 continuous blocks.
- Within pilot parking management district, blocks where SF*park* conducted rate adjustments during the evaluation timeframe. This excluded many blocks and lines outside the SF*park* areas.
- Routes used by transit vehicles equipped with APC systems. (APC data were sampled from buses and trolley bus lines only, no rail.)
- No major service changes occurred across or during the data collection timeframe (spring 2011, spring 2012, and spring 2013).

Based on the criteria listed above, SFMTA identified segments from 11 bus routes that traveled through the SF*park* pilot and control parking districts. These segments are listed in Table A-2. Figure A-3 shows the locations of the route segments in each parking management district.

Table A-2. Segments of SFMTA Transit Routes Used in UPA Analysis

Parking Management District		Bus Route	Limits
Pilot	Marina	30-Stockton	On Chestnut between Fillmore and Divisadero
	Fillmore	22-Fillmore	On Fillmore between Jackson and McAllister
	Civic Center	21-Hayes	On Hayes between Van Ness and Laguna
	Mission	14-Mission	On Mission between 16th St. and 24th St.
		49-Van Ness-Mission	On Mission between 16th St. and 24th St.
	South Embarcadero	10-Townsend	On 2nd St. between Folsom and Townsend
		10-Townsend	On Townsend between 2nd and 5th St.
	Fisherman's Wharf	47-Van Ness	On North Point between Jones and Powell
Control	Richmond	2-Clement	On Clement between 11th Ave and Arguello
	Union	41 Union	On Union between Steiner and Gough
		45-Union-Stockton	On Union between Steiner and Gough

Source: SFMTA, 2014.



Source: SFMTA, 2014.

Figure A-3. Transit Routes in SF*park* Pilot and Control Parking Management Districts Used in Congestion Analysis

A.1.3 Visitor/Shopper Survey Data

Information on travelers' perception of congestion in the SF*park* pilot and control parking management districts came from a survey of visitors and shoppers sponsored by SFMTA. The data consisted of two cross-sectional surveys of persons intercepted on the street, who had arrived by private vehicle and parked in the area either on the day of the survey or sometime during the past year. Approximately 1500 surveys were completed in both surveys, which were administered in a subset of all the parking management districts: five pilot districts and two control districts. The first survey was conducted in the spring of 2011 prior to the start of variable pricing and, thus, represented the baseline or "before" condition for measuring changes. The second survey was conducted in the spring of 2013, following multiple price changes occurring over 19 months, which was thought to be sufficient time for the population to have made behavioral changes in response to the SF*park* pricing system. Section B.2 of Appendix B – Pricing Analysis contains additional details on the survey methodology.

A.2 Findings from Roadway Sensor Data

This section presents findings on link speeds and on the ratio of peak to off-peak travel speeds.

A.2.1 Link Speeds

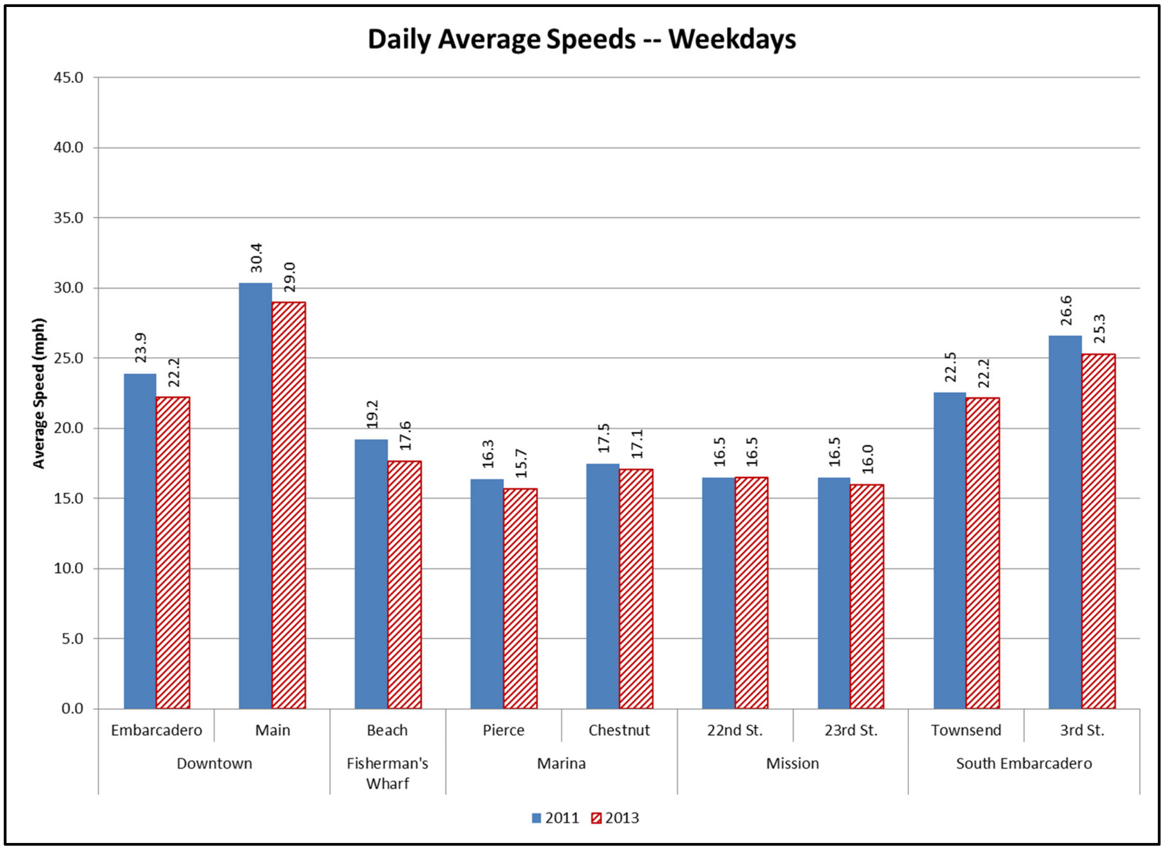
As discussed in Section A.1.1, link speeds were collected by SFMTA in select corridors using traffic sensors embedded in the pavements. Link speeds data were collected in 15-minute intervals from March 2011 through May 2013, covering multiple price changes in the pilot parking management districts. Because pricing strategies were deployed at different times in each of the corridors, SFMTA aggregated the link speed data into two evaluation periods:

- **2011** – This period represented the interval of time before variable pricing was deployed in the corridor. During this time, the price of parking remained constant at the rate that existed in the corridor prior to implementing any demand-based pricing strategy. Data from this interval were collected in the spring of 2011.
- **2013** – This period represented the interval of time when variable pricing had been active in the corridor for more than a year and represented the performance of the roadway after several pricing adjustments had been made. This interval was intended to capture roadway performance after drivers had become familiar with the new pricing strategies and had adjusted their parking behaviors. Data from this interval were collected in the spring of 2013.

Figure A-4 shows the average daily travel speeds for weekdays and weekends in the pilot parking management districts where valid traffic sensor data were available. The values represent the travel speed averaged from 7:00 a.m. to 8:00 p.m. The figure shows that average weekday travel speeds were the same or lower in eight of the nine roadways in the pilot districts during 2013 compared to 2011. Average weekday travel speeds were the same or lower in 2013 on the following facilities:

- Embarcadero and Main in the Downtown pilot district;
- Beach St. in the Fisherman's Wharf pilot district;
- Pierce and Chestnut in the Marina pilot district;

- 22nd and 23rd St. in the Mission pilot district; and
- Townsend and 3rd St. in the South Embarcadero pilot district.



Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure A-4. Average Daily Link Speeds from Available Roadway Sensors in SF*park* Pilot Parking Management Districts

Because of issues associated with the sensor data, it was not possible to perform statistical analyses of the difference in link travel speeds collected by the roadway sensors. It should be noted that all of the changes in average link speeds were relatively small and well within the margin of error of the sensors. Furthermore, travel speeds on these facilities were constrained by the speed limit.

Table A-3 shows relative changes in the 2013 average daily link speed compared to 2011. These changes are shown for weekdays only. Average weekday travel speed declined on all but one roadway. The roadway experiencing the greatest change in SF*park* parking management districts appeared to be the Embarcadero in the Downtown pilot district, where average link speeds dropped by 1.7 mph in 2013 for weekday travel.

Table A-3. Change in Measured Average Daily Link Speeds (mph) from Available Sensors in SF*park* Pilot Parking Management Districts

Pilot Management District	Roadway	Average Weekday Daily Link Speed (mph)			
		2011	2013	Net Change	Percent Change
Downtown	Embarcadero	23.9	22.2	-1.7	-7.11%
	Main	30.4	29.0	-1.4	-4.61%
Fisherman's Wharf	Beach	19.2	17.6	-1.6	-8.33%
Marina	Pierce	16.3	15.7	-0.6	-3.68%
	Chestnut	17.5	17.1	-0.4	-2.29%
Mission	22nd St.	16.5	16.5	0.0	0.00%
	23rd St.	16.5	16.0	-0.5	-3.03%
South Embarcadero	Townsend	22.5	22.2	-0.3	-1.33%
	3rd St.	26.6	25.3	-1.3	-4.89%

Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

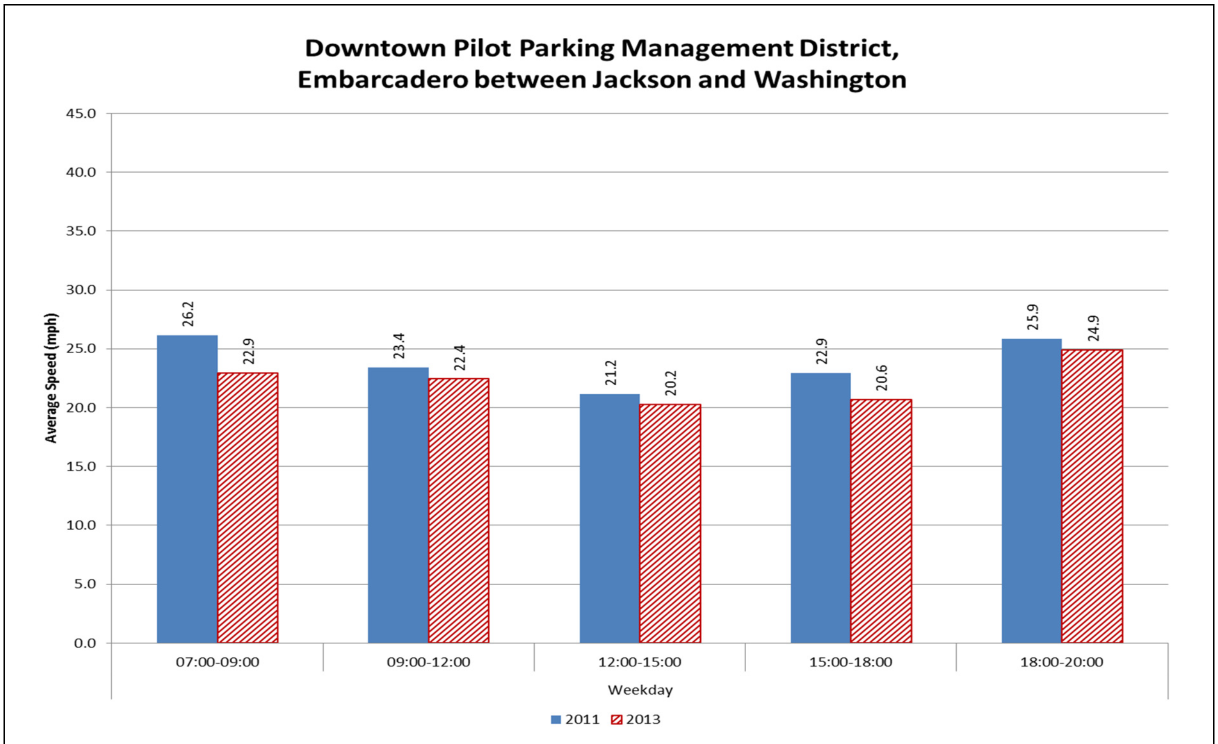
An analysis of average speeds was performed by time of day. It should be noted that most parking meters in the city are operational Monday through Saturday from 7 a.m. to 6 p.m. or 9 a.m. to 6 p.m., depending on location. In a portion of the South Embarcadero pilot area, meters within SFMTA jurisdiction operate until 10 p.m. to facilitate special event pricing, particularly during baseball games at AT&T stadium. Meters at Fisherman's Wharf are operational every day from 7 a.m. to 7 p.m., and meters in areas administered by the Port of San Francisco (mostly along the Embarcadero) are operational every day from 7 a.m. to 11 p.m. The hours of operations for each parking management district are as follows:[1]

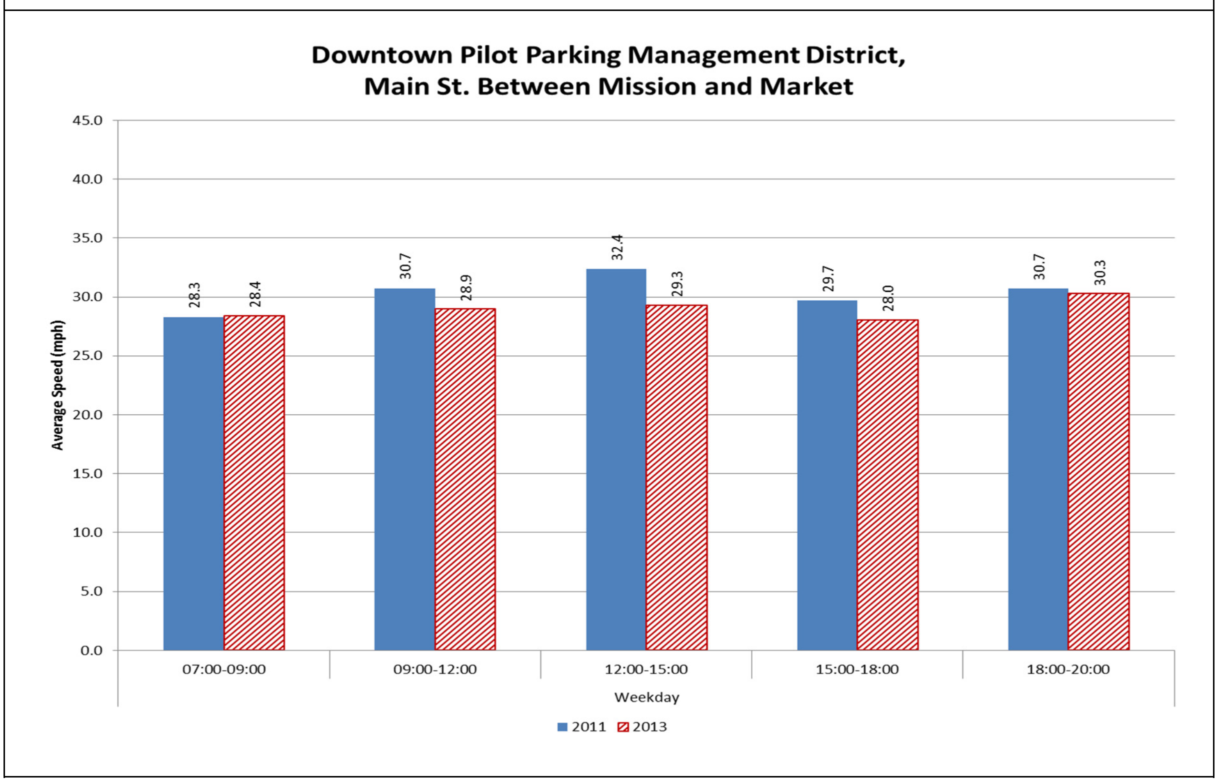
- Civic Center: 7:00 a.m. to 6:00 p.m.
- Downtown: 7:00 a.m. to 6:00 p.m.
- Fillmore: 9:00 a.m. to 6:00 p.m.
- Fisherman's Wharf: 7:00 a.m. to 7:00 p.m.
- Marina: 9:00 a.m. to 6:00 p.m.
- Mission: 9:00 a.m. to 6:00 p.m.
- South Embarcadero: 9:00 a.m. to 6:00 p.m.

Figure A-5 through Figure A-9 show the weekday average speeds in each of the pilot districts by time of day. From these figures, the following observations can be made:

- For the most part, average link speeds remained relatively constant across all time-of-day intervals.
- With the exception of the early morning interval (7:00 a.m. to 9:00 a.m.), average travel speeds on Saturdays were similar to those observed on weekdays across all times of day.
- In the Mission, Fisherman's Wharf, and Marina pilot districts, average travel speeds remained relatively constant throughout the day, which suggests that travel speeds in these pilot districts were relatively unaffected by the variable parking pricing. Generally, average travel speeds in these corridors were low to begin with (under 20 mph), suggesting that factors other than parking may have had a greater influence on travel speeds in the corridors.
- In the Downtown pilot parking management district, average travel speeds were lower than their initial levels in all time-of-day intervals.

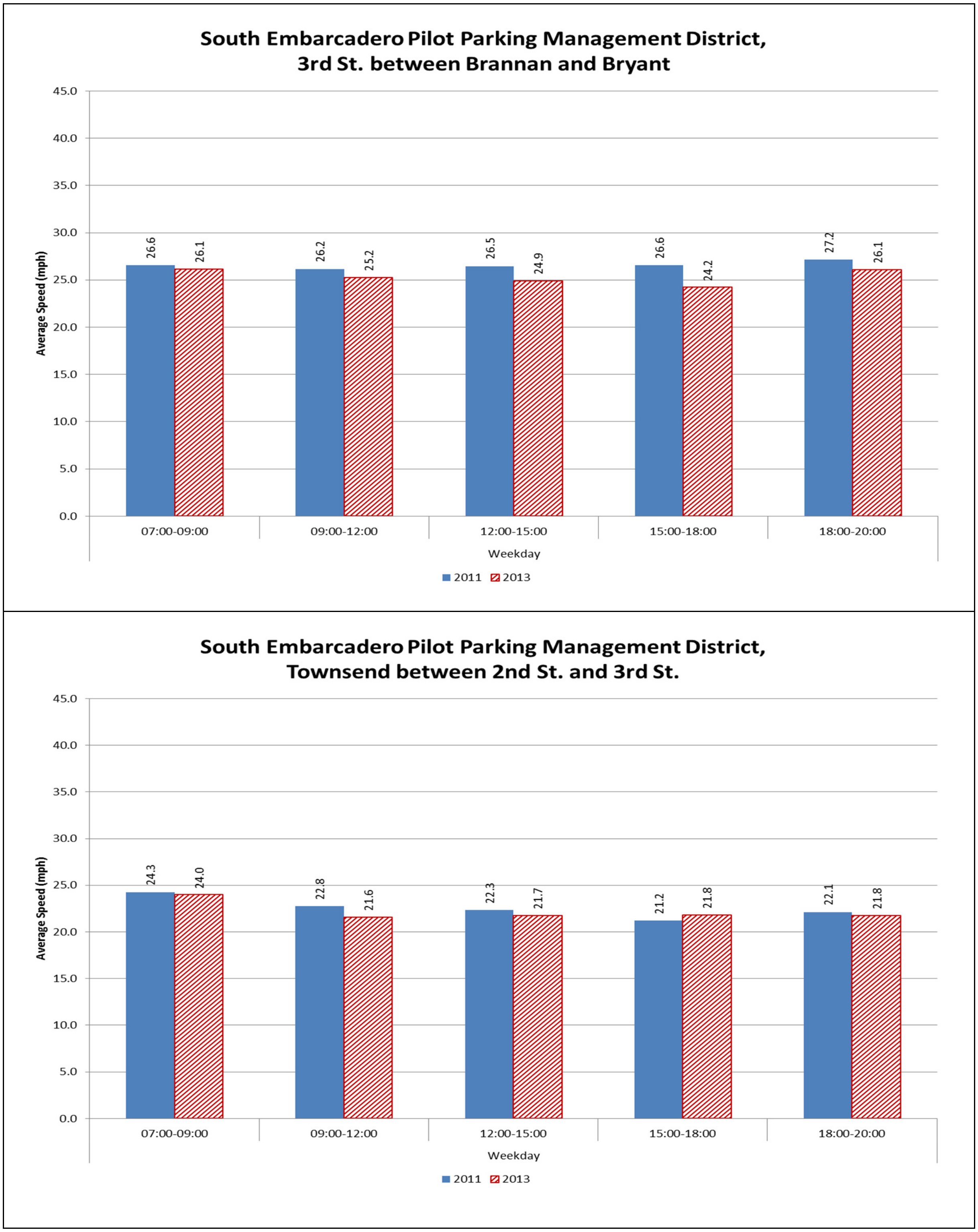
[1] *SFpark Putting Theory into Practice: Pilot Project summary and Lessons Learned*. Available at http://sfpark.org/wp-content/uploads/2014/06/SFpark_Pilot_Overview.pdf.





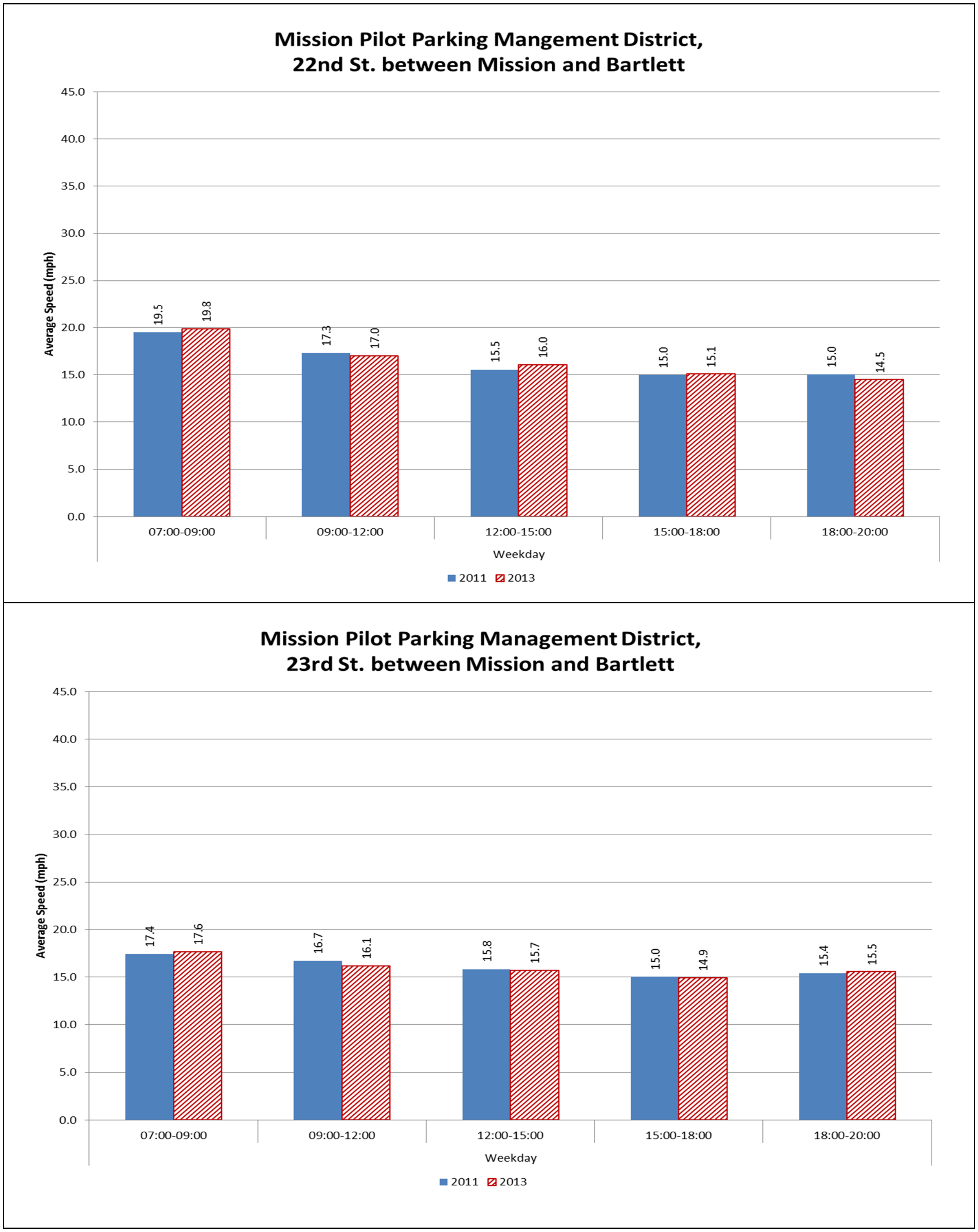
Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure A-5. Average Travel Speeds from Roadway Sensors by Time-of Day in SF*park* Downtown Pilot Parking Management District



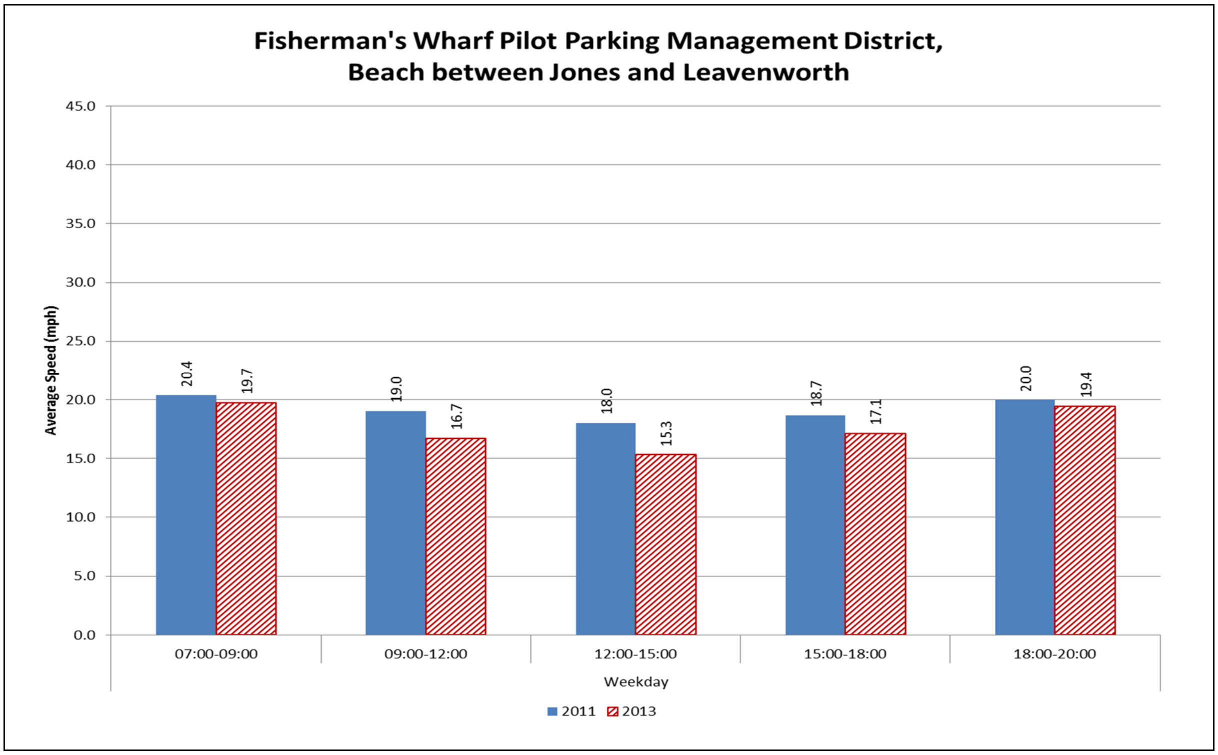
Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure A-6. Average Travel Speeds from Roadway Sensors by Time-of Day in SF*park* South Embarcadero Pilot Parking Management District



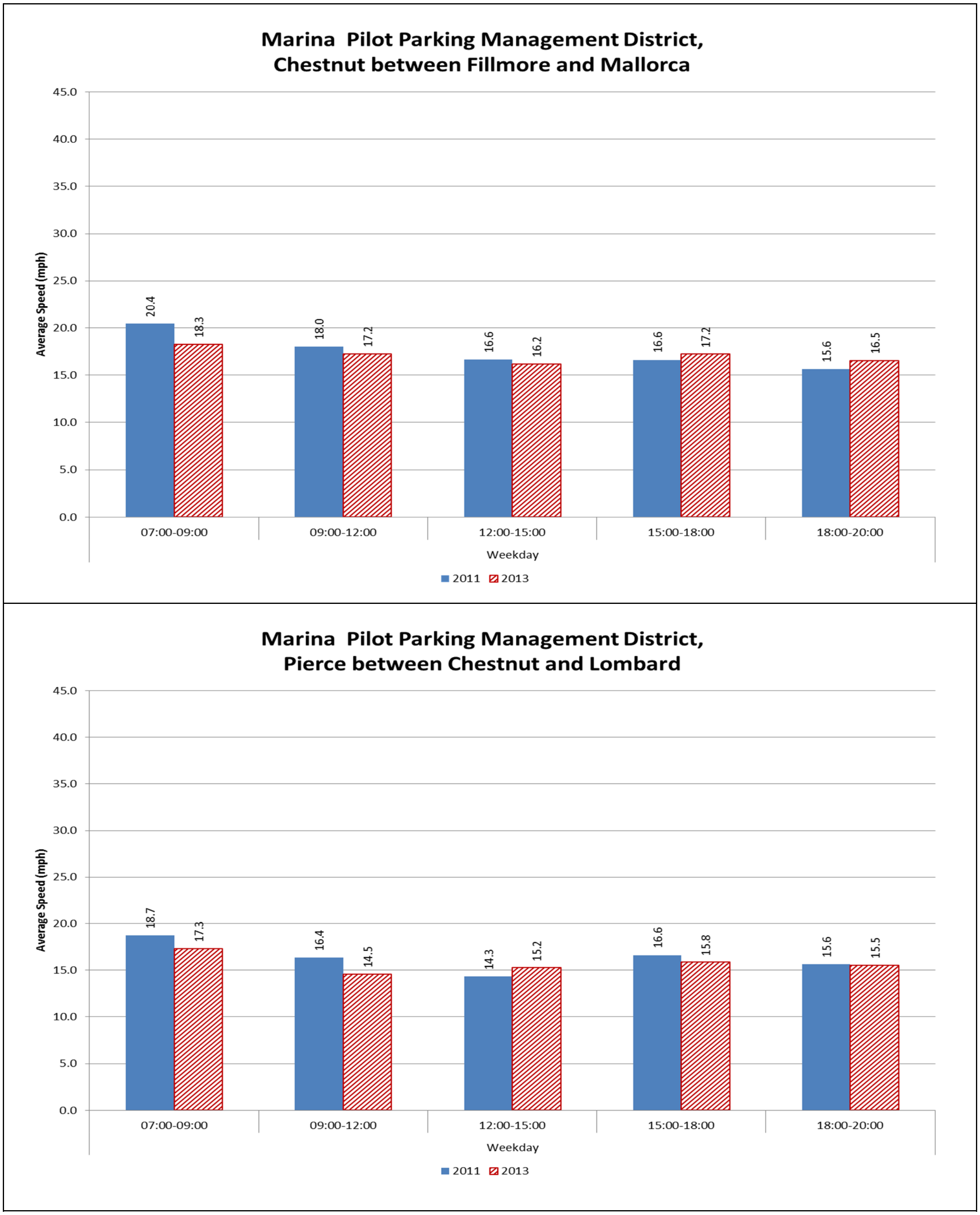
Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure A-7. Average Travel Speeds from Roadway Sensors by Time-of Day in SF*park* Mission Parking Management District



Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure A-8. Average Travel Speeds from Roadway Sensors by Time-of Day in SF*park* Fisherman's Wharf Pilot Parking Management District



Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure A-9. Average Travel Speeds from Roadway Sensors by Time-of Day in SF*park* Marina Pilot Parking Management District

Table A-4 shows the changes in the average a.m. and p.m. peak period travel speeds in pilot management districts where data were available. For this analysis, the a.m. peak period has been defined as the interval between 7:00 a.m. and 9:00 a.m. and the p.m. peak period has been defined to be the interval between 3:00 p.m. (15:00) and 6:00 p.m. (18:00). It should be noted that in the Marina, Mission, and South Embarcadero Districts metering is not in effect until 9:00 a.m., and thus averages in the a.m. speeds are not reported in those areas as they could not be affected by variable pricing. For all districts, metering is in effect through 6:00 p.m. during the p.m. peak.

The table shows that average travel speeds in the a.m. peak showed no consistent pattern on the streets with metering before 9:00 a.m. Embarcadero speeds declined by 3.3 mph, Beach declined by 0.6 mph, and Main increased by 0.1 in 2013.

Table A-4. Change in Average Weekday Peak Periods Travel Speeds (mph) from Available Sensors in SF*park* Pilot Parking Management Districts

Pilot Management District	Roadway	A.M. Peak (07:00-09:00)			P.M. Peak (15:00-18:00)		
		2011	2013	Net Change	2011	2013	Net Change
Downtown	Embarcadero	26.2	22.9	-3.3	22.9	20.6	-2.3
	Main	28.3	28.4	+0.1	29.7	28.0	-1.7
Fisherman's Wharf	Beach	20.4	19.7	-0.6	18.7	17.1	-1.6
Marina	Pierce	NA	NA	NA	16.6	15.8	-0.8
	Chestnut	NA	NA	NA	16.6	17.2	+0.6
Mission	22nd St.	NA	NA	NA	16.0	16.4	+0.4
	23rd St.	NA	NA	NA	15.0	14.9	-0.1
South Embarcadero	Townsend	NA	NA	NA	21.2	21.8	+0.6
	3rd St.	NA	NA	NA	26.6	24.2	-2.4

NA: Not applicable, as metering was not in effect during between 7:00 a.m. and 9:00 a.m.

Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

In the p.m. peak, while some roadways experienced slight increases in average travel speeds in 2013, average speed declined by 2 mph below the 2011 condition on the Embarcadero and 3rd St.

This finding suggests that deploying variable pricing did not result in a significant increase in travel speeds in the pilot parking management districts. In most of the pilot districts (where data were available), average travel speed remained constant or even declined slightly after variable pricing policies were implemented.

As data from the control areas were not available for comparison, it is difficult to determine if any of the changes in average travel speeds that were observed were directly attributable to the changes in parking pricing or due to other causes.

In addition to the national evaluation findings reported here, SFMTA performed its own comparison of average link speeds in and around parking management districts that experienced changes in parking availability.[2] To identify districts where parking availability changed, SFMTA examined the amount of time that parking spaces within a four block radius of a roadway sensor were occupied. Those parking management districts showing an increase in the amount of time that spaces within this radius were fully occupied (i.e., occupied 90 percent of the time or more) were categorized as experiencing a "worsening" of parking availability while those districts showing a decrease in the amount of time spaces were fully occupied were categorized as having "improved" parking availability. SMFTA then computed the average travel speeds from roadway sensors in districts where the parking availability "improved" and "worsened" between 2011 and 2013. Roadway sensor speeds from 6:00 a.m. to 9:00 p.m. on weekdays were used to compute the average link speed for those districts.

Table A-5 shows the change in average link speeds in those districts where parking availability either improved or worsened. The table shows that in those districts where parking availability improved (i.e., experienced a reduction in the amount of time where the spaces were fully occupied), average link speeds declined by less than 1 mph. For those pilot districts where parking availability decreased (i.e., "worsened"), average link speeds declined by 1.5 mph. This suggests that in those districts where parking availability was scarce, travel speeds were more negatively impacted as individuals searched for available parking spaces.

Table A-5. Change in Average Link Speeds for those Parking Management Districts Experiencing a Change in Parking Availability

Change in Parking Availability	Average Link Speeds (mph)		Net Change	Percent Change
	2011	2013		
Improved, Pilot Districts	19.9	19.1	-0.8	-4.3 %
Worsened, Pilot Districts	20.2	18.7	-1.5	-7.6%
Worsened, Control Districts*	20.5	21.2	0.7	3.4%

*Only the Inner Richmond parking management district was included from the control districts. This district showed only a worsening of parking availability.

Source: SFMTA, 2014.

[2] Verbal and email communication between the national evaluation team and SFMTA staff.

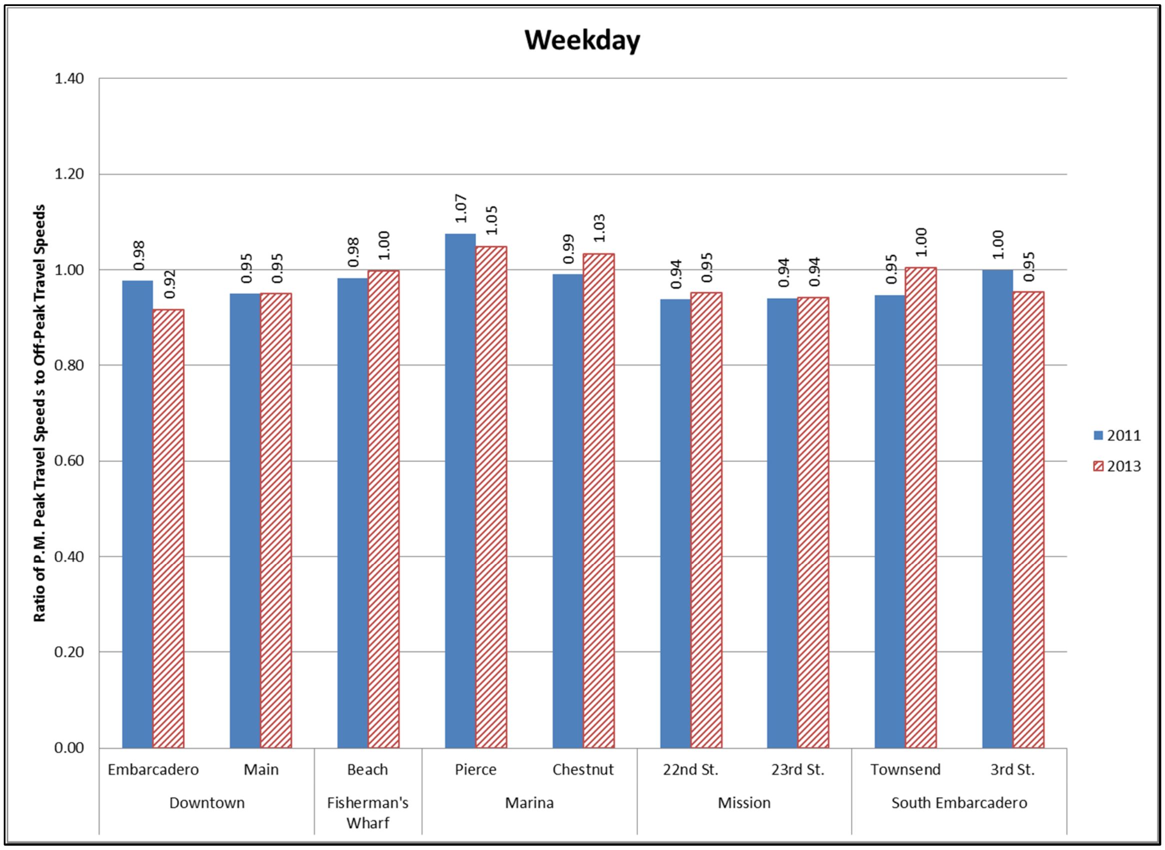
A.2.2 Ratio of Peak to Off-Peak Travel Speeds

Figure A-10 depicts changes in the ratio of average peak speeds to off-peak speeds observed in each of the parking management districts from 2011 to 2013. It was hypothesized that the ratio would be lower after pricing was implemented compared to before. The rationale was that the speed in the peak period would have been relatively constant, as most of the drivers would not have been looking for a parking space. In the off-peak period, when there were fewer vehicles, speeds would have been more sensitive to drivers searching for parking, with an improvement in expected in the off-peak speed after price changes. Thus, a drop in the ratio might have indicated that parking pricing had had an effect.

For this analysis, the weekday peak period travel speeds were analyzed in the p.m. peak (i.e., from 3:00 p.m. to 6:00 p.m.). The morning peak was excluded because metering is not in effect until 9:00 a.m. for Marina, Mission, and South Embarcadero Districts. In locations where metering was in effect beginning at 7 a.m., morning parking occupancy was generally low, and, thus, variable meter rates would not be expected to affect overall travel speeds impacted by vehicles cruising for parking. For all districts, metering is in effect through 6:00 p.m. during the p.m. peak.

A ratio of 1.0 would imply that the average peak period speeds were equal to the average speeds during off-peak conditions. A ratio greater than 1.0 would imply that average peak speeds were greater than the average speed during off-peak conditions, while a ratio less than 1.0 would imply the average speeds during the off-peak tended to be higher than average speeds during the peak period.

Figure A-10 shows that in most of the pilot districts the ratio of average peak period speeds to off-peak speeds centered around 1.0. This implies that that speeds in most of the pilot districts were relatively consistent in most of the peak period. The figure shows that very little change in the ratio of peak to off-peak travel speeds occurred throughout the duration.



Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure A-10. Changes in the Ratio of Peak Travel Speeds to Off-Peak Travel Speeds for the various SF*park* Parking Management Districts

As shown in the figure, the ratio of p.m. peak travel speeds to off-peak travel speeds in improved from 2011 to 2013 in five of the parking management districts. The greatest improvement in the ratio of p.m. peak to off-peak travel speeds occurred on Chestnut Street in the Marina district and on Townsend Street in the South Embarcadero district. On these two facilities, the ratio of p.m. peak speeds to off-peak speed increased by approximately 5 percent. Three facilities showed a drop in the ratio of the p.m. peak speeds to off-peak speed. These include the Embarcadero Street in the Downtown district, Pierce Street in the Marina district, and 3rd Street in the South Embarcadero district.

A.3 Findings from Transit Data

This section presents findings from the analysis of transit travel time data collected by SMFTA in both the control and pilot parking management districts.

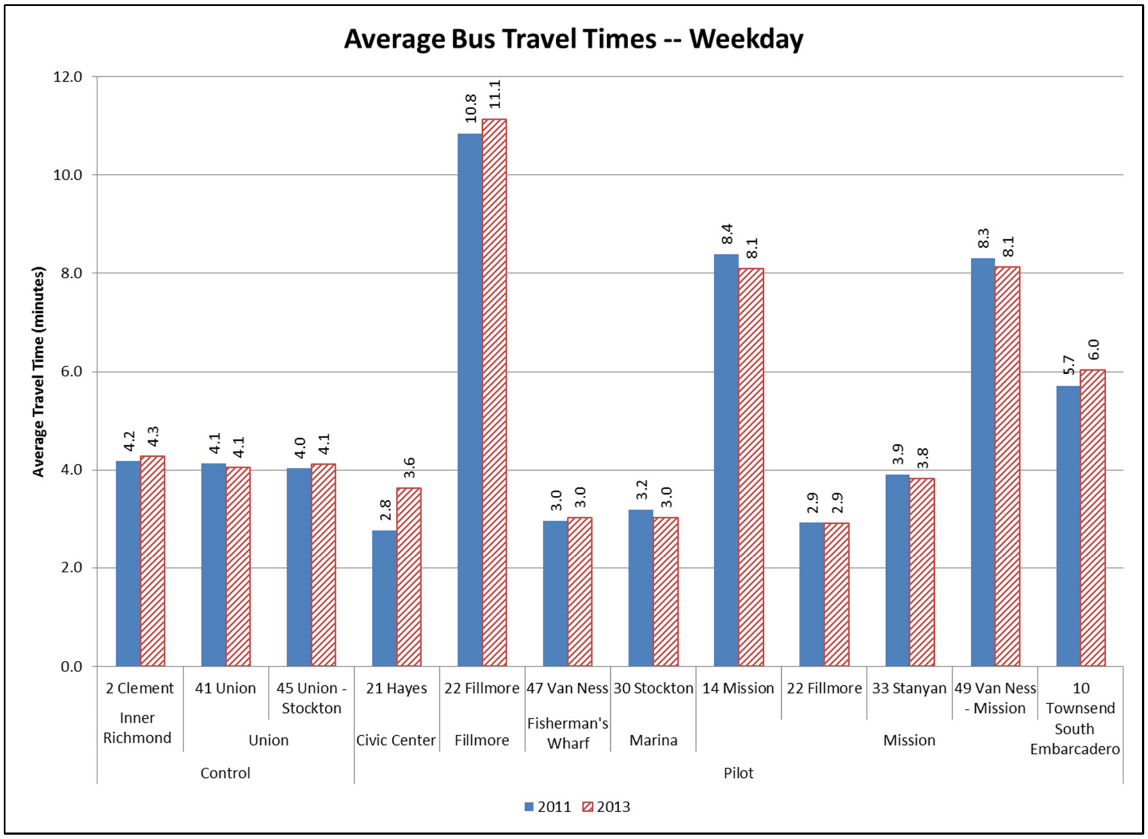
A.3.1 Transit Travel Times and Speeds

Because traditional means for collecting travel time data were not feasible for this evaluation, transit travel time was selected as a suitable surrogate for vehicle travel times in the congestion analysis. The rationale for using transit travel times as a surrogate measure of traffic stream performance was that the reduction in congestion caused by reduced parking search times would translate into improved travel times, running speeds, and travel time reliability for transit vehicles traveling through the pilot parking management districts just as the improvements would benefit other non-transit vehicles.

It should be noted that travel time data were not available on every roadway in each parking management district. Transit travel times through the control parking management districts were available from three routes: the #2-Clements route in the Inner Richmond control parking management district, and the #41-Union and #45-Union/Stockton routes through the Union parking management district. The routes in the pilot parking management districts include the following:

- The #21-Hayes route in the Civic Center parking management district;
- The #22-Fillmore route in the Fillmore parking management district;
- The #47-Van Ness route in the Fisherman's Wharf parking management district;
- The #30-Stockton route in the Marina parking management district;
- The 14-Mission, the #22-Fillmore, the #33-Stanyon and the #49-Van Ness/Mission routes, all from the Mission parking management district; and
- The #10-Townsend route in the South Embarcadero parking management district.

Figure A-11 presents the average travel times of transit vehicles traveling through the various pilot and control parking management districts on weekdays. The figure shows that, as expected, average transit travels on the routes in the control parking management districts did not change, as there were no price changes during the evaluation periods. In the control districts, average travel times remained around four minutes in the after evaluation period (spring 2013). This pattern suggests that the background level of congestion (at least that affecting transit travel times) remained the same over the duration of the evaluation period. Furthermore, because parking pricing was not varied in these control districts over the course to the evaluation period, any changes in transit travel times that might have occurred in the control districts would have been due to other reasons.

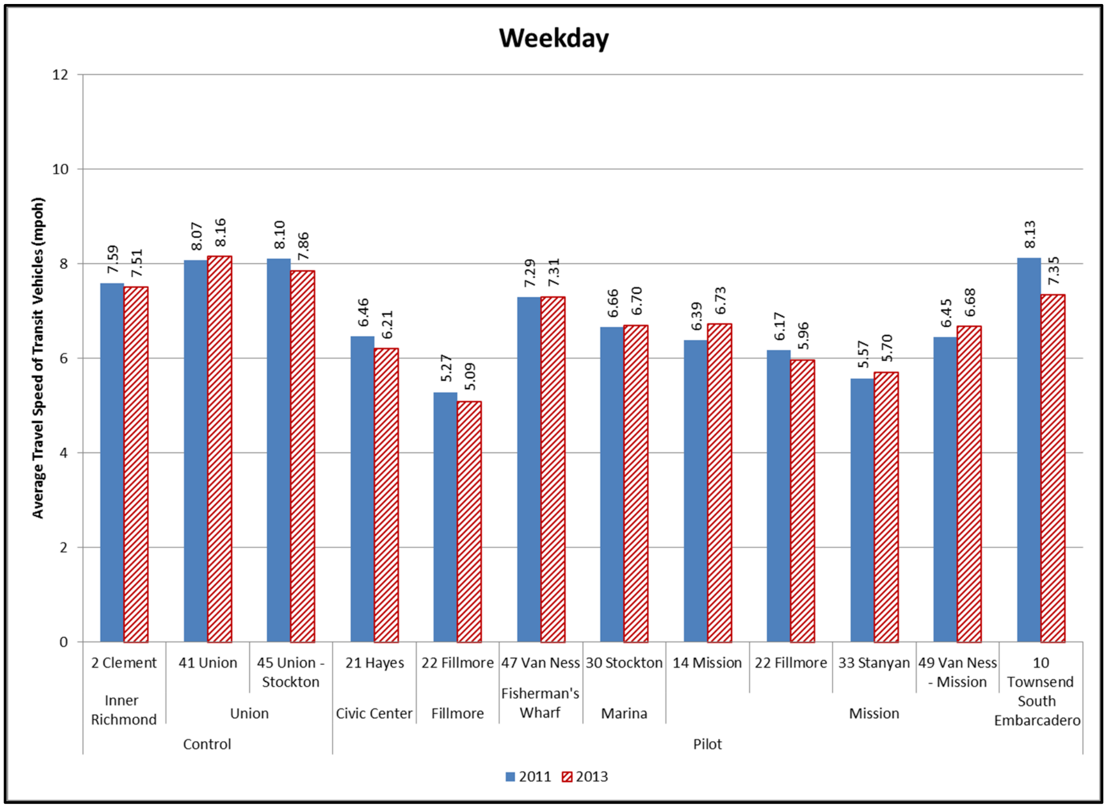


Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure A-11. Weekday Average Transit Travel Times by Routes in Pilot and Control Parking Management Districts

Figure A-11 also shows the average weekday transit travel times on the transit routes traversing through the parking management districts where variable pricing was applied (i.e., the pilot districts). For weekday travel, the figure shows that average transit travel times remained relatively constant on all the routes through the pilot parking management districts – never changing more than 0.3 minutes – except for one route: the #21-Hayes route in the Civic Center pilot parking management district. For that route travel times increased in 2013, although the overall change in travel times was less than a minute. A possible explanation for increased travel times around the Civic Center is more congestion due to an improving economy.

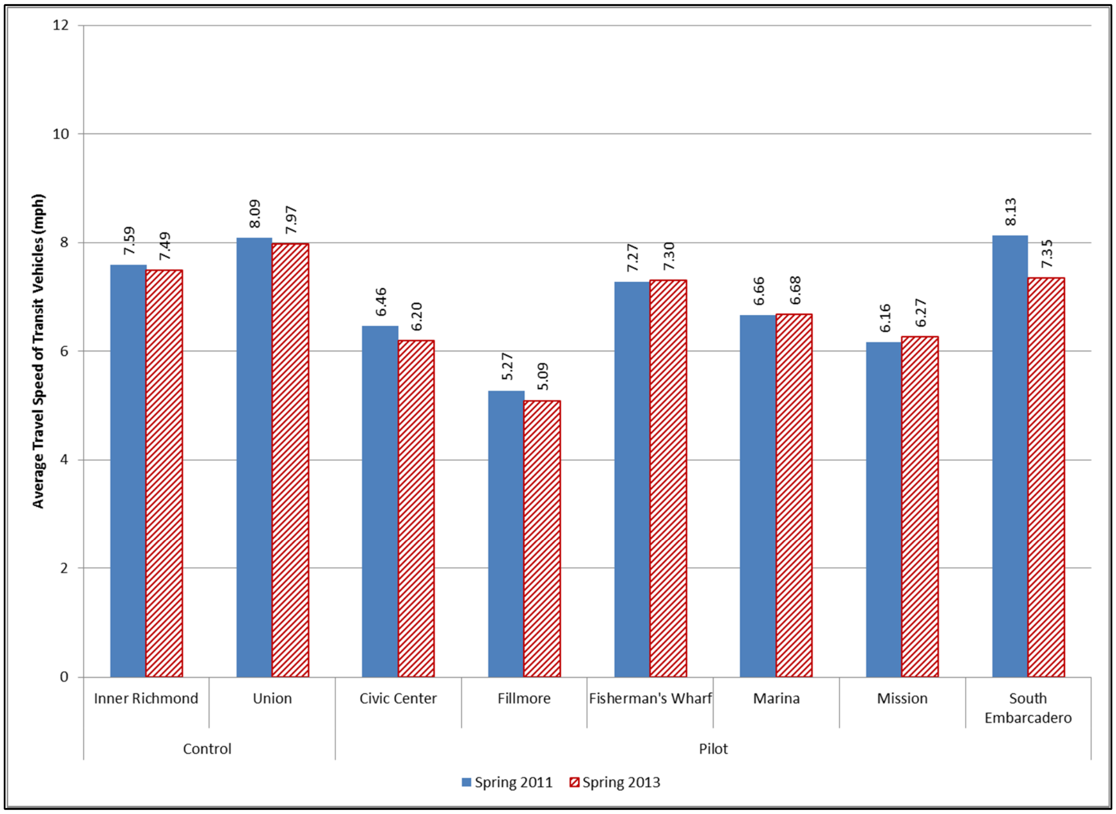
Figure A-12 shows the average speed of transit vehicles for each transit route in the control and parking management districts. In the control districts, average speed of transit vehicles remained relatively constant at around 8 mph on each transit route. The average speed of transit vehicles in the parking management districts in the pilot district ranged from approximately 5 mph to 8.5 mph over the course of the evaluation period. The changes in average speed were relatively small. The greatest decline in travel speed occurred on the #10 Townsend route in the South Embarcadero parking management district.



Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure A-12. Average Speed of Transit Vehicles by Transit Route

Figure A-13 shows the change in average transit speeds aggregated across all transit routes within a parking district. The figure shows that average travel speed of transit vehicles in the two control districts gradually declined, albeit only slightly, from 2011 to 2013.



Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure A-13. Average Speed of Transit Vehicles per Parking Management District

Table A-6 shows the results of the statistical analyses of average travel speed of transit vehicles by parking management district. The shaded cells in the table represent statistically significant differences at a 95 percent confidence level. Those values shaded in red (or negative value) represent reductions in average speeds while those values shaded in green (or have a positive value) represent increases in average speeds compared to 2011 averages. The results show that average transit travel speeds changed very little. In the control parking management districts average speeds were approximately 0.1 mph lower in 2013 compared to 2011. The average travel times of transit vehicles in the pilot districts also showed no increase in travel speeds in 2013.

Table A-6. Statistical Comparison* of the Change in Average Transit Speeds by Parking Management District

Parking Management Districts		Change in Average Speed (mph) of Transit Vehicles Between Spring 2011 to Spring 2013		
		ΔSpeed	Std. Error	t-value
Control	Inner Richmond	-0.07	0.066	-1.06
	Union	-0.15	0.042	-3.60
	Total	-0.13	0.035	-3.66
Pilot	Civic Center	-0.29	0.063	-4.61
	Fillmore	-0.18	0.040	-4.37
	Fisherman's Wharf	0.06	0.056	1.18
	Marina	0.10	0.052	1.83
	Mission**	0.13	0.024	5.30
	South Embarcadero	-0.82	0.074	-11.12
	Total	-0.02	0.017	-0.95

*T-test for significant before/after difference in average speeds was performed. Shaded cells indicate t-values that are statistically significant at 95 percent level of confidence.

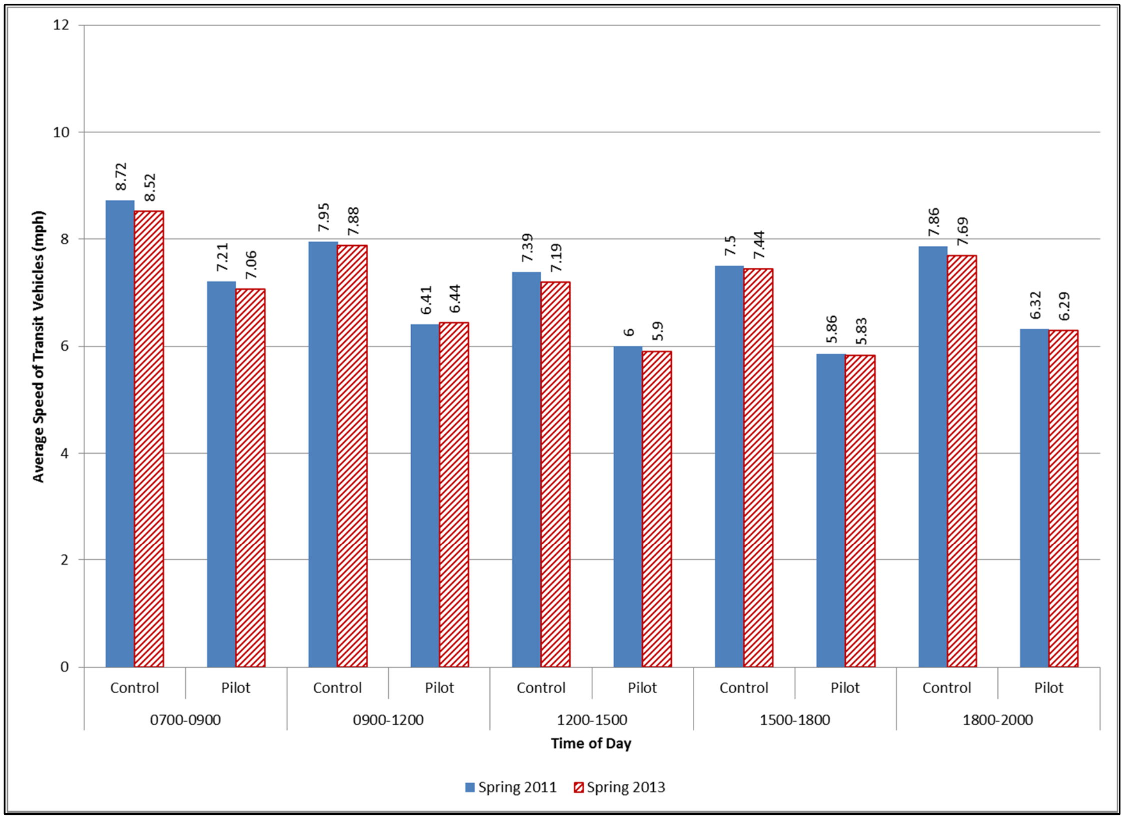
**Data for Mission routes 14 and 49 for 2012 not included due to impact of construction.

Source: Texas A&M Transportation Institute, 2014.

The results also indicate the following with respect to specific control and pilot parking management districts:

- For the control districts, the speeds were slightly worse in both parking management districts but only statistically significant at the Union in spring 2013.
- For the pilot districts, average transit travel speeds were statistically higher in only the Mission parking management district in 2013. No change was observed in average transit travel speeds in the Fisherman's Wharf and Marina parking management districts. Average transit travel speed deteriorated with statistical significance in the Civic Center, Fillmore, and South Embarcadero parking management districts.
- The most substantial decline in transit travel speeds was through the South Embarcadero parking management district, where speeds declined by 0.8 mph.

Figure A-14 shows the change in average speeds of transit vehicles traveling in the control and pilot parking management districts for different time intervals throughout the day. The figure shows that average travel speed of transit vehicles in both the control parking management districts and the pilot parking management districts remained relatively constant throughout the entire day. The figure also shows that average travel times did not change substantially between 2011 and 2013.



Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure A-14. Comparison of Average Speed of Transit Vehicles in Control and Pilot Parking Management Districts by Periods of the Day

Table A-7 shows the results of a linear mixed effect statistical analysis that examined how average travel speeds in certain periods of the day changed between spring 2011 and spring 2013. The shaded cells in the table represent statistically significant differences at a 95 percent confidence level. Those values shaded in red (or negative value) represent reductions in average speeds compared to 2011 averages.

Table A-7. Statistical Comparison of the Change Average Travel Speeds of Transit Vehicles by Time of Day

Parking Mgmt Districts	Time Period	Change in Average Speed (mph) of Transit Vehicles Between Spring 2011 and Spring 2013		
		Δ Speed	Std. Error	t value
Control	0700-0900	-0.10	0.067	-1.50
	0900-1200	-0.11	0.086	-1.31
	1200-1500	-0.30	0.094	-3.21
	1500-1800	-0.05	0.070	-0.76
	1800-2000	-0.17	0.090	-1.93
	Total	-0.13	0.036	-3.57
Pilot**	0700-0900	-0.10	0.043	-2.41
	0900-1200	0.06	0.036	1.74
	1200-1500	-0.05	0.036	-1.29
	1500-1800	-0.02	0.035	-0.48
	1800-2000	0.00	0.042	0.04
	Total	-0.02	0.017	-0.95

*T-test for significant before/after difference in average speeds was performed. Shaded cells indicate t-values that are statistically significant at 95 percent level of confidence.

**Data for Mission routes 14 and 49 for 2012 not included due to impact of construction.

Source: Texas A&M Transportation Institute, 2014.

The results of the statistical analysis indicated the following:

- When averaged across all time periods, the average travel speed of transit vehicles was lower by 0.13 mph in 2013, compared to 2011 in the control parking management districts. For the pilot parking management districts, the average travel speed of transit vehicles (when averaged over all time periods) was unchanged in 2013.
- For the pilot parking management districts, average transit travel speeds for most time periods (except from 7 a.m. to 9 a.m.) were unchanged in 2013 compared to pre-deployment levels in 2011 with no time periods experiencing a statistically significant change in average travel speed. Transit vehicles did experience a 0.10 mph reduction in average travel speeds in the 7 a.m. to 9 a.m. time period in 2013. This reduction in travel speeds was statistically significant at a 95 percent confidence level. However, that time of day is prior to the start of pricing for on-street parking on most streets.
- For the control group, the average speed of transit vehicles did not change significantly between 7 a.m. and noon and from 3 p.m. to 8:00 p.m. Between noon and 3:00 p.m. average speed declined by a statistically significant 0.30 mph.

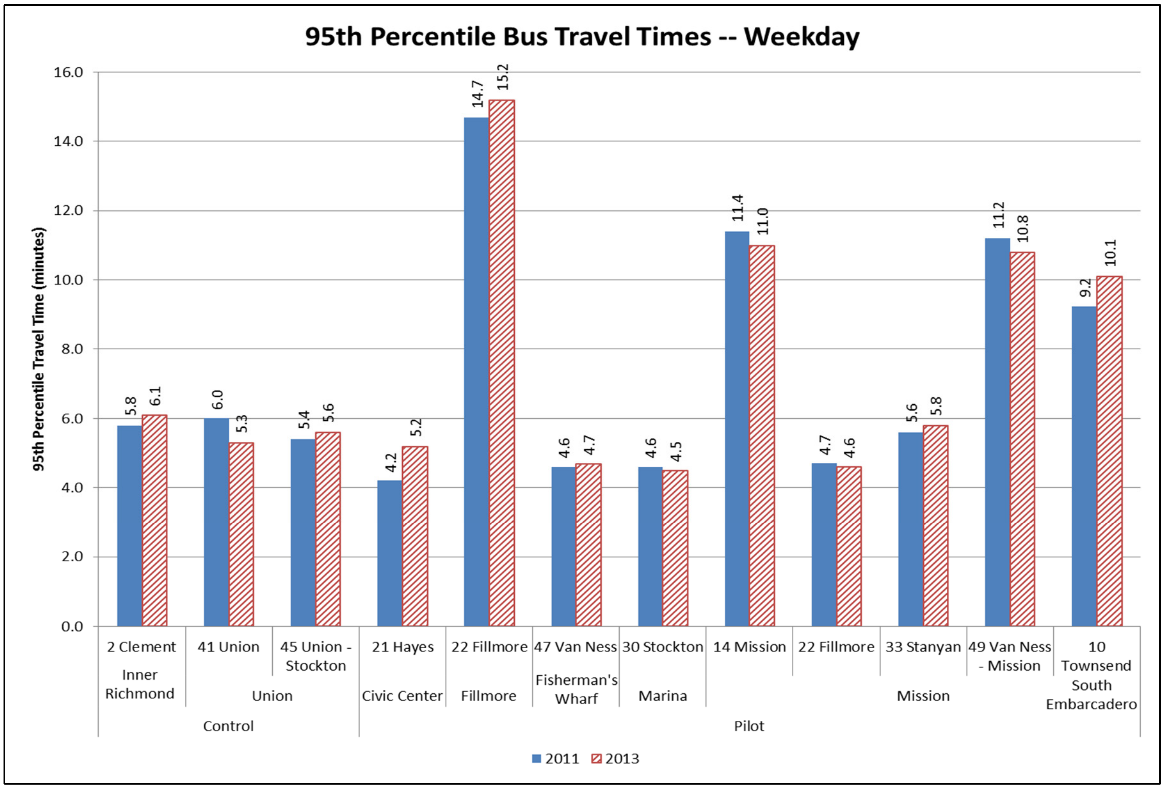
It should be noted, however, that most of the changes in travel speeds were relatively minor (less than 0.2 mph) and well within the margin of error of the equipment used to collect average travel speeds of the transit vehicles.

A.3.2 Transit Travel Time Variability and Reliability

Other measures of congestion are travel time variability and reliability, and transit travel times were examined to assess the impact of variable parking pricing in the pilot districts. The 95^{th} percentile travel times of transit vehicles were examined to determine how transit travel time variability changed over time and among the various parking management districts.

Figure A-15 shows the 95^{th} percentile travel times of transit vehicles on the routes in control and pilot parking management districts. The figure shows that the 95^{th} percentile travel times exhibit the following trends:

- Only minor changes in the weekday 95^{th} percentile travel times for transit vehicles were observed in the control sections;
- The largest drop in 95^{th} percentile travel times occurred on the #49 Van Ness/Mission route in the Mission pilot parking management district; and
- The 95^{th} percentile travel times increased on four routes in the weekdays with the greatest increase occurring in the Civic Center parking management district. The 95^{th} percentile travel times in this district increased by 1 minute.

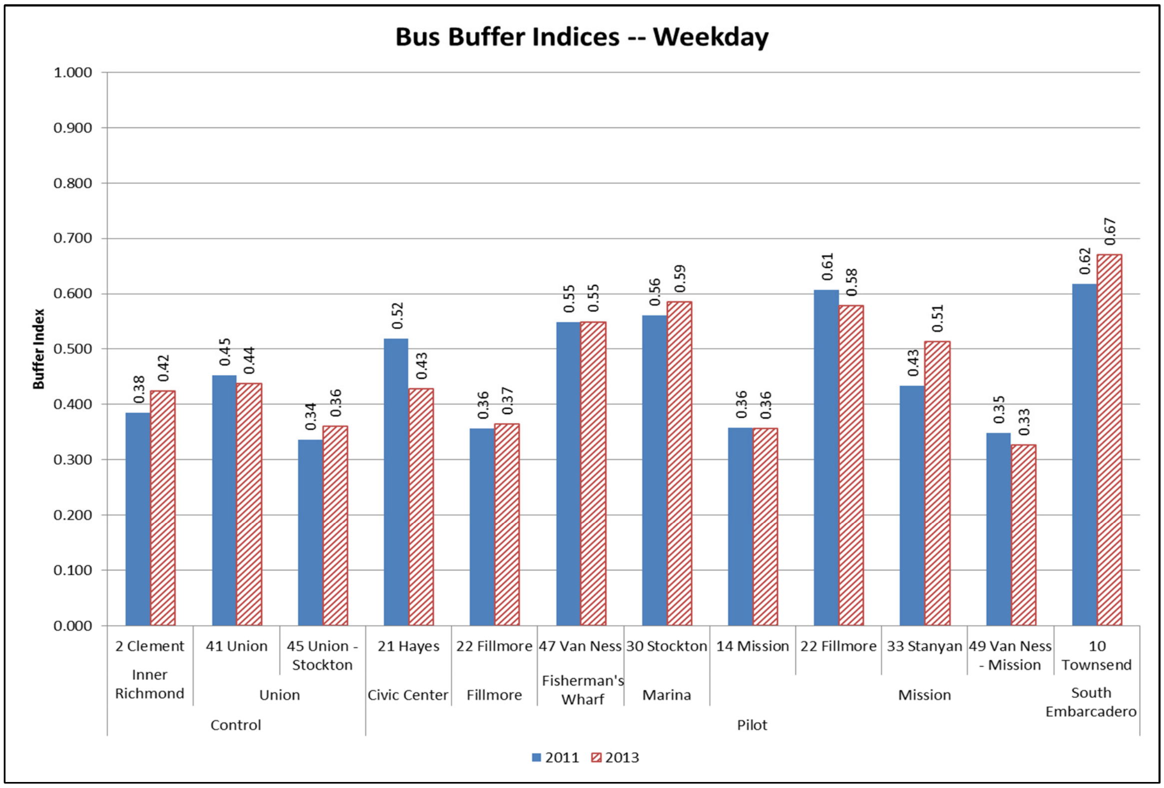


Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure A-15. Weekday 95th Percentile Transit Travel Times by Routes in Pilot and Control Parking Management Districts

The buffer index is a measure of travel time reliability. It is computed as the ratio of the difference between the 95th percentile travel times and the average travel time divided by the average travel time. For transit vehicles, the buffer index represents the amount of extra time that must be built into the schedule to ensure an on-time arrival 95 percent of the time.

Figure A-16 shows the buffer indices of transit vehicles on the routes through the various control and pilot parking management districts. The figure shows that the buffer indices did not change substantially in most parking management districts. The greatest drop in the weekday buffer index occurred in the #21-Hayes route in the Civic Center pilot parking management district. For this route, the buffer index dropped by approximately 10 percent between 2011 and 2013. This suggests that variable parking pricing had a positive impact on transit performance by reducing the amount of extra time needed to ensure on-time arrivals on #21-Hayes. Most of the other routes showed only minor changes in their buffer indices.



Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure A-16. Weekday Buffer Indices by Routes in Pilot and Control Parking Management Districts

A.3.3 Vehicle and Person Throughput

The national evaluation does not include an assessment of the effects of the improvements on vehicle and person throughput because of issues associated with the roadway sensor data. Because of inconsistencies with the traffic count data provided by the road traffic sensors, SFMTA determined that the quality of data along with the lack of sensor validation surveys limited the findings generated from the roadway sensor data.

SFMTA performed an assessment of the changes in average traffic volumes in districts where parking availability improved or worsened.[3] SFMTA categorized changes in parking availability based on the amount of time that parking districts within a four block radius of a roadway sensor were occupied. Those districts showing an increase in the amount of time that spaces within this radius were fully occupied (i.e., occupied 90 percent of the time or more) were categorized as experiencing a "worsening" of parking availability while those districts showing a decrease in the amount of time spaces were fully occupied were categorized as having "improved" parking availability. SFMTA then computed the averages of all the volume readings from 6:00 a.m. to 9:00 p.m. on weekdays to determine the average volume on the link.

Table A-8 shows the change in average link volume in those districts where parking availability improved and worsened. The table shows that in those districts where parking availability improved (i.e., experienced a reduction in the amount of time where the spaces were fully occupied), average hourly traffic volume declined slightly, while for those districts where parking availability worsened, traffic volume remain relatively the same or increased slightly. While these changes are relatively slight, it does suggest that improving parking availability in some parking management districts might result in less circulating vehicles looking for parking spaces.

Table A-8. Change in Average Hourly Volume for those Parking Management Districts Experiencing a Change in Parking Availability

Change in Parking Availability	Average Hourly Volumes (vph)		Net Change	Percent Change
	2011	2013		
Improved, Pilot	377	348	-29	-7.7 %
Worsened, Pilot	349	347	-2	-0.4%
Worsened, Control*	280	295	15	5.3 %

*Only the Inner Richmond Parking Management District was included from the control section. This section showed a worsening of parking availability.

Source: SFMTA, 2014.

[3] Email and personal communication between the national evaluation team and SFMTA staff.

A.4 Perceptions of Congestion

Several of the questions in the visitor/shopper survey were pertinent to understanding how travelers view traffic congestion in San Francisco and whether those perceptions changed after variable pricing of parking. The data also suggest how travelers have been impacted by changes in parking availability and traffic congestion.

To directly measure the perception of congestion, respondents were asked the question "how much traffic was in the area?" Table A-9 presents the responses by SF*park* control and pilot parking management districts and time periods before and after variable pricing was in effect. Chi-square tests were performed on the difference in the distributions between the two periods and between the pilot and control districts, as shown in Table A-10.

Table A-9. Summary Statistics (N and Percent) for "How Much Traffic Was in the Area?" by Parking Management District Group and Time Period

Parking Management Districts	How Much Traffic was in the Area? (1=no traffic, 5=a great deal of traffic)	Before N (Percent)	After N (Percent)
Control	1	67 (10.47%)	79 (11.69%)
	2	178 (27.81%)	208 (30.77%)
	3	231 (36.09%)	247 (36.54%)
	4	120 (18.75%)	108 (15.98%)
	5	44 (6.88%)	34 (5.03%)
	Total	**640 (100.00%)**	**676 (100.00%)**
Pilot	1	50 (7.51%)	81 (11.22%)
	2	169 (25.38%)	138 (19.11%)
	3	237 (35.59%)	251 (34.76%)
	4	143 (21.47%)	153 (21.19%)
	5	67 (10.06%)	99 (13.71%)
	Total	**666 (100.00%)**	**722 (100.00%)**

Source: Battelle based on data from SFMTA, 2014.

Table A-10. Results from Chi-Square Test for Significant Differences in "How Much Traffic Was in the Area?" by Parking Management District Type and Time Period

Test for Significant Differences Across Parking Management Districts (Control/Pilot)		Test for Significant Differences Across Time Periods (Before/After)	
Time Period	**Chi-Square P-Value**	**Parking Management District Group**	**Chi-Square P-Value**
Before	0.0600	Control	0.3100
After	<0.0001*	Pilot	0.0044*

*The chi-square test of the distribution of data was significant at the 0.05 level.

Source: Battelle based on SFMTA data, 2014.

A surprising finding is that only a minority of respondents in both control and pilot parking management districts in both time periods felt traffic was heavy in the district in which they parked, i.e. responded with a 4 or 5. However, the perception changed somewhat over time. In the before period, there was not a significant difference in the response distribution between the control and pilot districts but there was in the after period. In the after period a larger percentage of respondents in the pilot parking management districts reported heavy traffic (answers 4 and 5) compared to the control districts. In the control districts, the distribution of answers did not significantly differ between the two periods but they did in the pilot districts. The percentage of respondents that chose 5 (a great deal of traffic) increased by 3.65 in the pilot districts. However, the percentage that chose 1 or 2 (little to no traffic) remained very close (32.89 vs. 30.33 percent) with fewer choosing 2 and more choosing 1 in the after period. Thus, in districts in which variable pricing was implemented travelers did not perceive a reduction in traffic congestion as had been expected but instead the effect was in the opposite direction. On the other hand, the perceived increased congestion was rather small and could be attributable to other factors, such as more traffic coming to the districts as the economy improved during the post-deployment period. Unfortunately, no data on traffic volume is available due to issues with the roadway sensors.

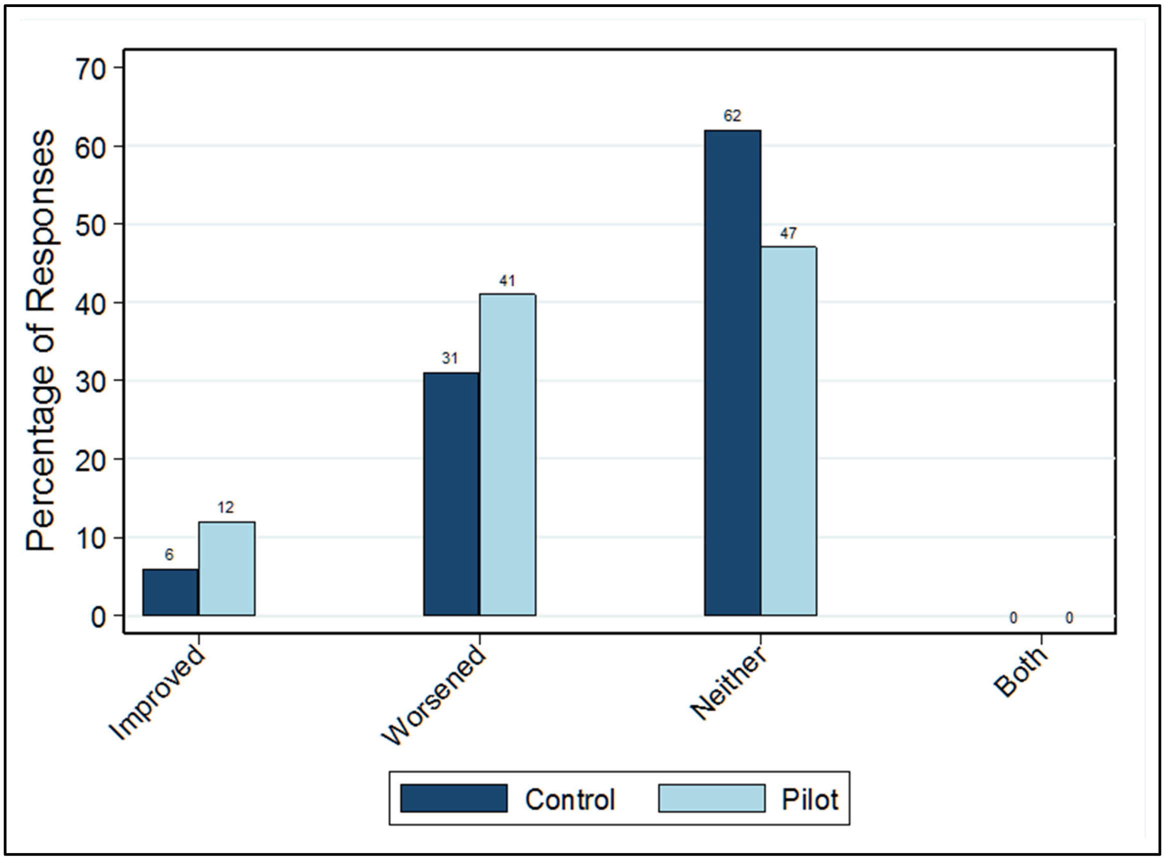
Another survey question that revealed travelers perception of parking conditions was the following: "Has parking availability in the area improved or worsened?" This question was asked only during the after survey. Table A-11 and Figure A-17 show the responses to the question.

Table A-11. Summary Statistics (N and Percent) "Has parking availability in the area improved or worsened?" by Parking Management District Group in the After Period

Has parking availability in the area improved or worsened?	Parking Management District Group*	
	Control (n=619)	Pilot (n=612)
Improved	38 (6.14%)	71 (11.60%)
Worsened	193 (31.18%)	252 (41.18%)
Neither	386 (62.36%)	288 (47.06%)
Both	2 (0.32%)	1 (0.16%)
Total	**619 (100.00%)**	**612 (100.00%)**

*The chi-square test of the distribution of data was significant at the 0.05 level.

Source: Battelle based on SFMTA data, 2014.



Source: Battelle based on SFMTA data, 2014.

Figure A-17. Percentage of Responses for "Has parking availability in the area improved or worsened?" by Parking Management District Group in the After Period

There was a significant difference in response distributions between the pilot and control parking management districts after variable pricing was implemented (p-value<0.0001). A greater percentage of respondents believed parking availability changed – 52.78 percent said improved or worsened – in the pilot districts compared to 62.36 percent in the control districts who saw no change. Of those who reported a change in the pilot districts, almost four times as many said that parking had worsened.

While the two questions on perceived traffic congestion and parking availability pertain to the general environment of the traveler coming to the area, two other questions shed more light on the actual parking experience of the respondent. These were the amount of time it took to look for parking and the number of blocks from the destination that the respondent parked. Analysis of these questions revealed that the actual parking experience reported by the respondent was more positive than the conditions encompassed in the previous two questions.

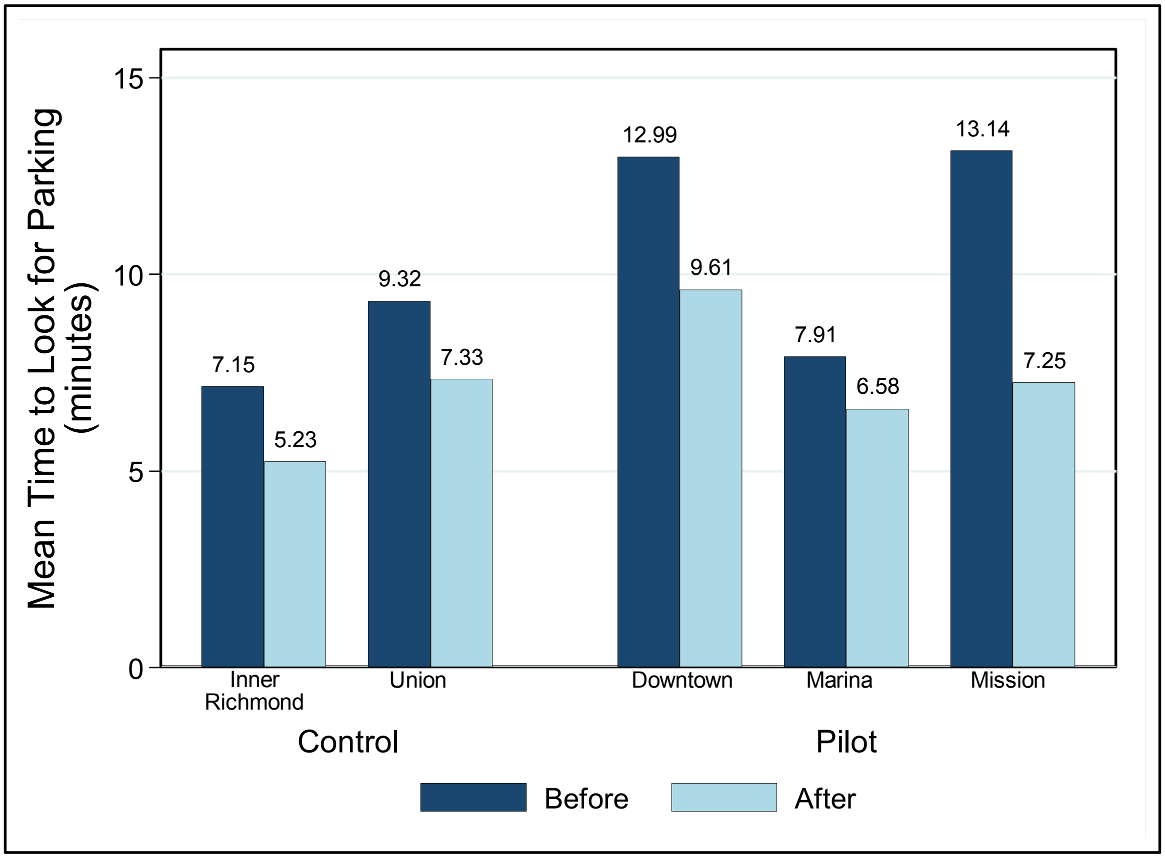
Table A-12 presents the average number of minutes that it took the respondent to find parking, and the results are shown graphically in Figure A-18. Respondents generally found parking in fewer minutes in control parking management districts than in the pilot districts prior to the start of variable pricing, perhaps owing to different characteristics of the control districts (e.g., more residential relative to the pilot parking management districts) reducing the demand for parking. The before/after comparison showed a post-deployment reduction in minutes in both the control and pilot parking management districts.

Table A-12. Mean and 95 Percent Confidence Interval for the Time to Look for Parking (in Minutes) by Neighborhood

Parking Management Districts		Before		After	
		N	Mean (CI)	N	Mean (CI)
Control	Inner Richmond	316	7.15 (6.23, 8.07)	345	5.23 (4.34, 6.13)
	Union	324	9.32 (8.33, 10.31)	342	7.33 (6.19, 8.48)
	Total	**640**	**8.25 (7.57, 8.93)**	**687**	**6.28 (5.55, 7.01)**
Pilot	Downtown	273	12.99 (11.55, 14.43)	264	9.61 (8.34, 10.88)
	Marina	199	7.91 (6.56, 9.26)	248	6.58 (5.68, 7.48)
	Mission	196	13.14 (11.67, 14.62)	225	7.25 (5.98, 8.53)
	Total	**668**	**11.52 (10.67, 12.37)**	**737**	**7.87 (7.20, 8.55)**

Source: Battelle based on SFMTA data, 2014.

To gain further insight into the nature of the change, an analysis of variance (ANOVA) model was fitted to the data with fixed effects for time period and phase with an interaction term added to test whether the difference between control and pilot districts was different between time periods. The results of the ANOVA model, shown in Table A-13, indicate that there was a significant difference in the time spent looking for parking between time periods (p-value<-0.0001). There was also a significant difference in the amount of time respondents spent looking for parking in the control districts compared to the pilot districts (p-value<0.0001). The interaction effect was also significant (p-value=0.0251), which indicates that the mean difference between the time spent looking for parking in the control versus pilot districts depended on the time period. For the before period, respondents in the pilot districts spent 3.27 minutes longer finding parking than in the control districts. In the after period, the difference between pilot and control districts was reduced to 1.59 minutes (a reduction of 1.68 minutes). These finding suggest that SF*park* pricing was effective in making it faster to find a place to park in the pilot relative to the control districts.



Source: Battelle based on SFMTA data, 2014.

Figure A-18. Mean Time to Look for Parking (in Minutes) by Neighborhood and Time Period

Table A-13. Results from ANOVA Model Testing for Significant Differences in Time to Find Parking by Parking Management District Group and Time Period

Comparison	Difference in Time (Minutes)	P-Value
Before (Pilot Districts – Control Districts)	3.27	<0.0001*
After (Pilot Districts – Control Districts)	1.59	0.0022*
After (Pilot Districts – Control Districts) – Before (Pilot Districts – Control Districts)	1.68	0.0251*

*Comparison significant at the 0.05 level.

Source: Battelle based on SFMTA data, 2014.

In addition to the time to find parking, respondents were also asked, “How far did you end up parking from your destination,” which they answer in number of blocks. Table A-14 shows the results by control and pilot parking management district group and by time period. In general, respondents in control districts were able to park closer to their destination than those in the pilot districts; in the control districts 44.96 and 57.17 percent parked within a block or less before and after respectively, whereas the percentages in the pilot parking management districts were 30.22 and 45.59. These findings are consistent with the question on time to find parking in pilot vs. control. Table A-15 further substantiates these trends, as the chi-square test results show significant differences in response distributions between the pilot and control parking management district group in both time periods. The distance from parking to the destination was shorter in the control districts than in the pilot parking management districts in both periods. In addition, both the control and pilot parking management districts had significant differences in the response distribution across the two periods. The distance from parking to the destination was shorter after for both parking management district group compared to before. However, it isn’t possible to tell from these results to what extent variable pricing in the pilot parking management districts contributed to the shorter distances after relative to before.

Table A-14. Summary Statistics (N and Percent) for “How Far Did You End Up Parking from Your Destination?” by Parking Management District Group and Time Period

Parking Management District Group	How Far Did You End Up Parking from Your Destination?	Before N (Percent)	After N (Percent)
Control	1. Less than 1 block away	189 (29.30%)	276 (40.12%)
	2. About 1 block away	101 (15.66%)	(17.15%)
	3. About 2 blocks away	135 (20.93%)	151 (21.95%)
	4. About 3 blocks away	116 (17.98%)	88 (12.79%)
	5. About 4 blocks away	47 (7.29%)	17 (2.47%)
	6. More than 4 blocks away	56 (8.68%)	38 (5.52%)
	7. Other	1 (0.16%)	0 (0.00%)
	Total	**645 (100.00%)**	**688 (100.00%)**
Pilot	1. Less than 1 block away	131 (19.47%)	213 (28.90%)
	2. About 1 block away	73 (10.85%)	123 (16.69%)
	3. About 2 blocks away	179 (26.60%)	166 (22.52%)
	4. About 3 blocks away	127 (18.87%)	123 (16.69%)
	5. About 4 blocks away	68 (10.10%)	51 (6.92%)
	6. More than 4 blocks away	93 (13.82%)	60 (8.14%)
	7. Other	2 (0.30%)	1 (0.14%)
	Total	**673 (100.00%)**	**737 (100.00%)**

Source: Battelle based on SFMTA data, 2014.

Table A-15. Results from Chi-Square Test for Significant Differences in "How Far Did You End Up Parking from Your Destination?" By Parking Management District Group and Time Period

Test for Significant Differences Across Parking Management Districts (Control/Pilot)		Test for Significant Differences Across Time Periods (Before/After)	
Time Period	**Chi-Square P-Value**	**Parking Management District Group**	**Chi-Square P-Value**
Before	<0.0001*	Control	<0.0001*
After	<0.0001*	Pilot	<0.0001*

*The chi-square test of the distribution of data was significant at the 0.05 level.

Source: Battelle based on SFMTA data, 2014

A.5 Findings of Congestion Impacts

The following provides a summary of the interpretation of the congestion analysis results and the effect of the implemented UPA improvements on congestion in San Francisco. Table A-16 summarizes the impacts of the UPA on congestion for the two hypotheses in the national evaluation.

The evaluation showed the results to be inconclusive as to whether the SF*park* and associated 511 improvements reduced congestion in the pilot parking management districts. Based on the observed data, the traditional measures of congestion (link travel speeds and travel times) did not change substantially after SFMTA implemented variable pricing in the pilot districts. One possible explanation might be the lack of sensitivity of utilized measures to changes caused by parking maneuvers. The type of sensors used in this evaluation provides point estimates of speeds, and cannot measure perturbations (such as those caused by parking maneuvers) unless they occur in the immediate vicinity of the sensor. Furthermore, performance issues associated with the traffic sensors resulted in less than the desired quantity of data, which may have been insufficient for evaluating the congestion impacts of pricing. Also, these issues raise concerns about the accuracy of the data used.

Measuring the effects of parking maneuvers on traffic operations and congestion requires speed derived from travel times (i.e., space mean speeds) or travel times to be measured directly. Because traditional means of measuring travel times were not available, an attempt was made to use travel times from transit vehicles as a surrogate. The results suggest, however, that travel times available from transit vehicles were also not sensitive enough to detect the impacts on parking maneuvers on congestion level. First of all, not every vehicle in SFMTA's fleet is equipped with the sensors to collect transit travel times; therefore, travel time information was available on only a small portion of the transit vehicles traveling through each parking management district. Furthermore, the portions of the routes passing through individual parking management districts are relatively short in distance. Therefore, the likelihood of a parking maneuver impacting a bus' travel time is relatively small. Finally, other factors such a traffic signal operations and schedule adherence criteria are likely to have a greater impact on transit travel times than parking maneuvers in these corridors. These factors may also have reduced the ability to quantify the impacts of parking maneuvers on transit travel times.

Travelers' perception of congestion was based on changes in survey responses prior to and after variable pricing. Two survey questions dealt with perception—one on traffic congestion and the other on parking availability. For both questions the results showed that visitors and shoppers did not perceive an improvement in the districts where variable pricing was implemented compared to the control districts. While only a minority of respondents felt that traffic was heavy in the district in which they parked, that percentage increased in the pilot districts from 32 to 35 percent after variable pricing was implemented. Forty-one percent of respondents in pilot districts also thought parking availability had worsened compared to 31 percent in control districts. While SF*park* did not appear to influence perception of improved conditions where variable pricing was implemented, respondents did report an improvement in actual parking experience. The time it took to find parking went down after variable pricing was in effect and it went down more sharply (by 1.68 minutes) in the pilot than control districts. Moreover, respondents in both pilot and control districts were able to park closer to their destination based on the number of blocks they reported than in the baseline period.

Table A-16. Summary of Conclusions from Congestion Analysis by the National Evaluation Team

Hypotheses	Conclusions	Evidence
The deployment of SF*park* and the 511 improvements will reduce traffic congestion on selected travel routes in the areas in which they were implemented	Inconclusive	Major reductions in transit travel times or in travel time reliability measures, such as 95th percentile and buffer indices, were not observed in those portions of the transit routes passing through the SF*park* pilot parking management districts.
	Unknown	Traffic sensor issues did not permit the vehicle throughput or person throughput measures to be collected.
	Inconclusive	Implementing the UPA improvements had little to no impact on the ratio or average peak period to off-peak period speeds, which remained at approximately the same levels from 2011 to 2013. The speed in the peak period was expected to have been relatively constant, as most of the drivers would not have been looking for a parking space. In the off-peak period, when there were fewer vehicles, speeds would have been more sensitive to drivers searching for parking with an improvement expected in the off-peak speed after price changes. Thus, a drop in the ratio might have indicated that parking pricing had had an effect.
Travelers will perceive that congestion has been reduced	Not supported	Survey respondents in pilot districts did not perceive a reduction in traffic, as the percentage who thought traffic was heavy increased slightly after variable pricing was implemented. Respondents in pilot districts also thought parking availability had worsened. The results were in the opposite direction for reported parking experience. Respondents in pilot districts reported less time to find parking and the decrease was larger than in the control districts. Respondents were generally able to park closer to their destination in both pilot and control districts than in the baseline period.

Source: Battelle, 2014.

Appendix B. Pricing Analysis

This appendix presents the pricing analysis of the San Francisco UPA projects. SF*park* is designed to increase parking availability by using parking sensors, real-time parking information, and payment technologies to implement demand-responsive pricing charges. The pricing analysis focuses on the effectiveness of variable pricing in managing San Francisco's parking supply and improving the parking experience for the traveler.

Table B-1 presents the six hypotheses for the pricing analysis. The first hypothesis focuses on the effect of parking pricing on parking availability in the SF*park* pilot area. If parking availability is increased in the pilot area, then there should be a reduction in parking search time and variability (second hypothesis) and double parking (third hypothesis). Increases in parking pricing in the pilot area are likely to shorten the duration of parking events (fourth hypothesis), improve transit reliability and speed (fifth hypothesis), and shift some driving to routes outside of the pilot area, to modes other than the single occupancy auto, and less expensive parking in area garages (sixth hypothesis).

Table B-1. National Evaluation Pricing Hypotheses

Hypotheses
• Parking pricing will increase parking availability.
• Parking pricing will lead to reduced search time and variability.
• Parking pricing will reduce double parking.
• Parking pricing will shorten the duration of the average on-street parking session.
• Parking pricing will improve the reliability and speed of public transit.
• Parking pricing will cause a shift to other modes and other parking garages.

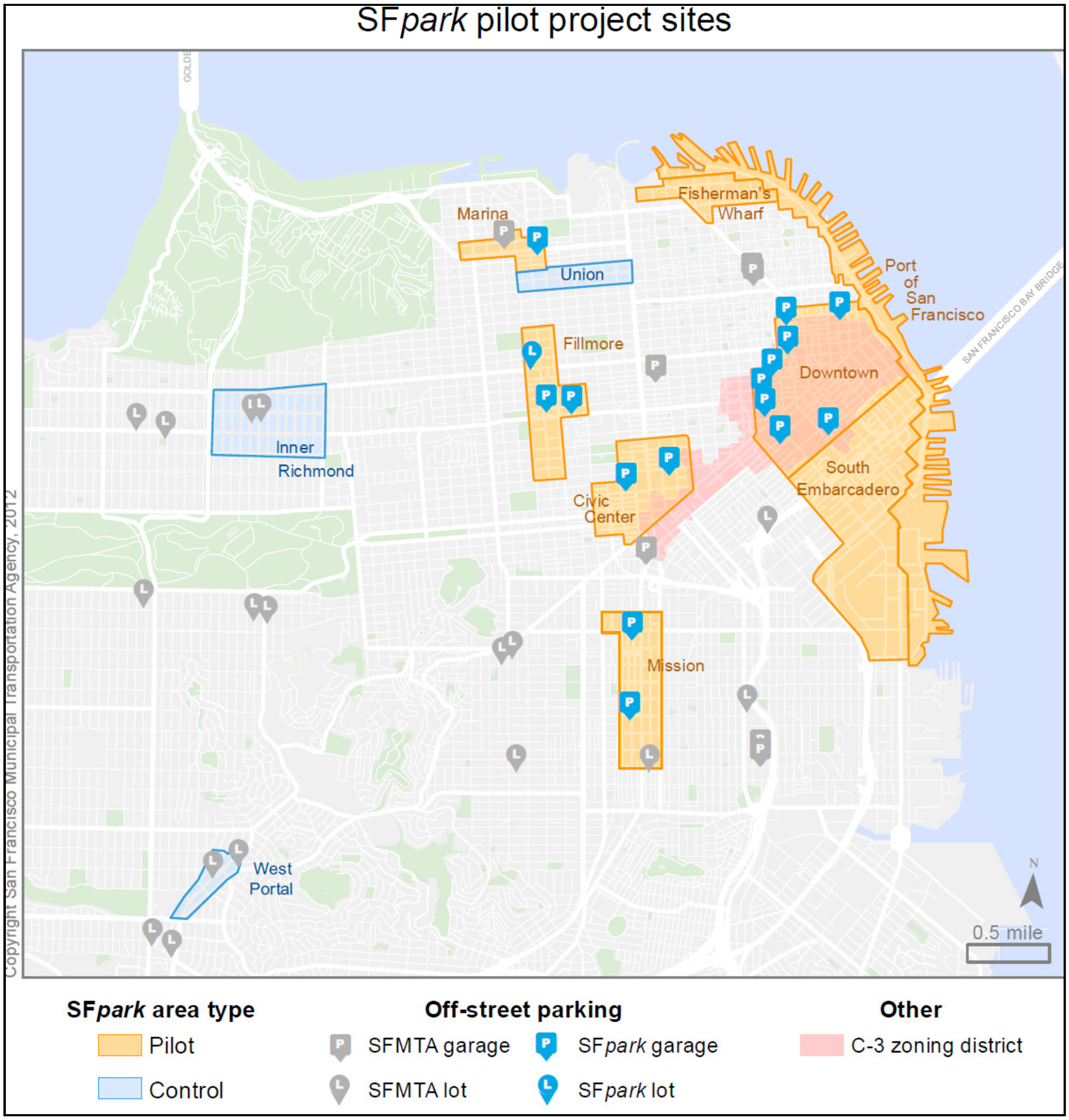
Source: Battelle, 2014.

The remainder of the report is divided into seven sections. Section B.1 describes the quasi-experimental design of the data collection and evaluation plan. Section B.2 describes the data collection and statistical analysis of the visitor/shopper survey. This is followed by a description of the field observation data (including parking search time and distance, double parking, and disabled placard parking) and the statistical analysis of that data in Section B.3. Section B.4 presents an analysis of trends in the average on-street parking occupancy, and the percentage of blocks exceeding 85 percent occupancy over the two-year evaluation period. The analysis also includes the estimation of regression models that evaluate the influence of parking price on parking occupancy, and details the movements in roadway data and off-street parking activity as determined from SFMTA garage and tax data. Section B.5 presents the results of analysis of the transit data. A summary of findings relative to the six hypotheses is presented in Section B.6.

B.1 Data Sources and Experimental Design

SFMTA provided the data for the pricing analysis of the SF*park* UPA evaluation. Data were collected in pilot and control areas, which are shown in Figure B-1. Data included:

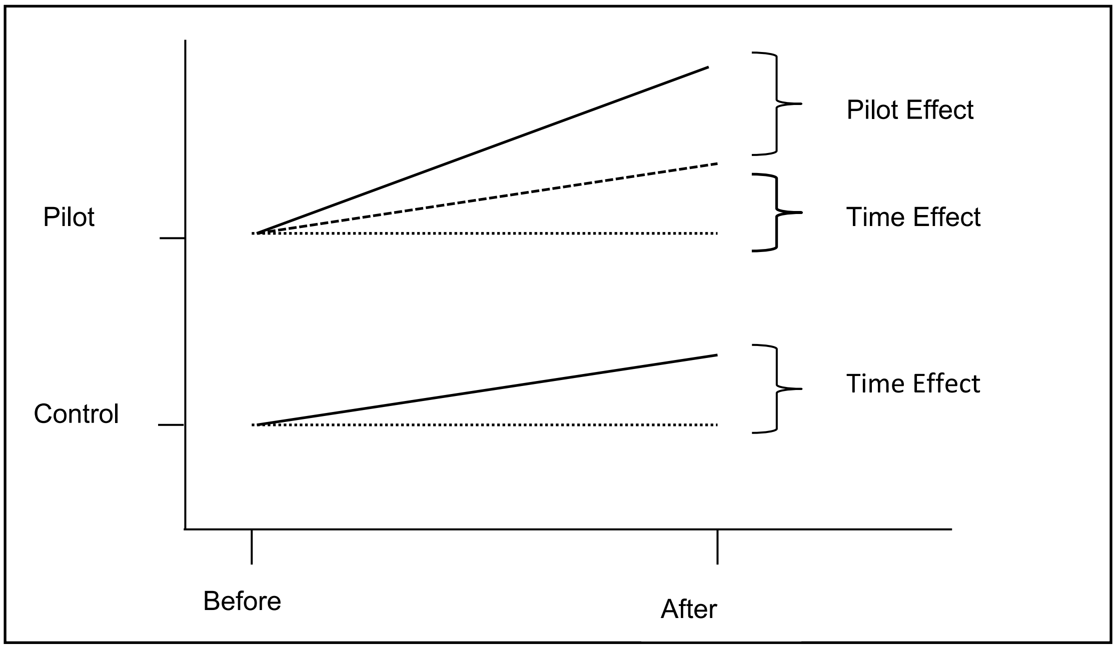
- The visitor/shopper survey data, based on two cross-sectional surveys. The first was conducted in the spring of 2011 before the implementation of demand-responsive pricing, and the second was conducted in the spring of 2013, approximately 21 months after the pricing changes had begun;
- Field observational survey data (parking search time, disabled placard and double parking, and occupancy), collected before pricing changes in the spring of 2011 and after pricing changes in the spring of 2013;
- Parking technology data (parking and garage sensors, meters), collected continuously from April 1, 2011 to July 31, 2013 in both pilot and control areas;
- Parking operations data (i.e., number and frequency of parking rate changes), covering the time period from September 1, 2011 to May 31, 2013;
- Parking tax data for garages (non-SFMTA garages), collected by the Controller's Office of the City and County of San Francisco covering the second quarter (April – June) of 2006 through 2013; and
- Transit data collected by SFMTA from the automatic passenger counters (APC) in MUNI buses traveling in the SF*park* pilot and control areas.



Source: San Francisco Municipal Transportation Agency, 2013.

Figure B-1. Pilot and Control Areas for SF*park*

The pricing evaluation of SF*park* employs a quasi-experimental design. Independent data samples were collected in both the control and the pilot areas before and after the implementation of the pricing pilot in the summer of 2011. Figure B-2 below shows why data are collected in both control and pilot areas before and after the implementation of the pilot. Over time, the effect of the pilot on measured outcomes may be confounded by economic and demographic changes. This is the "Time Effect" in Figure B-2. Data are collected in a control area that is as similar as possible to the pilot in order to measure changes over time that may confound the analysis. For example, an economic decline or sharp rise in gas prices may result in reduced traffic and congestion during either the before or the after data collection period. One can see in Figure B-2 below that the effect of the pilot would be significantly overestimated if the time effect was not controlled. The opposite is also true. A significant improvement in the local economy may spur additional traffic and congestion. If this time effect is not accounted for in the evaluation, then the positive effect on traffic and congestion may be masked.



Source: Caroline Rodier, 2014.

Figure B-2. Hypothetical Illustration of Possible Time and Intervention Effect in the Control and Pilot Areas

B.2 Visitor/Shopper Survey

To gather data on the impact of SF*park* on the customer's parking experience a survey of pedestrians was conducted in selected control and pilot areas in two waves, one before and one after the start of SF*park* pilot. The visitor/shopper survey, as it was called, consisted of a five- to six-minute intercept with questions covering such topics as their trip that day (or the last day they drove to the area), the type and cost of parking, perceptions about the availability of parking and congestion, potential changes in mode and parking, and use of parking information sources. Approximately 1,500 respondents were interviewed in both waves of the survey.

Because the study used different samples in the control and pilot areas and pre-intervention and post-intervention time periods, information was gathered in the survey to determine the comparability of these two samples. This included demographic characteristics of individuals (income, age, gender, home ZIP Code, and purpose of travel) and survey implementation (area, time of day, the day of the week, and driver status). If significant differences were found across these characteristics (commonly known as covariates) among samples, then they could be controlled for in the statistical analysis.

To obtain probability samples in each survey wave, the staff was trained to invite every second pedestrian or driver who had just parked a vehicle in the control or pilot areas to take the intercept survey. Surveys were administered when parking charges were in effect: on weekdays (Monday to Friday) from 9 a.m. to 7 p.m. and Saturday from 10 a.m. to 7 p.m. The frequency of completed surveys by time in the control and pilot areas are presented in Table B-2. Only respondents 18 years of age or older were included in the intercept. The survey was offered in English, Spanish and Chinese.

The surveys were implemented and samples collected before the pilot implementation in April 2011 and after implementation in April and May of 2013. SF*park* pricing was rolled out during the summer of 2011 and was in effect in all garages and pilot areas by August 2011. Thus, by the spring of 2013 price changes had occurred multiple times in the SF*park* pilot areas thereby providing sufficient time to have elapsed to measure the impact of the changes on the respondents. Questions were added to the after survey to assess the impact of certain SF*park* features, such as the use of parking information sources. The surveys were administered and responses collected at three pilot areas—Marina, Downtown, and Mission—and two control areas—Union and Inner Richmond.

Table B-2. Completed Surveys by Wave and Location

Area		Wave	
		Before	After
Pilot	Marina	243	271
	Downtown	390	275
	Mission	289	245
	Pilot Total	922	791
Control	Union	254	402
	Inner Richmond	377	391
	Control Total	631	793
Total		**1,553**	**1,584**

Source: Caroline Rodier, 2014.

Prior to the start of the study, the survey contractor worked with SFMTA staff to identify intercept locations in the pilot and control areas. Criteria for the selection of intercept locations included pedestrian volume in metered areas as well as proximity to public and private garages, parking lots, commerce, dining, and other potential destinations. For larger areas with multiple commercial corridors, such as downtown, surveyors were positioned to achieve a balance among the district's main commercial areas. The locations were defined as a two street block radius in between two intersections, and included the block span and opposing block faces.

Field surveyors kept a daily log of events in the area, as well as a tally of the number of people that they approached and invited to participate in the survey. If a person intercepted had not driven to the area that day or during the past year, they were politely thanked by the field interviewer but not further interviewed. Table B-3 provides the response rates for the control and pilot areas by wave. Response rates were considerably higher in the before survey relative to the after. There are several possible explanations for the lower response rates. Questions were added to the after survey that may have increased the time to complete the survey and/or respondents may have found some of the added questions off-putting. Another possibility is that field interviewers may have changed between the before and after periods thereby affecting the response rates. Significant differences were found between the before and after time periods according to the time of day and the day of the week when surveys were administered in all areas. Perhaps there was heightened awareness of the upcoming change in the parking system prior to implementation that motivated people to respond to questions about parking in the before survey.

Table B-3. Survey Response Rate by Wave and Location

Area	Wave	
	Before	After
Pilot Total	91.9%	76.3%
Control Total	86.5%	70.2%
Total	89.4%	73.2%

Source: Caroline Rodier, 2014.

The dataset was carefully screened for unreasonable responses and/or extreme values. Six cases with suspicious responses and those with a high number of missing values (two in the before survey data and four in the after survey) were removed from the survey. The remaining missing data were examined graphically with missing value pattern analysis in SPSS[1] and the results indicated that data were missing at random.[2] Missing data accounted for less than five percent of all responses to each question with the exception of the income question.

[1] Statistical Package for the Social Sciences (SPSS).

[2] For example, if missingness on income is a function of income in that those with very low and high income do not report their income on the survey then income is not missing at random.

As a result, list-wise deletion methods were used for missing data other than income (i.e., deleting just the question from participant in which the response was missing).

Twenty percent of the sample was missing responses to the income survey question. Missing income was imputed using the Markov Chain Monte Carlo Multi-Imputation method. Two types of models were then estimated, one with imputed income and one in which missing data was eliminated using the pairwise deletion method (i.e., respondents who declined to answer income were eliminated from the dataset). The results indicated that goodness-of-fit was significantly better in the models in which missing data was eliminated through pairwise deletion compared to the models that used imputed income. As a result, use of imputed income was rejected in favor of pairwise deletion of respondents who declined to respond to the income question.

The survey data were found to include people who lived and worked in the SF*park* areas and had free parking. Since these individuals would not be affected by SF*park* pricing, 383 cases (228 cases in wave 1 and 155 cases in wave 2) were removed from the dataset. Table B-4 provides the sample size after the dataset was screened. Table B-5 describes the percent of respondents by demographic characteristics in the before and after survey.

Table B-4. Final SF*park* Visitor/Shopper Survey Dataset Used for Statistical Analysis

Area		Wave	
		Before	After
Pilot	Marina	203	248
	Downtown	275	265
	Mission	198	225
	Pilot Total	676	738
Control	Union	326	343
	Inner Richmond	321	345
	Control Total	647	688
Total		**1,323**	**1,426**

Source: Caroline Rodier, 2014.

Table B-5. Percent of Respondents by Demographic Characteristics

Categories	Before	After
Income		
Less than $10,000	4.8	4.2
10,000-24,999	9.5	4.5
25,000-34,999	11.8	6.4
35,000-49,999	14.1	9.8
50,000-74,999	18.4	16.6
75,000-99,999	11.2	14.6
100,000-149,999	11.9	17.1
150,000-199,999	7.5	13.9
200,000-249,999	3.6	6.6
250,000 or more	7.1	6.4
Age		
18-24	10.0	10.2
25-34	28.1	28.7
35-44	22.2	23.2
45-54	19.1	19.3
55-64	12.8	11.8
65-74	5.7	5.4
75-84	1.7	1.2
85 and older	0.4	0.2
Gender		
Male	54.0	53.9
Female	46.0	46.1
Location		
San Francisco county	80.7	78.9
Other	19.3	21.1

Source: Caroline Rodier, 2014.

In addition to the data screening, descriptive statistics and cross-tabulations were used to prepare the data for model estimation as discussed in Section B.2.1 and to provide data for use in evaluation analyses presented in other appendices. For the modeling, categories of covariate variables were developed in which sample sizes were sufficiently large to use in the models. Several categories for each covariate were developed and tested in every model developed to identify the form with the overall best goodness-of-fit across all models. The following were the final categories selected: three income categories (high, medium, and low), time of day (categories defined by changes in parking rates), home ZIP code (in and outside of San Francisco County), age (collapsed categories aged 65 and over), day of week (weekday and Saturday), driver and non-driver, gender, and purpose of travel.

B.2.1 Methods of Analysis

The primary interest of this study is the effect of the pricing program implemented in three parking areas (pilot) where the survey was conducted as compared to two parking areas that did not have this program implemented (control). The study design included surveys in all five parking areas prior to implementation of the pricing program. To account for the area effects and time effects as well as other potentially confounding variables, the following model was fit:

(1) $\text{Logit}(Y>j|\text{effect})=\log[P(Y>j|\text{effect})/P(Y<=j|\text{effect})]=\beta_{0j}+b_0+\beta_p d_p+\beta_{wp} d_{wp}+\beta_{wc} d_{wc}+\beta_1^t \mathbf{x}$

where $d_p = \begin{cases} 1 \text{ if pilot area} \\ 0 \text{ otherwise} \end{cases}$, $d_{wp} = \begin{cases} 1 \text{ if After pilot area} \\ 0 \text{ otherwise} \end{cases}$, and $d_{wc} = \begin{cases} 1 \text{ if After control area} \\ 0 \text{ otherwise} \end{cases}$.

The above model is known as a cumulative logit model. This model was used when survey questions had ordinal (e.g., low to high) response categories. The dependent variable or survey question of interest is Y in equation (1). Models were estimated to evaluate changes in response categories (total number of response categories minus 1). For example, if j response categories are ordinal ("Overall, how easy was it to find parking using a scale from 1 to 5 where 1 is the best and 5 is the worst?"), four cumulative logit models were estimated that compare relative changes (i.e., how likely the response is to be in category j or below versus a category higher).

Multinomial logit models were used when response categories were categorical but not ordered (see equation 2 below). The number of models estimated is one less than the number of response categories. For example, for a question such as "How did you get to the [area] today?" with three categories: personal vehicle, transit, or active (walk and bike) modes, two multinomial logit models were estimated. One response category was used as a reference (e.g., personal vehicle) and estimated parameters for transit and active modes were each relative to personal vehicle (i.e., transit relative to personal vehicle and active mode relative to personal vehicle). The model in this case was modified as follows:

(2) $\text{Logit}(Y>j|\text{effect})=\log[P(Y=j|\text{effect})/P(Y=\text{ref}|\text{effect})]=\beta_{0j}+b_0+\beta_p d_p+\beta_{wp} d_{wp}+\beta_{wc} d_{wc}+\beta_1^t \mathbf{x}$

β_{0j} is an intercept for the jth response category to a survey question and β_{0j} is a constant term. The random area effect in both models is b_0. It is reasonable to expect some conditions affecting responses to be similar in the same area and therefore, to affect responses of survey participants. This random effect accounts for the variance structure imposed by the study design, which makes responses in the same area more alike than responses from different areas.

The time effect in the pilot areas is measured by β_{wp} and in the control areas by β_{wc}. Thus, β_{wp}-β_{wc} measures the effect of the pricing program. If these coefficients are different and, therefore, the difference is not zero, then whatever change perceived by the survey participant that may have occurred was different in pilot and control areas. Test statistics were then applied to determine whether the time effects were significantly different in pilot and control areas at a 95 percent confidence level.

The pilot area effect is β_p and it models differences that might exist between pilot and control areas. If this effect is significant, then responses to survey questions were different before implementation of the pricing program. Interpretation of this coefficient only makes sense if β_{wp}-β_{wc}=0. In that case, the time effect (whatever it may be) is the same in pilot and control areas. Since the intervention (pricing changes) happened between the two survey waves, whatever change occurred over time was the same in the control and pilot areas and, therefore, a pilot area effect means there were differences between pilot and control areas prior to the intervention that persisted.

The effect of confounders (or covariates) is measured by β_1. It is a vector that includes coefficients for all confounding variables included in the model, such as income, age, gender, home ZIP Code, time of day, the day of the week, and driver status. Chi squared tests indicated significant differences in the set of respondents across these variables in the before and after samples by area, but the model controls for these differences.

To understand the interpretation of β_{wp}-β_{wc} one should consider a response to a survey question that asks participants to rate how much traffic was in the area from 1 to 5 with categories j=1 no traffic and 5 =great deal of traffic. Suppose further that a great deal of traffic is the reference category. Then β_{wp} is the log odds ratio of being in a category that rates traffic as decreasing, in other words falling into the category of 4 or below versus 5 after implementation in the pilot area. If β_{wp} >0 then the interpretation of the log odds ratio of being in a category that rates traffic as decreasing is more likely after than before the implementation of the pilot. In the proportional odds model, this effect is assumed to be the same for all categories. In a general cumulative logit model, category-specific log odds ratios can be estimated allowing a separate comparison for each category level. A negative effect would indicate that the response is less likely after than before the intervention. The coefficient β_{wc}>0 has the same interpretation for the control areas.

The difference β_{wp}-β_{wc} measures the pricing program effect. For the example described above, Table B-6 illustrates the set of possible outcomes when the response categories are ordinal and cumulative logit models are estimated for β_{wp}, $\beta_{wc,}$ and β_{wp}-β_{wc}, interpretation of these outcomes, and the final interpretation of the effect of the intervention for survey responses. The interpretation of the exponent of β_{wp}, $\beta_{wc,}$ and β_{wp}-β_{wc} (or e^{p}, e^{c}, and $e^{(p-c)}$) is also provided in Table B-6 below in parentheses. One should recall that the exponent of a number less than zero is less than one and the exponent of a number greater than zero is greater than one. If both coefficients are positive (or greater than one for its exponent) and this difference is positive (or greater than one for its exponent), then the interpretation is that in both areas it is more likely that there is some traffic to no traffic versus a great deal of traffic, but this effect is more pronounced in the pilot area than in the control area. If both coefficients are positive but the difference is negative, then the effect is less pronounced in the pilot area than in the control area. If β_{wp}>0 and β_{wc}<0 then the likelihood of responding some traffic to no traffic versus a great deal of traffic is increased in after samples in the pilot area but is decreased in after samples in the control area, and thus the no traffic versus a great deal of traffic is more pronounced in the pilot. If β_{wp}<0 and β_{wc}>0 and the difference is negative, then the interpretation is that a response of some traffic to no traffic versus a great deal of traffic is less likely in the pilot area in the after sample (as compared to the before sample) but is more likely in the control area. If both coefficients are negative and the difference is negative, then in both areas no traffic versus a great deal of traffic is less likely in the after implementation sample. However, if the effect for after versus before is stronger in the pilot area, and if the difference is positive, then the effect is weaker in the pilot area.

Table B-6. The Set of Possible Outcomes for Cumulative Logit Models

β_{wp} (e^{p})[1]: pilot time effect	β_{wc} (e^{c}): control time effect	β_{wp}-β_{wc} $(e^{(p-c)})$: pilot effect	Interpretation of Intervention Effect on Traffic
>0 (>1)	>0 (>1)	>0 (>1)	Worsens in both, but more so in pilot
>0 (>1)	>0 (>1)	<0 (<1)	Worsens in both, but less so in pilot
>0 (>1)	<0 (<1)	<0 (<1)	Worsens in pilot, but improves in control
<0 (<1)	>0 (>1)	<0 (<1)	Improves in pilot, but worsens in control
<0 (<1)	<0 (<1)	<0 (<1)	Improves in both but more so in pilot
<0 (<1)	<0 (<1)	>0 (>1)	Improves in both, but more so in control

[1] Figures in parentheses are the exponent of the corresponding coefficient.

Source: Caroline Rodier, 2014.

Similarly, Table B-7 illustrates the set of possible outcomes when the response categories are categorical and multinomial logit models are estimated. In a multinomial logit model all coefficients are interpreted as the log odds ratio of being in category j versus being in the reference category. For example if the reference category for mode of transportation is passenger vehicle versus transit and active (walking and biking) modes then β_{wp} would be the log odds ratio of using the transit and active modes versus passenger vehicle mode in the pilot area.

Table B-7. The Set of Possible Outcomes for Multinomial Logit Models

β_{wp} (e^{p})[1]: pilot time effect	β_{wc} (e^{c}): control time effect	β_{wp}-β_{wc} $(e^{(p-c)})$: pilot effect	Interpretation of Intervention Effect on Mode Choice (transit & active mode versus passenger vehicle)
>0 (>1)	>0 (>1)	>0 (>1)	Increase in both, but more so in pilot
>0 (>1)	>0 (>1)	<0 (<1)	Increase in both, but less so in pilot
>0 (>1)	<0 (<1)	<0 (<1)	Increase in pilot, but decreases in control
<0 (<1)	>0 (>1)	<0 (<1)	Decreases in pilot, but increases in control
<0 (<1)	<0 (<1)	<0 (<1)	Decreases in both but more so in pilot
<0 (<1)	<0 (<1)	>0 (>1)	Decreases in both, but more so in control

[1] Figures in parentheses are the exponent of the corresponding coefficient.

Source: Caroline Rodier, 2014.

The survey includes participants who drove to the pilot and control areas on the day of the survey and those who did not drive on the day of the survey, but had driven to the area within the last year. The latter were asked to answer questions based on their recollection of the last time they drove to the area. As a result of possible recall bias introduced by this question on the part of non-drivers on the day of the survey, separate models are developed for those who drove and those who did not drive to the areas on the day of the survey.

The ordinal package in R[3] and multinomial logit in SPSS were used to estimate the models described above. It was not possible to treat area as a random effect in available statistical packages for multinomial logit models. As a result, area is treated as a fixed effect in the estimated multinomial logit models. The failure to treat area as a random effect will tend to decrease standard errors and increase the possibility of committing a Type I error (falsely finding significance).

B.2.2 Results

This section describes the model results for the survey questions related to pricing hypotheses. The model results are presented in the tables below as odds ratios (i.e., the exponent of β_{wp}, β_{wc}, and β_{wp}-β_{wc} [or e^{p}, e^{c}, and $e^{(p-c)}$]), which represents the odds that an outcome will occur given the presence of a particular intervention, such as the SF*park* pricing program in this study. An odds ratio of one indicates that the intervention does not affect the odds of an outcome; an odds ratio of greater than one is associated with higher odds of an outcome; and an odds ratio of less than one is associated with lower odds of an outcome. The 95 percent confidence interval is equivalent to a statistical test applied to determine whether the time effects (β_{wp}-β_{wc} or $e^{(p-c)}$) are significantly different (at 0.05 level) in the pilot and the control. A 95 percent confidence interval for $e^{(p-c)}$ that excludes the value of one provides evidence for a significantly different time effect. A 95 percent confidence interval that includes the value of one does not provide evidence of a significantly different time effect.

Table B-8 and Table B-9 provide the cumulative logit model results for survey questions with ordinal response categories by SF*park* pricing hypotheses for driving and non-driving respondents, respectively. To illustrate the interpretation of the odd ratios in these models, we describe the model outcomes for the parking availability hypothesis (1) and the survey question that attempts to measure this hypothesis: “How far did you end up parking from your destination” in Table B-8. The response categories include 1=less than one block, 2=about 1 block away, 3=about 2 blocks away, 4=about 3 blocks away, 5=about 4 blocks away, and 6=more than 4 blocks away. The reference category is 6 (or extremely long). The estimated odds ratios for the pilot (e^{p}) and the control areas (e^{c}) for response category 5 can be interpreted as the odds of falling into category 5 or below versus 6; for response category 4, it is the odds of falling into category 4 or below versus the categories greater than 4; for response category 3, it is the odds of falling into category 3 or below versus the categories greater than 3; for response category 2, it is the odds of falling into category 2 or below versus the categories greater than 2; and for response category 1, it is the odds of falling into category 1 versus the categories greater than 1.

[3] R is a free software programming language and software environment for statistical computing and graphics.

Table B-8. Results for Driver Outcomes Predicted by Intervention and Time

Hypotheses	Survey Question (reference answer in parentheses)	Category j[1]-1	Exponent of Coefficient for Pilot and Control Areas			95% Confidence Interval $e^{(p-c)}$ Lower, Upper	N
			$EXP(Pilot)$	$EXP(Control)$	$EXP(Pilot - Control)$		
Parking pricing will increase parking availability	And how far did you end up parking from your destination? (1 short to 6 long, with 6 being the reference)	1	1.93	1.46	1.32	0.60, 2.94	1,223
		2	2.42	1.81	1.34	0.63, 2.86	
		3	2.01	3.10	0.65	0.28, 1.52	
		4	2.57	2.69	0.96	0.31, 2.99	
		5	3.01	2.32	1.30	0.31, 5.38	
	Overall, how easy was it to find parking? (1 best to 5 worst, with 5 being the reference)	1	1.95	0.88	2.22	0.97, 5.08	1,216
		2	1.63	1.11	1.47	0.67, 3.24	
		3	1.90	1.38	1.37	0.54, 3.47	
		4	1.73	1.76	0.98	0.27, 3.57	
Parking pricing will lead to reduced search time and variability.	Parking search time (1 short to 5 long, with 5 being the reference)	1	1.22	0.87	1.40	0.57, 3.47	1,242
		2	2.32	1.45	1.59	0.75, 3.41	
		3[2]	3.46	2.23	1.55	0.69, 3.48	
Parking pricing will cause a shift to other routes, modes, and other parking garages.	What kind of parking did you use today? (meter)	Garage/Lot	1.05	1.79	0.59	0.18, 1.91	1,262
		Other		1.74	0.83	0.53, 1.29	
	How did you get to the (area) today? (passenger vehicle)	Transit		0.90	1.22	0.54, 2.73	2,175
		Active[3]		2.51	**0.35**	0.25, 0.49	
	How many people were in the car with you, including yourself? (SOV[4])	HOV[5] 1.44	0.36	0.64	0.56	0.26, 1.19	1,275

1.1
0.88

[1] Last response categories; [2] Category 4 combined with category 3 due to low number of responses; [3] Active=walk and bike; [4] SOV=single occupant vehicle; [5] HOV=high occupant vehicle.

Source: Caroline Rodier, 2014.

Table B-9. Results for Non-Driver Outcomes Predicted by Intervention and Time

Hypotheses	Survey Question	j1-1	Exponent of Coefficient for Pilot and Control Areas			95% Confidence Interval $e^{(p-c)}$ Lower, Upper	N
			$EXP(Pilot)$	$EXP(Control)$	$EXP(Pilot - Control)$		
Parking pricing will increase parking availability	And how far did you end up parking from your destination? (1 short to 6 long)	1	1.06	1.99	0.53	0.22, 1.31	1,088
		2	1.12	1.24	0.90	0.41, 1.98	
		3	1.23	1.15	1.07	0.49, 2.31	
		4	1.58	1.25	1.27	0.49, 3.31	
		5	1.64	0.91	1.81	0.54, 6.02	
	Overall, how easy was it to find parking? (1 best to 5 worst)	1	0.66	2.07	0.32	0.16, 0.65	1,067
		2	0.95	1.66	0.57	0.34, 0.96	
		3[2]	1.11	1.93	0.57	0.33, 1.00	
Parking pricing will lead to reduced search time and variability.	Parking Search Time (1 short to 5 long)	1	0.45	1.00	0.45	0.07, 3.10	1,068
		2	0.68	1.01	0.68	0.16, 2.95	
		3	1.31	1.81	0.72	0.20, 2.64	
		4	2.21	1.70	1.31	0.02, 70.42	
Parking pricing will cause a shift to other routes, modes, and other parking garages.	What kind of parking did you use today? Parking Type (meter)	Garage/ Lot	0.85	0.52	1.39	0.37, 7.17	913
		Other	0.74	0.50	1.49	0.85, 2.61	
	How many people were in the car with you, including yourself? (SOV[3])	HOV[4]	0.68	1.21	0.56	0.27, 1.17	1,142

[1] Last response categories; [2] Category 4 combined with category 3 due to low number of responses; [3] SOV=single occupant vehicle; [4]HOV=high occupant vehicle

Source: Caroline Rodier, 2014.

In Table B-8 for the question that asks "How far did you end up parking from your destination?" (1 short to 6 long), the odds ratio for categories 1 and 2 is greater than one in both the control and the pilot areas and thus the odds of finding a parking space that is an extremely or a very short distance from the respondent's destination is greater than finding a space that is farther away from the respondent's destinations in both areas. The odds are higher in the pilot than the control, which indicates a positive association between the pilot and parking availability; however, the 95 percent confidence interval test for significantly different time effects in the pilot and the control ($e^{(p-c)}$) includes the value one and thus there is no evidence for this association. The odds ratio for categories 3 and 4 are also greater than one in both the control and the pilot but the effect is larger in the control than in the pilot, which suggests that the odds of falling into the extremely short, very short, short, and long categories are greater than the very long and extremely long categories in the control relative to the pilot; however, again, the 95 percent confidence interval includes the value one, and, thus, it cannot be concluded that the time effect is significantly different between the pilot and control. The odds ratio for category 5 is greater than one in both the pilot and control and the value is higher in the pilot than in the control. As a result, the odds of falling into the extremely long category versus very long to very short are higher in the pilot and the control: however, again, the 95 percent confidence interval includes the value one, and there is no evidence of significant difference.

In general, the outcomes for respondents that drove to the area on the day of the survey (Table B-8) suggest greater parking availability and reduced search time in the pilot areas; however, the 95 percent confidence interval does not support the statistical significance of these findings. The results for non-drivers (Table B-9) suggest the opposite but, again, the 95 percent confidence interval indicates a lack of statistical significance. The results for non-drivers may be due to recall bias and/or could indicate the possibility that those who decided not to drive to the pilot area have had a particularly bad experience parking there in the past.

For drivers in Table B-8, the multinomial logit model results for shifts in use of modes and parking type suggest that the pilot is associated with greater use of metered parking relative to garages and other types of parking. The pilot is also associated with an increase in transit use and a decrease in walking, biking, and carpooling. However, the only statistically significant association between the pilot and control is the change in walking and biking. The results for non-drivers in Table B-9 suggest that the pilot is associated with a greater use of non-meter parking types and a decrease in carpooling, but the statistical significance of these results is not supported by the 95 percent confidence interval.

The multinomial logit model was used with questions that asked, both driving and non-driving respondents in the pilot and control (in after samples only), to reflect on changes in parking availability, mode shifts, and departure time choice. Table B-10 and Table B-11 present results for drivers and non-drivers, respectively. Both drivers and non-drivers are less likely to indicate that parking availability in the pilot had improved and worsened relative to the control area, but only the "worse" response is statistically significant. Drivers are more likely to shift to other modes of travel and non-drivers were less likely in the pilot compared to the control but these results are not statistically significant. Non-drivers in the pilot are less likely to use active travel modes and more likely to use transit; however, only the active travel result is statistically significant. Both drivers and non-drivers in the pilot do not change their time of travel to obtain cheaper parking relative to the control area, but only the result for drivers is statistically significant.

Table B-10. Results for Driver Outcomes Predicted by Intervention Only

Hypothesis	Variable: "Compared to a year ago,..."	j[1]-1	Exponent of Coefficient for Pilot Relative to Control $EXP(Intervention)$	p-value	N
Parking pricing will increase parking availability	Parking Availability (relative to no change)	Better	0.61	0.30	633
		Worse	0.36	0.00*	
Parking pricing will cause a shift to other routes, modes, and other parking garages.	Mode Change? (relative to yes)	No	0.60	0.08	726
	Change Time of Travel for Cheaper Parking (relative to yes)	No	3.04	0.00*	717

[1] Last Response categories

*Significant at the 95 percent confidence interval

Source: Caroline Rodier, 2014.

Table B-11. Results for Non-Driver Outcomes Predicted by Intervention Only

Hypothesis	Variable: "Compared to a year ago,…"	j[1]-1	Exponent of Coefficient for Pilot Relative to Control $EXP(Intervention)$	p-value	N
Parking pricing will increase parking availability	Parking Availability (relative to no change)	Better	0.12	0.06	405
		Worse	0.46	0.02*	
Parking pricing will cause a shift to other routes, modes, and other parking garages.	Mode Change? (relative to yes)	No	1.64	0.16	469
	Mode Change (relative to vehicle)	Transit	1.43	0.27	1176
		Active	0.34	0.00*	
	Change Travel Time for Cheaper Parking (relative to yes)	No	1.87	0.12	460

[1] Last Response categories

*Significant at the 95 percent confidence interval

The wide variation in the responses (and data) are likely due to the Likert scale response categories included in the survey in order to reduce the time to complete the survey and thus increase the response rate. Individuals may have different definitions of the scales, for example, individual A in the same traffic jam as individual B may rate congestion differently: individual A may perceive it as 4 while individual B may perceive it as a 5. Use of panel samples (i.e., survey responses collected from the same individuals before and after the implementation of the pilot), as opposed to the independent (or cross-sectional) samples in the current study design, could have reduced the variability in the perception of scale values. However, the cost of implementing a panel survey ruled this option out for SFMTA.

The survey design could have carefully screened respondents to identify those truly and similarly affected by the SF*park* project to minimize the variability among respondent experiences. Many respondents had to be eliminated from the model because they lived or worked in the area and had access to free parking. Variation could have been minimized by targeting larger samples that focused, for example, on specific times of the day, day of week, trip purposes, and frequency of travel by time of day and day of week. However, this may have increased the cost of the survey beyond the available resources.

Close proximity of control and pilot areas (i.e., the Marina and Union) may have contaminated responses. For example, non-driving respondents intercepted in the Union control area may have responded to questions about a travel and parking event that took place in the Marina. The close proximity of this pilot and control and the difficulty of identifying control areas similar to the pilot areas may have contributed to the results.

The analysis described above was replicated without the data from the Mission pilot area, the reason being that a large construction project in the Mission area had disrupted the use of variable pricing in the area after many of the parking sensors were removed. Thus, SFMTA was not able to operate it as a true pilot area, which might have affected the responses of survey respondents in the Mission pilot area. However, the findings of the re-analysis of the visitor/shopper survey were not significantly different from those reported above.

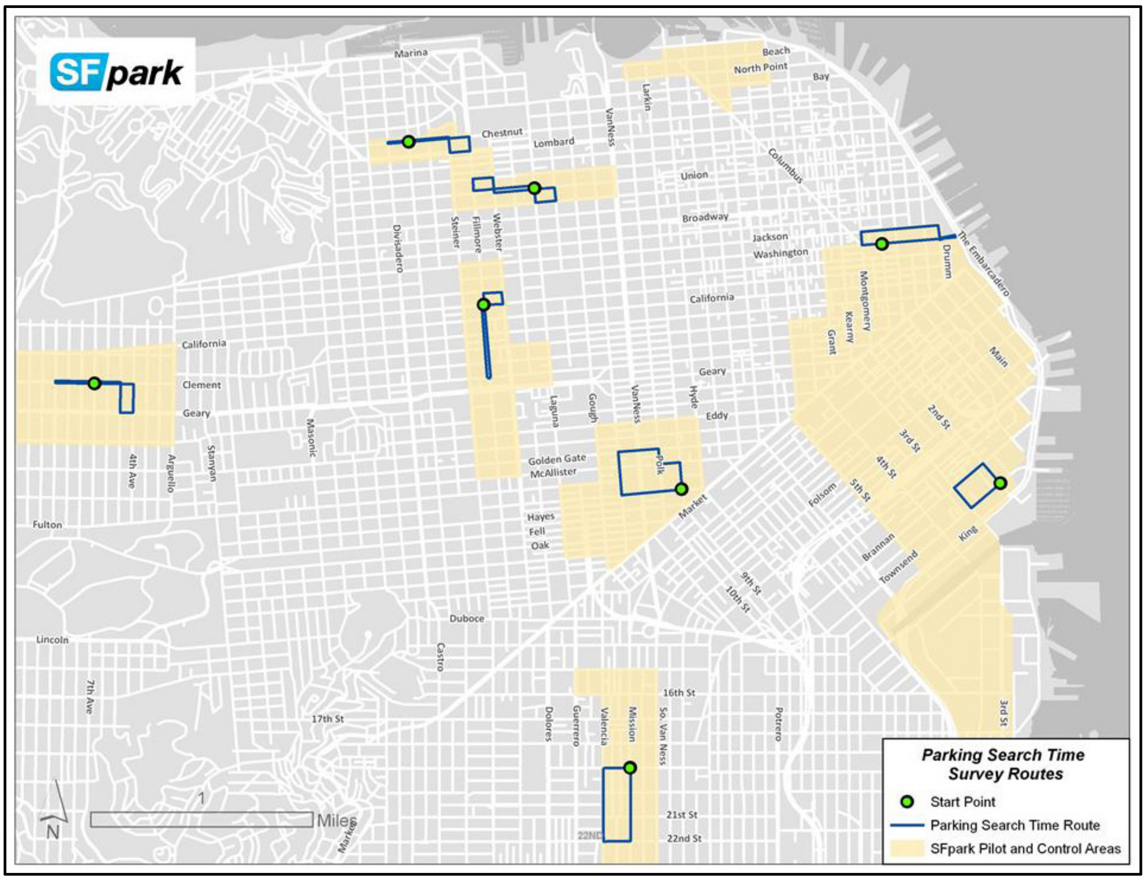
B.3 Field Observation Survey Data

Field observations were conducted to collect types of data related to parking patterns in SF*park* pilot zones and control zones that would not be available from the installed parking technology. The following data were collected in field surveys conducted before and after the implementation of the SF*park* in August 2011: parking search time and distance, disabled placard, double parking, and parking occupancy data (including motorcycle occupancy).

B.3.1 Parking Search Time and Distance

Parking search time and distance data were collected in both control and pilot areas in the spring of 2011 before the implementation of the pricing program and in the spring of 2013 after its implementation.

Surveyors followed a predefined route in each of the pilot and control areas, as shown in Figure B-3. Surveyors biked along each of the routes, recording the elapsed time for each run. Surveys were not scheduled in locations with special events that could distort parking search time data (e.g., parades, street fairs, street cleaning, or major sporting events). Data were collected in each pilot and control area on weekdays (Tuesday, Wednesday, or Thursday) and on both Saturday and Sunday for four time periods: 8:00 to 10:00 a.m., noon to 2:00 p.m., 4:00 to 6:00 p.m., 8:00 to 10:00 p.m., and where meter operating hours extended into the evening from 10:00 p.m. to 12:00 a.m. The parking search time original sample size was 6641 (including both failed and non-failed searches), which was reduced to 6,466 usable data points following removal of failed searches. After discussions with SFMTA, the research team decided to exclude the Mission pilot data. The implementation of SF*park* in the Mission was so minimal due to construction in that area that it could not be considered a true treatment case. A total of 5967 data points remained after the exclusion of Mission.



Source: San Francisco Municipal Transportation Agency.

Figure B-3. Parking Search Time Survey Routes in City-Wide Context

SFMTA established the following protocol for collecting data on parking search time:[4]

1. Timing of the surveys will be coordinated with rate adjustments so as to not overlap.
2. The surveys will be performed on bicycles along pre-defined survey routes.
3. Each route has a designated start point located at a major intersection; surveyors will begin each run at the near-side crosswalk of the intersection.
4. Surveyors will note the start time and activate a stopwatch.
5. Surveyors will bicycle along the assigned route searching for a parking space. Surveyors will attempt to maneuver in traffic exactly as a passenger vehicle would while searching for parking and will follow all traffic laws.
6. Surveyors will continue to ride along the pre-assigned route until they find a vacant legal parking space to accommodate a full-sized sedan (e.g., Honda Accord). Surveyors could not park in loading meter spaces until after 6 p.m. or according to other specific meter guidelines.
7. Surveyors will be trained to follow consistent rules that remove, to the extent possible, subjective judgments about when and if a space is open. For example, one rule will be to not wait for drivers preparing to leave a parking space.
8. Once a suitable parking space is located, surveyors will turn the bicycle into the parking space (or to a “safe harbor” at the side of the road), stop the stopwatch, and note the elapsed search time to the second. They will also record the number of times they passed the starting point before arriving at the vacant, legal parking space (i.e., the number of completed “laps” of the assigned parking search route).
9. Next, surveyors will note either the meter number of the metered space or the nearest physical address for unmetered spaces.
10. Surveyors will have up to 30 minutes to find a parking space. If the surveyor finds a parking space before the 30 minutes is up, they will return to the starting point and wait four minutes before starting another run.
11. If a parking space is not found within 30 minutes, the surveyor will record that search as a “failed search,” return to the starting point, and then start a new search immediately, without waiting four minutes.

Parking search distances were calculated as follows: “Each survey run includes the meter post ID where parking was found as well as the number of laps completed. Distance is measured in feet and is measured to each meter post ID, accounting for the number of completed laps for each survey run.”[5]

B.3.2 Disabled Placard, Double Parking, and Occupancy

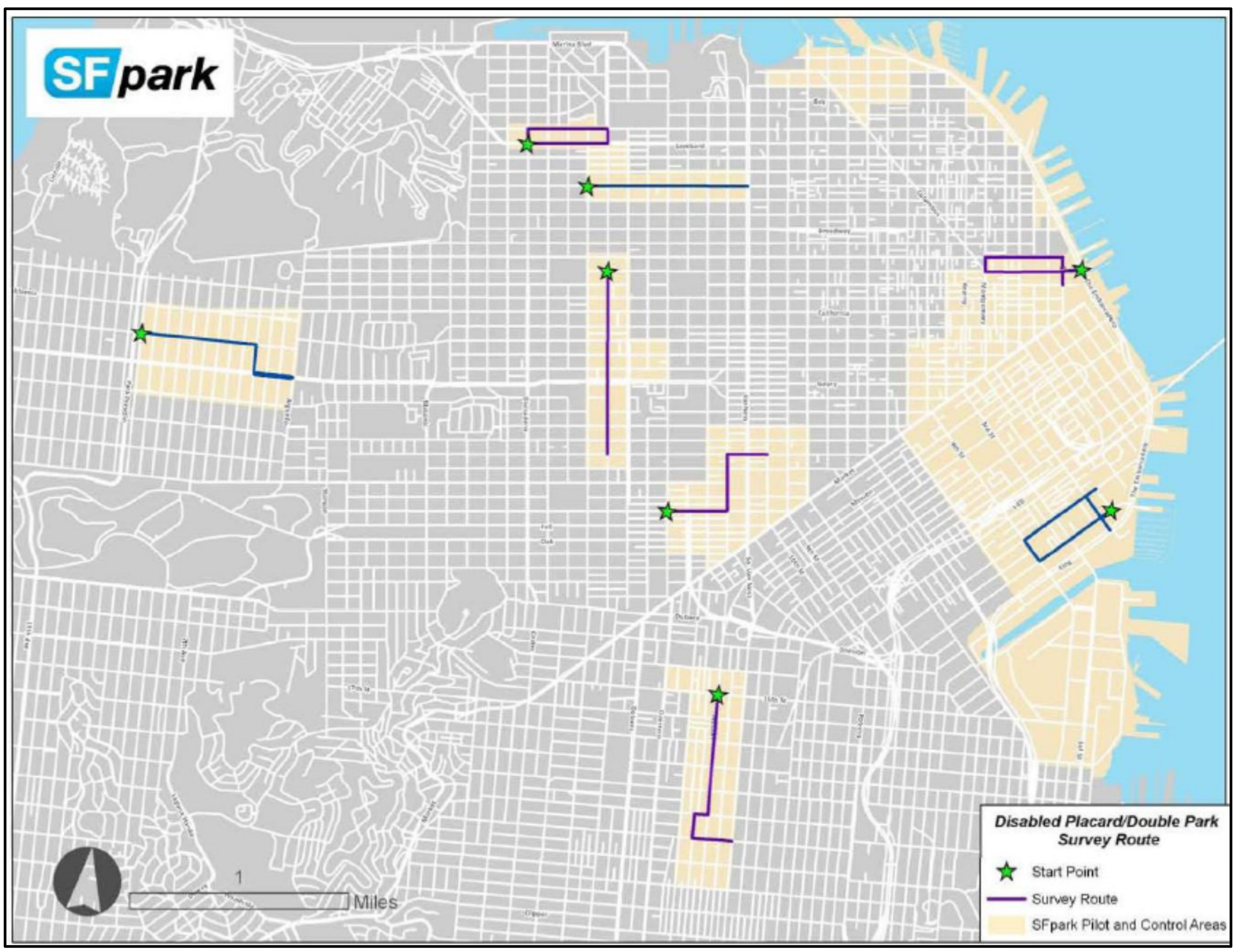
Disabled placard usage and double parking data were collected in the spring of 2011 and 2013 before and after the implementation of the pilot in both the pilot and control areas. Drivers with disabled placards are not required to pay for meter parking in San Francisco, and, thus, SF*park* rate changes will tend to be less effective on blocks with extensive disabled placard use. This survey provided both a count of disabled placards by block as well as length-of-stay data for each disabled placard vehicle on surveyed blocks. While parking sensors monitored occupancy of

[4] SFMTA, 2014 Parking Search Time Data Guide, pp. 15-16.

[5] SFMTA, 2014 Parking Search Time Data Guide, p. 11.

each SF*park* metered space, they were not able to detect double parked vehicles, and, thus, manual double parking survey data were collected on a sample of blocks in each pilot and control area. Occupancy data were also collected in this manual survey to provide a reference point for disabled placard and double parking samples.

Surveyors used a specified data collection route (including start and end points) and recorded occupancy and the number of park-able spaces or availability of legal metered and unmetered parking spaces (i.e., number spaces and any spaces that were blocked from use for some reason) on each block-face. Counts of disabled placards and double parked vehicles were also collected including vehicle type (i.e., commercial, personal, and government). For the disabled placard counts, vehicles parked in blue zones or spaces dedicated to disabled parking only were not included in the sample. Samples were collected on Tuesday, Wednesday or Thursday to represent a typical weekday for the following time periods: 8:00 to 10:00 a.m., noon to 2:00 p.m., 4:00 to 6:00 p.m., 8:00 to 10:00 p.m., and (where meters were in operation during evening hours in 2013) 10:00 p.m. to 12:00 a.m. Each time period included data from two completed routes. Observations of disabled placard, double parking, and occupancy were recorded at the same time for each block-face. Figure B-4 illustrates the routes by pilot and control areas for the disabled placard and double parking survey.



Source: San Francisco Municipal Transportation Agency, 2013.

Figure B-4. Disabled Placard/Double Parking Survey Routes

The disabled placard/double parking sample originally consisted of 9679 data points. However, with the exclusion of data for the Mission pilot area as discussed in Section B.3.1, the sample was reduced to 8879 cases.

B.3.3 Method of Analysis

Time and distance measures in the parking search time survey and count of disabled placard, double parking, and parking occupancy data are not independent random variables. They are a function of the time or distance to find the parking space and the time and distance to find the next parking space (or disabled placard and double parking). Longer search trips are less likely to be represented in the data because it takes longer to find spaces on those trips and, thus, get back to them within the scheduled time window. Counts of disabled placards and double parking may be very high during peak periods and very low during non-peak periods. As a result, parking searches are over-represented during non-congested time periods and disabled placard/double parking are under-represented. The reverse is true for congested time periods. For example, within a two-hour time period there could have been four, 20-minute search trips in time period 1 (more congested) and eight, 10-minute trips in time period 2 (less congested). The number of observations is reduced by half in the more congested conditions due to the two-hour time period restrictions. Similarly, during a congested two-hour time period, 40 instances of disabled placard parking or double parking may have been counted, but during an uncongested two-hour time period, one instance may be counted. Moreover, surveying did not always include the full survey time period because surveyors may have started late and/or ended early.

Although there were many thousands of measurements from these surveys, the data had to be transformed to avoid the bias introduced by the survey methodology. This was done by averaging all runs within each time period for each calendar day in which the surveys were implemented. For example, in the case of parking search time, the sum of total parking search time from 10 a.m. to noon on Tuesday May 3, 2011 was divided by the total number of parking spaces found. In the case of disabled placard and double parking counts, the sum of total parking events from noon to 2 p.m. on Wednesday May 4, 2011 was divided by the total number of parking spaces (excluding those parking spaces that were blocked for some reason). Thus, a single (aggregate) data point for each time period each day, regardless of the number of runs conducted, was used in the subsequent analysis. Without the creation of these averages, the use of data from individual runs would have required a very complicated survival model that would result in only minor improvement over the regression of the counts (or rates) approach used in the analysis.

The model framework described in B.2.1 equation (1) above is implemented with a generalized mixed effects model in which the dependent variable was assumed to have a Poisson distribution (i.e., the mean is equal to the variance) as described in equation 3 below:

(3) $\log[y_{ij}/t_{ij}] = \beta_0 + b_0 + \beta_p d_p + \beta_{wp} d_{wp} + \beta_{wc} d_{wc} + \beta_1^t \mathbf{x}$

where $d_p = \begin{cases} 1 \text{ if pilot area} \\ 0 \text{ otherwise} \end{cases}$, $d_{wp} = \begin{cases} 1 \text{ if After pilot area} \\ 0 \text{ otherwise} \end{cases}$, and $d_{wc} = \begin{cases} 1 \text{ if After control area} \\ 0 \text{ otherwise} \end{cases}$.

For parking search time and distance, the dependent variable is equal to total search time or distance (y) divided by total found spaces (t) in each time band on each survey day type (i) in each parking area (j). For disabled placard and double parking, the dependent variable is the total number of disabled placard or double parking incidents (y) divided by total “parkable” or available spaces (t) in each time band on each survey day type (i) and in each parking area (j). Confounding variables or covariates (x) include the time of day and the day of the week (i.e., weekday versus weekend[6]). The intercept is β_0 and the random parking area effect is b_0. The time effect in the pilot areas is measured by β_{wp} and in the control areas by β_{wc}. Thus, β_{wp}-β_{wc} measures the effect of the pricing program. The pilot area effect is β_p and it models differences that might exist between pilot and control areas. If β_p is significant, then measured outcomes were different before implementation of the pricing program. Interpretation of this coefficient only makes sense if $\beta_{wp}-\beta_{wc}=0$.

Poisson, negative binomial, and Gamma Poisson are three approaches recommended for the analysis of count and rate data. The assumption of equality of variance and means did not hold for all estimated models, and, thus, the negative binomial and Gamma Poisson models were also estimated, but the results did not differ significantly from the Poisson model. Deviation from the Poisson distribution would not tend to bias parameter estimates, but it could increase the standard deviation for parameter values and, thus, could increase the chance of making a Type II error (or failure to reject a false null hypothesis). As a result, the analysis presented here may be conservatively biased with respect to p-values. If the true variation is larger than suggested by a Poisson model, then ignoring the correct variation should result in an underestimate of the variance. This results in a confidence interval that is too narrow and, thus, increasing the Type I error. A confidence interval that is too wide increases the Type II error.

B.3.4 Model Results

The estimated model’s results according to pricing hypotheses are provided in Table B-12. The parameter estimates are presented in odds ratios (which were discussed previously in Section B.2.1). All estimates for the individual pilot parameters are significant at the 0.05 level or with the exception of the disabled placard outcome which implies that there was a significant time effect in the pilot areas. Only two of the parameters in the individual control parameters are significant (for parking search time and, marginally so, for distance). The remaining control parameters are not significant, which suggests that there was no statistically significant time effect in the control areas. The statistical significance of the difference between the pilot and control parameters is tested with the Wald test.

[6] For efficiency a single “weekend” covariate for both Saturday and Sunday was used in the model. When the model was run using two separate covariates for the weekend days, the results were nearly the same, which suggests that Saturday was not significantly different than Sunday. While SFMTA did not begin pricing on-street meter parking until January 2013, about a third of the parking search field data were collected on Sunday, and thus it was important to retain those data in the model for estimation purposes.

Table B-12. Results for Field Observation Outcomes (Occupancy, Disabled Placard, Search Time and Distance, and Double Parking) Predicted by Intervention and Time.

Hypothesis	Outcome Variable: Mean by Time Period by Day Type	Exponent of Coefficient for Pilot and Control Areas			N
		$EXP(Pilot)$	$EXP(Control)$	$EXP(Pilot - Control)$	
1. Parking pricing will increase parking availability.	Disabled Placard Parking per Available Spaces	0.99 (0.782)*	1.04 (0.495)	0.96 (0.616)	322
2. Parking pricing will lead to reduced search time and variability.	Search Time (seconds) per Parking Space	0.71 (0.001)	0.83 (0.000)	0.85 (0.026)	221
	Search Distance (feet) per Parking Space	0.73 (0.000)	0.83 (0.000)	0.88 (0.069)	221
3. Parking pricing will reduce double parking.	Personal Vehicle Double Parking per Available Spaces	0.56 (0.001)	0.65 (0.134)	0.86 (0.650)	322
	Commercial Vehicle Double Parking per Available Spaces	0.86 (0.020)	0.68 (0.540)	0.79 (0.425)	322

*p-values are in parentheses, and p-values less than or equal to .05 are considered statistically significant.

Source: Caroline Rodier, 2014.

For the parking availability hypothesis (1), the model results for the disabled placard model indicate that there was no significant change from 2011 to 2013 in the rate of disabled placard parking in either the pilot or the control areas, and the difference between the pilot and control was not significant based on the Wald test. This suggests that the effectiveness of SF*park* may be hindered where and when disabled placard parking is widespread.

The model's results for the parking search time hypothesis (2) indicate a 15 percent reduction in parking search time (total search time divided by total number of parking spots found for each time period for each survey day) in the pilot relative to the control. The model's results for parking distance (total search distance divided by total number of parking spots found in each time band for each survey day) decreased by about 12 percent in the pilot relative to the control. The change in parking search time based on the Wald test was significant at the 0.026 level, and the change distance was marginally significant at the 0.069 level.

The model's results for the double parking hypothesis (3) indicate that double parking for personal vehicles may have been reduced by about 14 percent and for commercial vehicles by about 21 percent in the pilot versus the control. However, the change was not statistically significant based on the Wald test. This result could be due to the high variability in the double parking rate, which might require a larger sample size to detect significance.

The field observations also include occupancy rates for parking spaces dedicated exclusively to motorcycles on weekdays by time periods (9-11 a.m., 1-3 p.m. and 7-9 p.m. time periods). Data were collected for two types of routes: (A) streets though the downtown; and (B) streets through the pilot and control areas but not in the downtown. There is only one occupancy rate by time period and route. As a result, it was not possible to test for statistical significance. Data were gathered in the spring of 2011 and 2013. The results are shown in Table B-13. In all but one case (7:00 p.m. for route A), the rates of motorcycle occupancy increased over time inside and outside the downtown area.

Table B-13. Motorcycle Occupancy Rates by Route, Time Period Before and After Pilot Implementation

Route	Time Period	2011 Occupancy	2013 Occupancy	Change in Rate 2013-2011
A	9:00 a.m.	0.42	0.58	0.16
A	1:00 p.m.	0.54	0.72	0.18
A	7:00 p.m.	0.18	0.16	-0.02
B	9:00 a.m.	0.19	0.21	0.02
B	1:00 p.m.	0.28	0.35	0.07
B	7:00 p.m.	0.2	0.25	0.05

Source: Caroline Rodier, 2014.

B.3.5 Application of Model Results

Whereas the results of the modeling shown in Section B.3.4 assess the relative impact of the pricing program, measures of the absolute changes in parking search time and distance were needed in other parts of the evaluation, including the environmental analysis and the benefit-cost analysis. Thus, the results of the parking search time and distance models were used to estimate total change (not just percentage change) in 2013 with and without the pilot. However, the average search distance and time tended to be shorter due to the design of the field test than those thought to be typically experienced by drivers, as reflected in the results of the visitor/shopper survey. Therefore, the question on parking search time from the visitor/shopper (or “intercept”) survey was used to develop factors to adjust search distance and times by time of day and day of week from the field survey. This resulted in “scaling up” the search times and distances from the field survey to achieve a best estimate of the true impact of variable pricing in the view of the national evaluation team.

The following discussion describes how parking search time and parking search distance from the field bike survey were adjusted (or scaled) by using reported parking search time from the visitor-shopper intercept survey. Total mean search time and distance by time of day and day of week from the bike survey and from the intercept survey were calculated using both pilot and control data for 2011 and 2013. Next the total mean search time by time of day and day of week from the intercept survey was divided by total mean search time by time and day of week from the bike survey. Total mean average search time by time of day and day of week from the 2011 intercept survey across all pilot areas were then calculated. The time effect and treatment effect by time of day and day of week were each multiplied by the time of day and day of week factor.

The time effect was added to the 2011 mean to obtain the 2013 estimate without the pilot and the pilot effect was added to the 2011 mean to obtain the 2013 estimate with the pilot. The intercept data only included reported search time. Thus, total average parking search speed (i.e., distance/time) was calculated from the bike survey by time of day and day of week using both pilot and control data for 2011 and 2013. The search time values were then converted to distance using these values.

Using this process, Table B-14 and Table B-15 show the results of average search time and distance, respectively, in 2013 with and without variable pricing in the pilot area by time period and day type.

Table B-14. Average Search Time (Seconds) in 2013 with and without SF*park* in the Pilot Area by Time Period and Day Type

Time	2013 without SF*park*		2013 with SF*park*		Percentage Change	
Weekday	**Field Survey**	**Intercept Survey**	**Field Survey**	**Intercept Survey**	**Field Survey**	**Intercept Survey**
8-10 a.m.	35.40	184.41	32.20	172.59	-9.930%	-6.846%
12-2 p.m.	116.69	515.98	106.37	464.51	-9.708%	-11.081%
4-6 p.m.	74.17	717.13	67.59	652.80	-9.741%	-9.855%
8-10 p.m.	92.95		84.72		-9.721%	
Weekend	**Field Survey**	**Intercept Survey**	**Field Survey**	**Intercept Survey**	**Field Survey**	**Intercept Survey**
8-10 a.m.	36.28		33.01		-9.918%	
12-2 p.m.	119.61	777.80	109.02	736.07	-9.707%	-5.670%
4-6 p.m.	76.02	562.81	69.28	535.34	-9.738%	-5.132%
8-10 p.m.	95.27		86.83		-9.719%	

Source: Caroline Rodier, 2014.

Table B-15. Average Search Distance in 2013 with and without SF*park* in the Pilot Area by Time Period and Day Type

Distance	2013 without SF*park*		2013 with SF*park*		Percentage Change	
Weekday	**Field Survey**	**Intercept Survey**	**Field Survey**	**Intercept Survey**	**Field Survey**	**Intercept Survey**
8-10 a.m.	340.36	1687.92	286.73	1502.10	-18.704%	-12.370%
12-2 p.m.	1267.14	4983.99	1067.50	3995.59	-18.701%	-24.737%
4-6 p.m.	762.95	6314.11	642.75	5403.27	-18.702%	-16.857%
8-10 p.m.	1147.07		966.35		-18.701%	
Weekend	**Field Survey**	**Intercept Survey**	**Field Survey**	**Intercept Survey**	**Field Survey**	**Intercept Survey**
8-10 a.m.	313.55		264.14		-18.705%	
12-2 p.m.	1167.31	6140.56	983.40	5407.67	-18.701%	-13.553%
4-6 p.m.	702.85	4399.92	592.11	3971.02	-18.702%	-10.801%
8-10 p.m.	1056.70		890.22		-18.701%	

Source: Caroline Rodier, 2014.

B.4 Parking Occupancy Analysis

This section describes the evaluation of changes in parking occupancy within the SF*park* areas as well as the relative influence of parking price on parking occupancy. This analysis evaluates the hypothesis: “Parking pricing will increase parking availability.” A number of datasets provided by SFMTA are applied in the analysis including parking occupancy, parking price, roadway data, and garage activity data.

In this section, “parking occupancy” is defined as the percentage of an hour that the spaces on a given block are occupied by vehicles parked on the street. Parking occupancy is the opposite of parking availability in that decline in parking occupancy implies a commensurate increase in parking availability.

The analysis of occupancy data to evaluate the hypothesis comprised two key efforts. The first was the analysis of the overall change in parking occupancy observed within the pilot areas. The second was an analysis of the influence (if any) of parking price on parking occupancy. These two analyses showed that SF*park* pricing actions were influential on overall parking occupancy to different degrees within different pilot areas across the city. The data suggest that parking price was influencing parking occupancy in most parts of the city, but in some pilot areas the impact on parking occupancy was more apparent than in others. The sections that follow detail the data, methodology, and results that support this conclusion.

B.4.1 The Data

This section describes the data used in the occupancy analysis: parking occupancy data, roadway sensor data, SFMTA garage data, and parking tax data.

Parking Occupancy Data

SF*park* collected occupancy information using sensors embedded in the streets within on-street parking spaces. These sensors reported occupancy in real-time, allowing SF*park* to display parking availability on their website. The historical data generated from these sensors were recorded as "parking sessions," which were effectively *lengths of time* an individual sensor reported being occupied by a vehicle. The parking session represented the smallest unit of measurement for parking activity, but it was reported to be subject to some uncertainty due to measurement error at this level of disaggregation. Therefore, for pricing decisions, SFMTA developed an aggregation of these sessions into hourly occupancies at the block level. The hourly parking occupancies measured the *percent of total time the sensors were collectively occupied* on the block during a given hour. The calculation of occupancy for a given block is as follows:

$$\frac{Total\ Occupied\ Seconds\ per\ Hour}{Total\ Vacant\ Seconds\ per\ Hour + \ Total\ Occupied\ Seconds\ per\ Hour}$$

SFMTA provided a historical dataset of all hourly parking occupancy measurements for all pilot and control areas. The dataset spanned 28 months, from April 1, 2011 to July 31, 2013. Over this time frame, SF*park* made 10 dynamic pricing decisions. The pricing decisions were generally implemented at two-month intervals.

The hourly occupancy data of interest in this analysis was defined by SFMTA as "general metered parking" (GMP) occupancy. GMP occupancy was the metric that SFMTA used to determine its pricing actions. General metered parking is what is commonly considered conventional on-street parking. It is open to the public and is paid for through parking meters or through the mobile applications developed for SF*park*. In most areas, it was active from 9 a.m. to 6 p.m. In some areas, such as downtown, GMP hours began earlier at 7 a.m., and extended to 6 p.m. In some blocks on Fisherman's Wharf, a tourist area in San Francisco, GMP pricing extended to 7 p.m. Because all areas charged for parking during the 9 a.m. to 6 p.m. time frame, the analysis was confined to these hours to maintain comparability across areas.

The parking occupancy dataset provided by SFMTA had 7,902,290 hourly parking occupancy observations. This included records outside the GMP time frame referenced above, which were about a third of the total data. During the course of the two-year study, many events took place within and outside the SF*park* environment that impacted the quality and usability of records within the dataset. These events were varied and included construction and/or repaving work, which temporarily or permanently removed sensors. In addition, sensor battery failures accumulated over time, reducing the ability of SFMTA to make informed decisions about parking pricing. For example, when conducting rate adjustments, SFMTA excluded any block for which the sample size of meters fell below 50 percent. Based on these events, SFMTA had to carefully consider the blocks to which they could apply dynamic pricing. Therefore, not all blocks initially placed in the pilot were ultimately subject to all 10 price adjustments. In addition to the occupancy data, SFMTA provided a summary of the number of pricing adjustments by block. As the evaluation was focused on the impact of pricing and occupancy, the analysis of pilot areas was restricted to the subset of blocks that had seven or more pricing actions during the evaluation period. Pilot areas with 7+ pricing actions were generally among those without large interruptions in occupancy data, and most were active through the end of the evaluation period, including not changing price when data indicated that occupancy was in the 60 to 80 percent target range. For all but one of the pilot areas, this subsample comprised at least 80 percent of the blocks in the original dataset. A summary of the count of blocks included by pilot area is shown in Table B-16.

Table B-16. Summary of Blocks Used in Analysis of Pilot Areas

Parking Management District	Total Blocks	Blocks with 7 or more Rate Adjustments	Subsample Percent of Total
Civic Center	45	37	82%
Downtown	40	36	90%
Fillmore	45	45	100%
Fisherman's Wharf	37	32	86%
Marina	19	19	100%
Mission	28	17	61%
South Embarcadero	43	40	93%

Source: Elliot Martin, 2014.

SFMTA also advised the evaluation team to discard the use of blocks in control areas. Control areas included Union, Inner Richmond, and West Portal, and these areas were not subject to pricing adjustments. Furthermore, control areas did not generally have smart meters, and thus the available data on parking activity from control areas were derived solely from occupancy data reported by the sensors. SFMTA also strongly advised that the evaluation discard any parking occupancy data from the West Portal area. This was due to numerous technical problems with data in this area as a result of difficulties in sensor communication. SFMTA reported that the presence of surface light rail, and the accompanying overhead wires, caused considerable interference with wireless communication. These and other issues caused SFMTA to place a low priority on upgrades and sensor fixes to West Portal. For this reason, West Portal is not included in this analysis. Outside of this restriction, the occupancy data provided for the other two control areas were relatively complete. In the Inner Richmond area, 3 of 31 blocks did exhibit a complete or near complete loss of data starting in 2013. These observations were dropped, but the remaining data in these blocks were retained with the remainder of the sample. In the Union area, data were complete, with 0 of the 16 block exhibiting major losses of data at the block level.

As mentioned above, SF*park* was subject to sensor battery failures that increased over time during the two-year evaluation period. This led to a gradual loss of information on block occupancy for a number of blocks. The rate of failure was uneven across the pilot and control areas. Under normal operation, sensors would report a status of vacant or occupied. A third, less common status was “unknown,” and the status was typically reported (or inferred) in the event of no report by the sensor, as would occur in the case of temporary or permanent battery failures. Following the rule established by SFMTA in their own pricing decisions, the analysis here for both pilot and control blocks was excluded from consideration for any block in which the sensors collectively reported unknown GMP occupancy for more than 50 percent of the time.

When the share of unknown time was less than 50 percent, the observation of parking occupancy was retained in the data but was scaled according to the unknown share. For example, if a given observation had an unknown time of 30 percent, an occupancy of 50 percent and a vacancy of 10 percent, the occupancy measurement would be scaled to (50 percent/ (1 - 30 percent)) = 71.4 percent. Effectively, when there was any unknown share of time, the measured occupancy is considered a random sample estimating the true occupancy. Naturally, the estimate became less reliable with a greater share of unknown time during the hour, and thus again following the rule applied by SFMTA, hourly parking occupancy observations were discarded when unknown shares rose above 50 percent.

Roadway Sensor Data

As discussed in Appendix A – Congestion Analysis, SFMTA provided roadway sensor data for the evaluation for the analysis of impacts of SF*park* o*n* traffic speed and congestion. These same data were applied to the parking occupancy analysis to gain some insight into the potential influence of traffic activity on changes in occupancy. For example, major spikes or dips detected in parking occupancy over time may have been due to changes in traffic into the area. The roadway data provided a second perspective on the vehicle activity in the area.

The roadway data were of a similar size to the parking data at 8,098,338 records. These constituted records of 15-minute length observations of traffic counts, average traffic speed, median traffic speed, and sensor occupancy (different from parking occupancy). This analysis used the data for a review of trends in average monthly traffic counts. The data were sorted by area and month and then averaged into trends of traffic counts. The roadway sensor data were not perfect, and its quality varied across areas. The sensors placed within some pilot areas did report data intermittently, with a number of interruptions in data observed by sensors over the two-year period. For the trends reported in traffic data, sensors with interruptions were excluded. This reduced the sample size of sensors available to evaluate traffic trends. Because different sensors produce vastly different vehicle counts, the trends were normalized to 1, so that changes in traffic were reported relative to the first month available in the dataset.

Garage Data

In addition to the parking occupancy data, SFMTA provided data on the daily entrances and exits of SFMTA-controlled parking garages within the SF*park* system. These data were analyzed to develop insights into the change in garage use over the course of the evaluation period. One objective of SF*park*, in addition to managing parking pricing, was to encourage greater use of off-street (garage) parking. The changes in garage activity were analyzed within each pilot area that has garages.

Parking Tax Data

Parking tax data were provided by SFMTA to serve as a proxy measure for parking activity that occurred in off-street parking lots and garages that SFMTA did not control. This information was used alongside SFMTA parking lot and garage data to evaluate the overall shift in parking to off-street garages.

B.4.2 Methodological Approach

The hypothesis on parking availability was evaluated using two complementary approaches. The first approach focused on evaluating the average change in year-over-year parking occupancy within each pilot and control area. The significance of the change was evaluated using a series of paired t-tests on occupancy measurements. The second approach focused on evaluating the impact of price on occupancy. This approach estimated a linear regression model to determine the sign and magnitude of influence that parking price had on parking occupancy, which was the dependent variable. This section details the methodology behind both approaches.

Application of Paired t-test on Parking Occupancy

The hypothesis that parking pricing increased parking availability was first tested with a standard paired t-test on year-over-year differences of parking occupancy. This test effectively looked at the impacts to on-street parking occupancy within a given pilot area in consideration of the overall pricing actions taken by SFMTA. As noted, SFMTA simultaneously made decisions to increase, decrease, and leave unchanged parking prices for various blocks over the course of the evaluation period. These decisions collectively were designed to shift parking to underused blocks within the area and to lower occupancy on the more congested blocks.

The paired t-test effectively measured how on-street parking occupancy as a whole changed as a result of those decisions. The measurement variable was the difference between two paired measurements of parking occupancies taken a year apart. The pairing process matched weekday to weekday (e.g., Tuesday to Tuesday), and hour to hour (11 a.m. to 11 a.m.). Understandably, it is not a pairing by date (say from April 1, 2011 to April 1, 2012), because these dates are different days of the week. But once the initial days were matched, all subsequent days within each year also matched accordingly. The pairing of days from 2011 to 2012 to 2013 is shown for the first 14 days of the dataset in Table B-17.

Table B-17. Year-Over-Year Alignment of Dates for First Two Weeks in Each Year

Day	Year 1 Date	Year 2 Date	Year 2 Date
Friday	4/1/2011	3/30/2012	3/29/2013
Saturday	4/2/2011	3/31/2012	3/30/2013
Sunday	4/3/2011	4/1/2012	3/31/2013
Monday	4/4/2011	4/2/2012	4/1/2013
Tuesday	4/5/2011	4/3/2012	4/2/2013
Wednesday	4/6/2011	4/4/2012	4/3/2013
Thursday	4/7/2011	4/5/2012	4/4/2013
Friday	4/8/2011	4/6/2012	4/5/2013
Saturday	4/9/2011	4/7/2012	4/6/2013
Sunday	4/10/2011	4/8/2012	4/7/2013
Monday	4/11/2011	4/9/2012	4/8/2013
Tuesday	4/12/2011	4/10/2012	4/9/2013
Wednesday	4/13/2011	4/11/2012	4/10/2013
Thursday	4/14/2011	4/12/2012	4/11/2013

Source: Elliot Martin, 2014.

While there were two years of data, the analysis here focuses on comparing 2011 and 2013. This pairing spans 28 months and constitute a sizeable sample with which to conduct a hypothesis test on changes in parking occupancy. For the analysis that follows, the pairing of 2011 to 2013 is presented, in that it most succinctly summarizes overall changes in parking occupancy over the entire evaluation period.

The occupancy data provided by SFMTA also contained information on the number of spaces monitored in each block. This number was extracted by dividing the total GMP sensor time by 3,600 seconds. The number of spaces determined for each block was used to weight the average block occupancies and produced weighted means for the paired t-test. Hence, the t-test calculation is conducted on data weighted by the number of spaces on the block (as opposed to the raw occupancy measurements). This was necessary (or preferred) because some areas exhibited considerable variation in the number of spaces across blocks. For example, in the Civic Center area, one block had three GMP spaces, while another had about 60. Naturally, the reported occupancy of the block with three spaces fluctuated far more widely, and it seemed unreasonable to weight the changes in occupancy on this smaller block with another block with 20 times the number of spaces.

Paired t-test on Transformations of Parking Occupancy

The section above described the structure of the paired t-test on the raw parking occupancy measurements provided by SFMTA. While the hypothesis states a general inquisition on the impact of pricing on parking availability, a key objective of SF*park* was to address highly congested parking. That is, changes in hourly parking occupancy on a block from 60 percent to 40 percent is less consequential to people looking for a single parking space than changes on a more full block, as a space is available on the less-occupied block in both cases. However, a change in parking occupancy of the same magnitude from 90 percent to 70 percent is far more impactful in maintaining a distribution of *some* parking availability everywhere. This concept has been advanced notably by UCLA Professor Donald Shoup, who has argued that the appropriate pricing of on-street parking should leave at least 1 in 8 spaces (87.5 percent occupancy) available on all blocks.[7]

This thinking motivated an analysis with the transformation of the parking occupancy measurement into a 0-1 indicator variable. The parking occupancy is assigned a value of 0, if it is less than a threshold of 85 percent, and it is assigned a value of 1 if it is greater than or equal to 85 percent. This transformation turns the variable into a Bernoulli variable, and changes with the count instances of such can be evaluated with tests on a binomial distribution. However, as sample sizes become large (>30), the distribution of such variables approaches the normal distribution, and the t-test can be used. The sample sizes in all cases evaluated in this analysis are large.

The same paired t-test measurement described in the previous section was conducted on this transformed variable. It evaluated whether the collective pricing actions of SF*park* reduced the number of instances in which hourly parking occupancies exceeded 85 percent. Effectively, the test on the transformed variable is measuring the change in the proportion of hours that occupancy exceeded 85 percent. For example, if 700 block-hours out of 1,000 block-hours were measured above 85 percent occupancy in the *before* period, and 500 block-hours out of 1000 block-hours were measured above 85 percent occupancy in the *after* period, the change of the transformed variable was 200 block-hours per 1,000 hour (0.2 per hour). In this example, the

[7] Shoup, D. (2006) "Cruising for Parking." *Transport Policy* (13) pp. 479-486.

proportion of block-hours exceeding this threshold dropped by 20 percent of all hours measured. This variable focuses on the impact of SF*park* pricing on the most congested blocks targeted for pricing increases and ignores movements in occupancy that do not cross this threshold.

Regression Analysis on Parking Occupancy

A linear regression model was also generated as part of the analysis to ascertain the magnitude, direction, and statistical significance of parking price on parking occupancy. The dependent variable for this model was average parking occupancy for a given month, pilot area, and hour. For example, a single observation of this dependent variable would be the average parking occupancy on a given block from 9 a.m. to 10 a.m. during May 2011. This dependent variable was calculated for each of the pilot areas and each hour between 9 a.m. and 6 p.m. (9 hours) across all months from April 2011 to July 2013.

The model exhibited a relatively simple structure of independent variables. The key independent variable was parking price. As mentioned earlier, SFMTA pricing actions occurred at two-month intervals, so prices remained constant between these actions. Pricing actions were also implemented within three, 3-hour intervals. These intervals were 9 a.m. to 12 p.m., 12 p.m. to 3 p.m., and 3 p.m. to 6 p.m. SF*park* had to keep prices constant within these intervals, but SFMTA had the discretion to change prices across them based on their occupancy reports. Under the same structure as the dependent variable, the independent variable was calculated as the average parking price of a given hour for a given block, during a given month.

The remaining independent variables were (0-1) indicator variables (also called dummy or Boolean variables) assigned to each block and each month. These variables are necessary to capture the diverse and inherent attributes of the block that influence its average level of parking occupancy. For example, some blocks may be near a large tourist attraction that leads to higher average parking occupancies all the time. Other blocks may have some unattractive qualities, such as high traffic speeds, that lead to lower parking occupancies. These inherent qualities are numerous and varied. The indicator variables, each of which is assigned a value of 1 for one, and only one block, captures the average influence of all these effects. Finally, events over the course of the evaluation period could have also influenced parking occupancy. Indicator variables were also assigned to each month in the dataset to control for the aggregate impacts of events within the city during year (e.g., holiday shopping, etc.). The general structure of the regression model is shown below:

$$\overline{\pi_{\iota t}} = \alpha + \beta\overline{R_{\iota t}} + \beta B_1 + \cdots + \beta B_{J-1} + \beta M_1 + \cdots + \beta M_{T-1}.$$

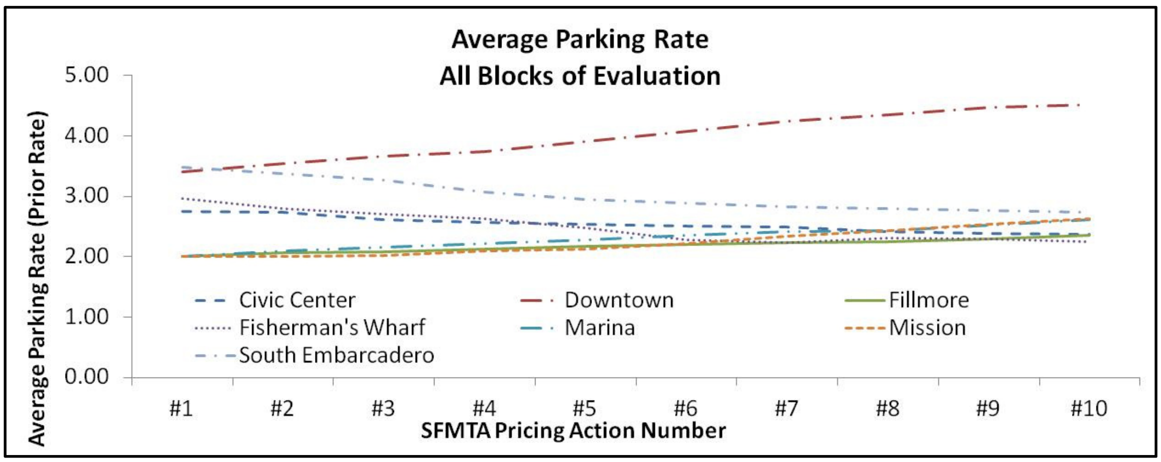
Where $\overline{\pi_{\iota t}}$ is average occupancy on block i during month t, $\overline{R_{\iota t}}$ is the average rate during the same period, and the B_i and M_i represent the respective indicator variables for blocks and months. As is standard practice in regression, one indicator variable with both the set of months and blocks was not assigned to avoid producing a singularity. Hence, block indicator variables were included up to *J – 1* blocks and *T – 1* months. Nine models were estimated for each pilot area, and the distribution of coefficient estimates (particularly that of the rate) show how the parking price influenced parking occupancy by time of day across all pilot areas.

B.4.3 Results by Pilot Area

The results are presented in this section for each pilot area followed by a summary across all pilot areas in Section B.5. Since changes in pricing were to be the driver of changes in occupancy, this section begins by summarizing the trends in pricing actions taken by SFMTA over the course of the evaluation period. Next is the analysis of each pilot area, which begins with a presentation of data describing overall parking activity recorded during the evaluation period. Then the results of the statistical tests are presented, followed by the regression analysis findings.

Two graphs provide a summary of SFMTA pricing actions for on-street parking during the course of the evaluation. SFMTA published a historical summary of block-by-block parking rates with each pricing action. These data were used to compute the trend in the average parking rate during the evaluation within each pilot area.

To maintain consistency with the occupancy analysis, Figure B-5 shows the average parking rate for all blocks that had 7 or more pricing actions within each pilot area. The average is unweighted, treating all blocks equally, and the rate averaged is the reported "prior rate". This was the rate on the block prior to the new rate determined with each pricing action. The plot shows overall average prices rising in four of the seven pilot areas, including Downtown, Fillmore, Marina, and Mission. Overall average prices fell in the Civic Center, Fisherman's Wharf, and South Embarcadero.



Source: Elliot Martin, 2014.

Figure B-5. Average Parking Rate of All Blocks with Seven or More Pricing Actions

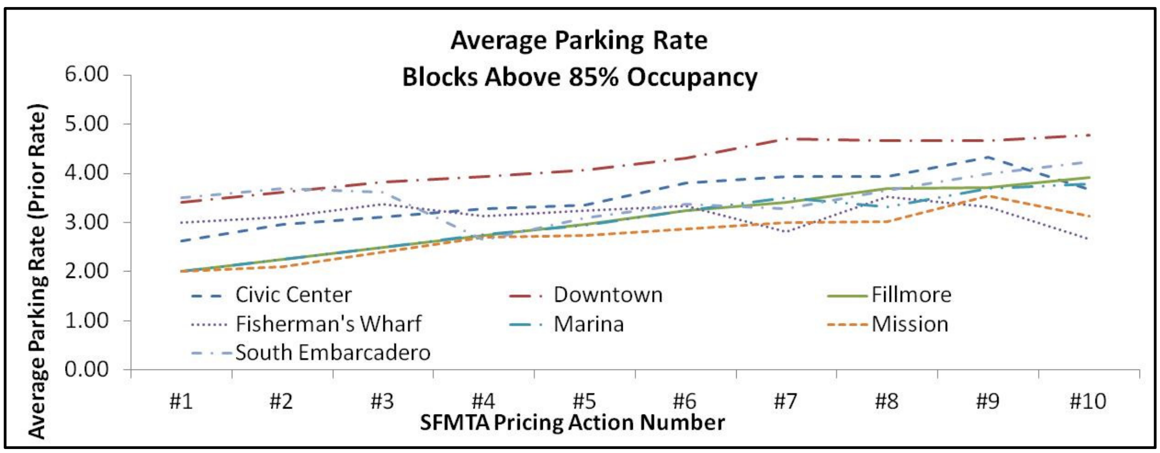
To implement variable pricing, SFMTA reviewed occupancies and set prices on blocks at intervals of approximately every two months (with some variability). The rules SFMTA applied for implementing price changes are listed in Table B-18:

Table B-18. SFMTA On-street Pricing Formula

Occupancy Range	Rate Adjustment
80% to 100%	$0.25
60% to 80%	No change
30% to 60%	-$0.25
0% to 30%	-$0.50

Source: SFMTA, 2014[8].

Figure B-6 shows the average parking rates of highly congested blocks (above 85 percent occupancy). For these blocks, the trend in average parking rates ended higher in all pilot areas except one, Fisherman's Wharf. An overall increase in average parking rates within these blocks was expected given SFMTA pricing rules. However, as parking rates changed, so too did the sample of blocks with high occupancies. New blocks with lower prices become more congested, and popular blocks with successive price increases become less congested. This shifting set of highly congested blocks explains in part why the trends in Figure B-6 are not continuously increasing, occasionally fall, and, in particular, why the average parking rate of highly congested blocks in the Fisherman's Wharf ended lower by the 10th pricing action.



Source: Elliot Martin, 2014.

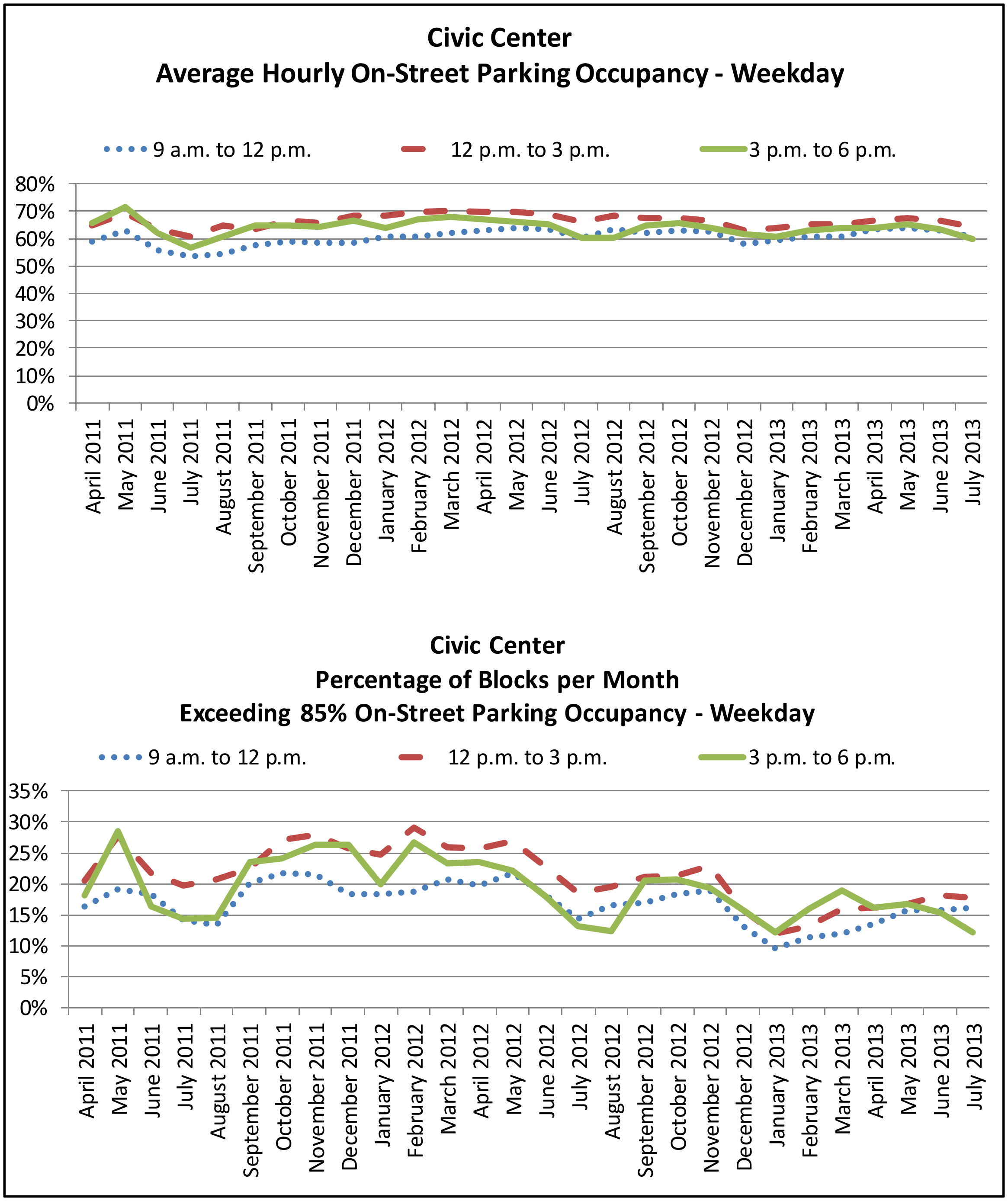
Figure B-6. Average Parking Rate of Blocks with Occupancy of 85 Percent or More

[8] SFMTA. Sensor Independent Rate Adjustments (SIRA), Methodology and Implementation Plan. SFMTA. May 14, 2014, p. 4.

B.4.3.1 Civic Center Pilot Results

Changes in Weekday Parking Occupancy within the Civic Center

Figure B-7 shows the overall trends in parking occupancy in the Civic Center area for two of the key metrics discussed in the methodology. The top figure within Figure B-7 shows the trend in weighted average GMP occupancy of all blocks in each month during weekdays from April 2011 to July 2013. The bottom figure within Figure B-7 shows the percentage (or proportion) of all hours in which occupancy on a block exceeded 85 percent, also during weekdays. This constitutes a sum of the indicator variables described above divided by the total blocks with measurable occupancy. Both graphs break these trends out by the three main pricing intervals during the day. The two figures show an important divergence that will also be evident in the t-tests that follow. The trend of average GMP occupancy (top figure of Figure B-7) is relatively stable across the three pricing intervals over the entire study. But the trend in the bottom of figure of Figure B-7 shows greater volatility and is downward, particularly during the latter half of the study period.

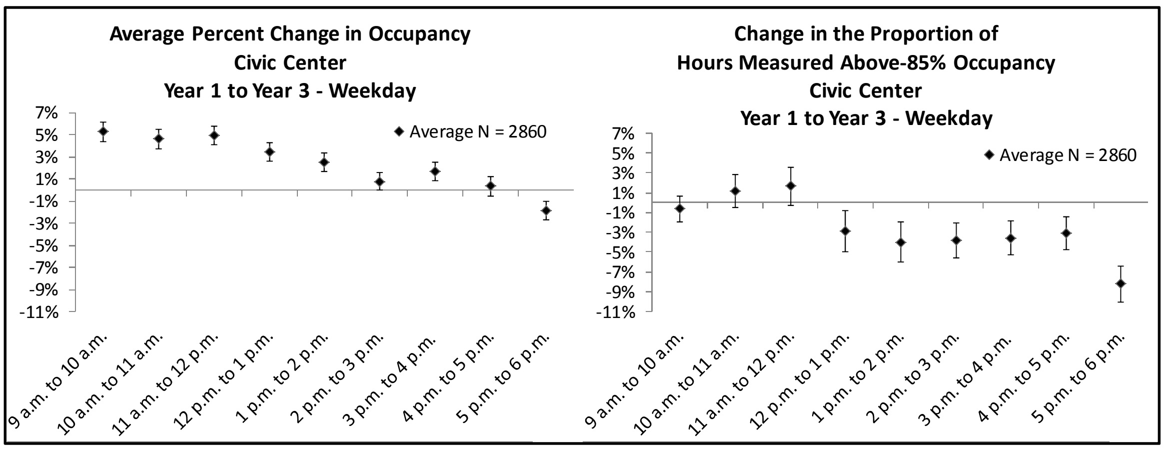


Source: Elliot Martin, 2014.

Figure B-7. Weekday Parking Activity in Civic Center during the Evaluation Period

The divergence of these trends suggests that some redistribution of parking occurred within the Civic Center area. Parking occupancy remained flat or even increased slightly, while the total number of blocks reporting occupancies above 85 percent simultaneously exhibited a noticeable decline.

This divergence of trends was further evident in the paired t-tests conducted on matched year-over-year occupancy data. Figure B-8 shows two graphs. Within each graph is a plot of the average differences calculated among paired blocks for each hour in the GMP time frame. That is, a single point in Figure B-8 (left) is the mean difference in occupancies, paired as described above for a single hour. Figure B-8 (right) shows the same mean difference but for the transformed occupancy by threshold. This represents the change in proportion of blocks exceeding an 85 percent threshold. The error bars around each point represent the 95 percent confidence interval about the mean. Any point in which the confidence intervals do not cross the x-axis at zero is statistically different from zero at the 95 percent confidence interval or greater. Otherwise, the value is not statistically different from zero, and the change year-over-year in parking occupancy was negligible for that hour of the day.



Source: Elliot Martin, 2014.

Figure B-8. Paired T-Test of Civic Center Weekday Parking Occupancy

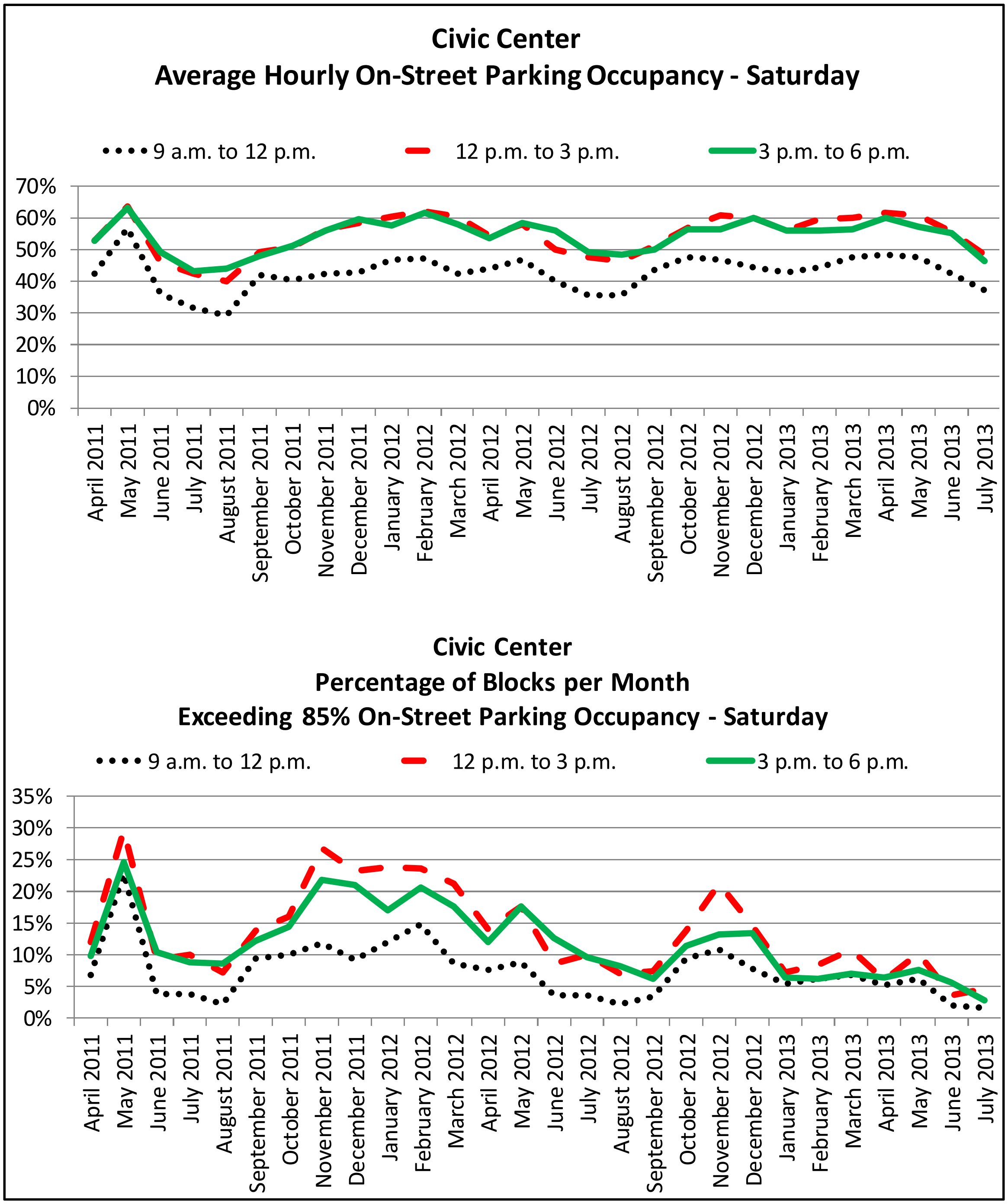
Sample sizes were a function of the number of block-hours available to compute differences and would have varied across hours due to a number of reasons. Some data were not available on a given block or hour, and a pairing could not be established. For example, if unknown time exceeded 50 percent for single hour, the value was discarded.

Figure B-8 shows the comparison from Year 1 to Year 3. Year 3 spans only four months from April 1, 2013 to July 31, 2013; hence, the average sample size across hours is smaller than if it constituted a whole year (2,860). Observations of parking occupancy in Year 3 were paired to analogous dates in 2011 as defined by Table B-17.

Figure B-8 also shows the same calculations, same time frame, and same paired observations as the top graph, except all occupancy measurements were transformed to the 0-1 indicator variables, assigned a value of 1 at occupancies above 85 percent. The bottom graph of Figure B-8 clearly shows a reduction in blocks that were above the 85 percent occupancy. During the morning hours, where average occupancy in the Civic Center was shown to increase, the average change in the number of blocks above 85 percent occupancy was statistically insignificant (no different from zero). For the hours of noon through the remainder of the afternoon, the number of blocks recording occupancies above 85 percent exhibited a statistically significant decline, even during hours in which the overall average occupancy of all blocks (from 12 p.m. to 4 p.m. in Figure B-8) exhibited a statistically significant increase. As mentioned above, the interpretation of the change can be thought of as a change in the proportion of all occupancy measurements above 85 percent. For example, from Year 1 to Year 3 during 12 p.m. to 1 p.m., the proportion of all weekday measurements of parking occupancy above 85 percent declined by about 3 percent and was statistically significant. However, during the same hour, average on-street occupancy exhibited a statistically significant increase of about 3 percent. How can this happen simultaneously? Simply put, if underutilized blocks (those well under 85 percent occupancy) experienced an increase in utilization; that increase would have contributed to an overall increase in the average occupancy. But the increase in occupancy of these underutilized blocks had no effect on the transformed variable, which only considered occupancies above 85 percent as important. These two results together could have signaled a redistribution effect occurring within the Civic Center area. Overall parking occupancy rose, yet in the afternoon hours particularly the number of blocks exceeding 85 percent occupancy fell. This divergent trend in the numbers offers an indication that SF*park* pricing in the Civic Center area was redistributing on-street parking away from the most congested blocks due to the rise in overall parking occupancy.

Changes in Weekend (Saturday) Parking within the Civic Center Pilot Area

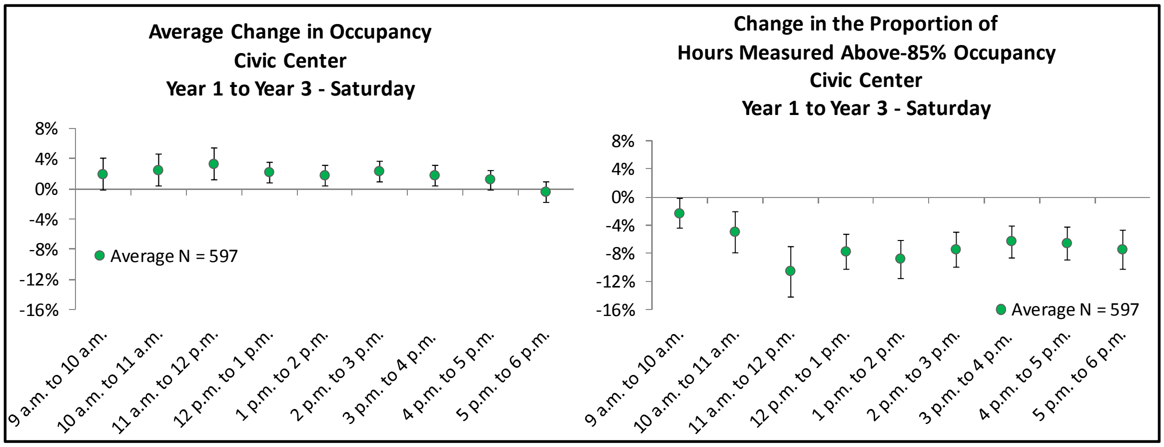
The same analysis was done for the Civic Center area on weekends. Weekend pricing was only implemented on Saturdays during most of the evaluation period. In early 2013, some limited Sunday pricing was implemented, but because this was a brief period late in the evaluation, all “weekend” results shown in this section are Saturdays only. Figure B-9 (top) shows the trends in average hourly on-street parking occupancy on Saturdays in the Civic Center. For Saturdays, there is greater seasonality and volatility over the evaluation period. However, average parking occupancy remains at relatively similar levels across the evaluation period. At the same time, there is a notable decline in the count of hours measured above 85 percent, as shown in Figure B-9 (bottom).



Source: Elliot Martin, 2014.

Figure B-9. Saturday Parking Activity in Civic Center during Evaluation Period

This downward trend in the count of blocks exceeding 85 percent in the face of relatively constant parking occupancy also speaks to a potential redistribution effect from the pricing of SF*park* in the Civic Center area. Indeed, Figure B-10 shows the results of the t-test on the mean change of the occupancy and above-85 percent indicator variables in the same format as Figure B-8.



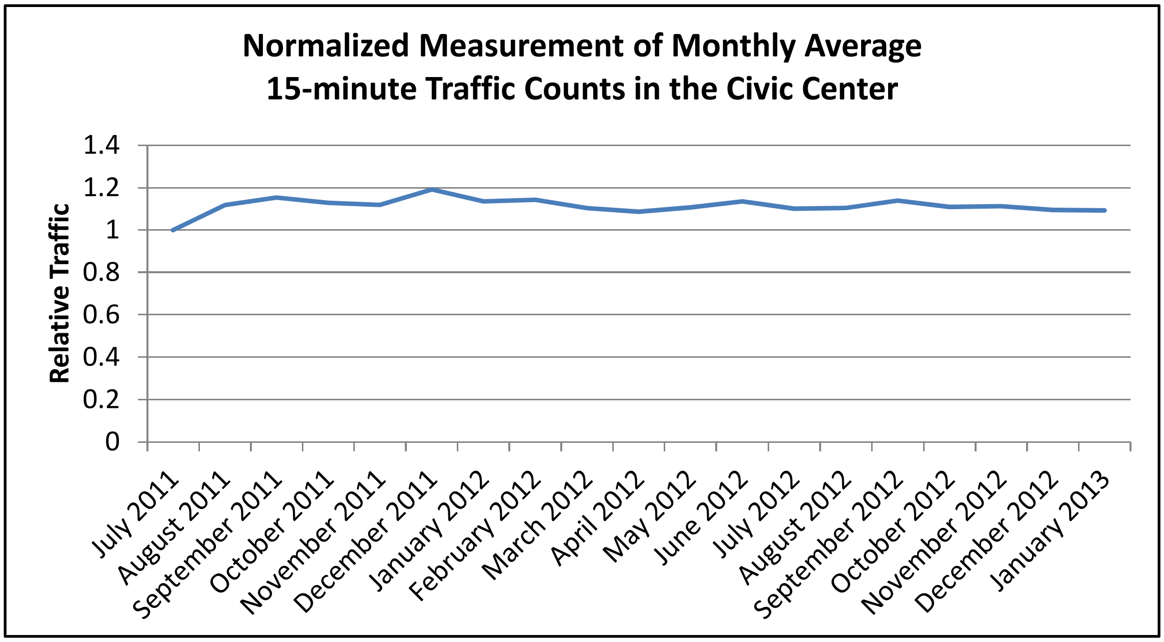
Source: Elliot Martin, 2014.

Figure B-10. Paired T-Test of Civic Center Saturday Parking Occupancy

The differences in the change of average parking occupancy and the indicator variables are larger. Average occupancy increased during the evaluation period for nearly every hour of the day, yet the proportion of hours in which occupancy exceeded 85 percent fell for all hours of the day on Saturdays in the Civic Center area. Nearly all changes were statistically different from zero. The reduction in the proportion of blocks exceeding 85 percent was also larger for nearly all hours, on the order of 8 percent to 11 percent. This further suggests that the SF*park* pricing on Saturdays was lowering parking on the most congested blocks even while the area was experiencing an overall rise in occupancy.

Civic Center Traffic Analysis

Roadway data were provided by SFMTA to assess changes in metrics, such as congestion and speed. The sensors also provided vehicle counts at 15-minute increments. Unfortunately, not all sensors reported at all times during the evaluation period, but a few sensors did provide continuous data. Within the Civic Center, three sensors provided continuous data for nearly the two-year evaluation. The 15-minute counts from these sensors were averaged across weekday GMP hours by month. The time series was then normalized to the start value, which is rescaled to 1. The resulting data did not reveal total traffic in the Civic Center area, but rather they exhibited relative changes in traffic experienced by the sensors that reported continuously. This plot is shown in Figure B-11.



Source: Elliot Martin, 2014.

Figure B-11. Normalized Measurement of Traffic in the Civic Center

Figure B-11 shows that the sensors detected a relatively constant level of traffic during the evaluation period in the Civic Center area. Traffic initially increased in the summer of 2011, and then stayed relatively flat. Effectively, the plot does not provide any evidence that the observed changes in parking occupancy patterns were driven by large changes in traffic to the Civic Center area. While these sensors comprise only a sample of traffic activity, they offer the best available measurement of potential changes in traffic in the area.

Civic Center Regression Analysis

The next component of analysis for the Civic Center area is a linear regression analysis on parking occupancy during weekdays. This analysis was a simple model in which the dependent variable was the average hourly parking occupancy on a block for a given month. The structure of the model is described earlier in the methodology section.

A separate model was estimated for each hour of the day (9 a.m. to 10 a.m., 10 a.m. to 11 a.m., etc.), which allows the model coefficients to show the change in influence of variables (such as price) over the course of the day. Table B-19 provides a summary of the most important coefficient, that of parking rate, as well as the overall model statistics, including fit and number of observations. The structure of the complete model is shown below these statistics.

Table B-19. Regression Analysis of Parking Occupancy during GMP Hours in the Civic Center

Parking Rate Model	Parking Rate Coefficient	p-value*	Adjusted R-squared	Total Number of Variables	# Observations
9 a.m. to 10 a.m.	-0.042	**0.000**	0.77	65	1020
10 a.m. to 11 a.m.	-0.043	**0.000**	0.73	65	1021
11 a.m. to 12 p.m.	-0.041	**0.000**	0.71	65	1022
12 p.m. to 1 p.m.	-0.045	**0.000**	0.73	65	1022
1 p.m. to 2 p.m.	-0.041	**0.000**	0.74	65	1022
2 p.m. to 3 p.m.	-0.032	**0.000**	0.73	65	1022
3 p.m. to 4 p.m.	-0.018	**0.001**	0.73	64	993
4 p.m. to 5 p.m.	-0.009	0.148	0.66	63	944
5 p.m. to 6 p.m.	-0.004	0.513	0.73	64	945

*Values in bold are statistically significant at 95 percent confidence level.

Source: Elliot Martin, 2014.

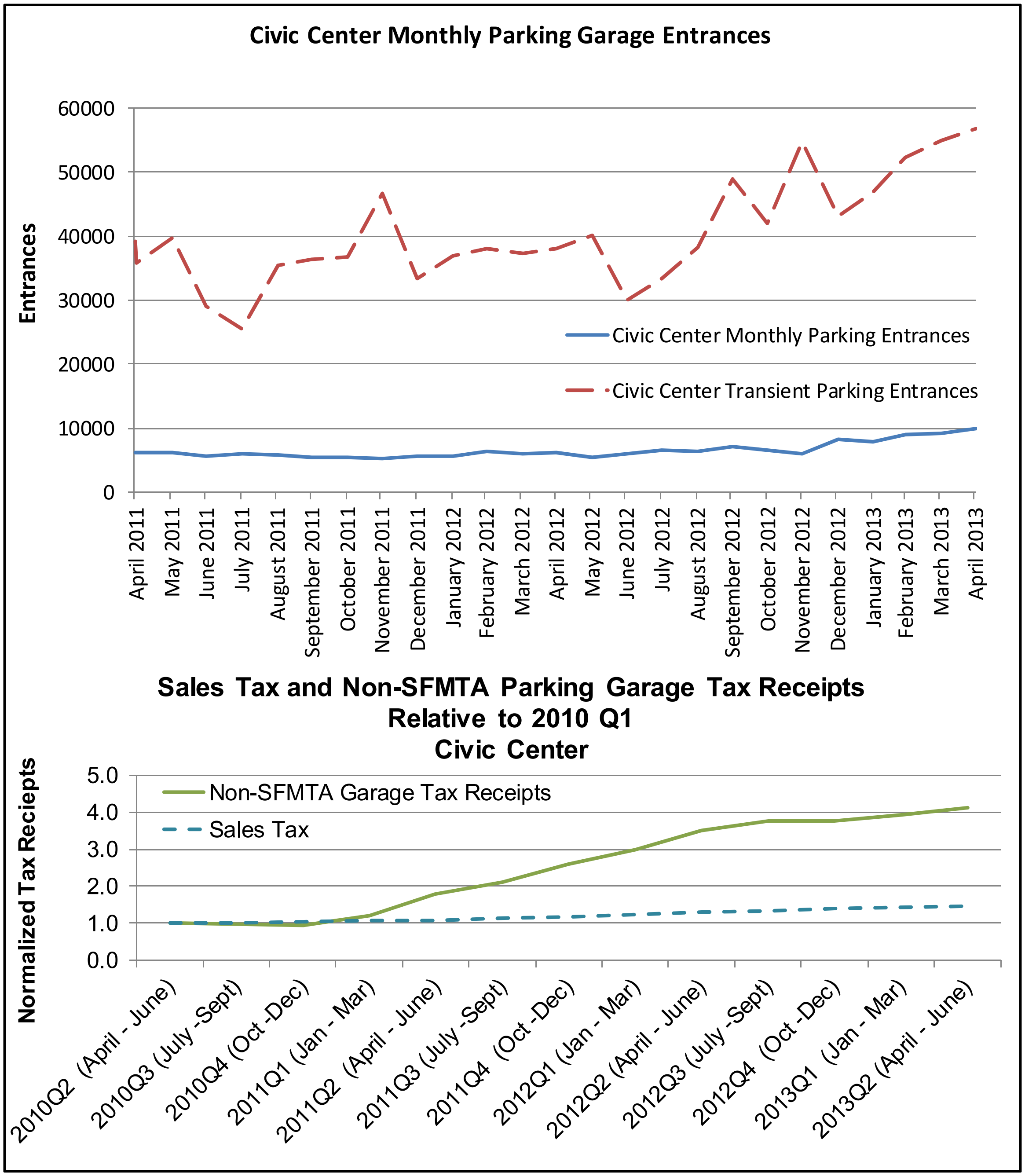
The results of Table B-19 show that price coefficient was statistically significant for seven of the nine models estimated. The magnitude of the coefficient was between -0.041 to -0.045 for the hours between 9 a.m. and 2 p.m. Because the model is linear, and the dependent variable is the percentage of block occupancy, these numbers have a direct interpretation. On average, every $1 increase in parking price reduced occupancy by an average of 4.1 percent to 4.5 percent during the morning and early afternoon. The influence of parking price on occupancy appears to have declined during the later hours of the day. The magnitude of the coefficient was cut by more than half by the 3 p.m. to 4 p.m. hour, but it was still significant. After 4 p.m., the data suggest that the influence of price on occupancy was waning, as the coefficients were no longer significant. This result may be consistent, however, with assumptions about human behavior as those people parking later in the day would know that they would only have to pay for a maximum of one to two hours and may not have been as sensitive to price.

The model fits were reasonably good, especially given the fact that parking activity on individual blocks was subject to considerable noise and only indicator variables were used in conjunction with an average rate variable. With an adjusted R^2 of 0.71, the model explained 71 percent of the variability in the data. The adjusted R^2 is better than simple R^2 goodness of fit statistic, particularly when there are multiple variables. Across all nine models this value ranges from 0.66 to as high as 0.77.

Civic Center Garage Activity

One of the objectives of SF*park* parking management was to increase the use of parking garages in conjunction with the pricing management of on-street parking. Two data sources were used to determine if that happened. One was SFMTA garage data for SFMTA-controlled lots and garages. The other was quarterly tax data for non-SFMTA-controlled garages. Figure B-12 is broken into two parts, with Figure B-12 (top) showing the change in activity within SFMTA-owned parking garages, and Figure B-12 (bottom) presenting a normalized plot of tax receipts from garages and parking lots in the Civic Center that are not controlled by SFMTA. As with the roadway data, this time series is normalized to the start value, which is rescaled to 1. Figure B-12 (bottom) also shows a normalized plot of sales tax receipts within the Civic Center. This sales taxes were for commercial establishments categorized as “Food Product, General Retail, and Miscellaneous” and included both chain stores and non-chain stores. The sales tax data were used for benchmarking the change in parking garage receipts to a measure of more general economic activity during the evaluation period. The data were available for each pilot area for the 2nd quarter of 2011, 2012, and 2013. To better align the data with time frame of the parking garage tax receipts, the sales tax data were linearly interpolated for the intervening quarter (e.g., Q3, Q4, and Q1).

Within Figure B-12 (top) two activities are shown, monthly pass vehicles and transient vehicles, which included anyone who paid by the hour or day. By May 2013, monthly pass entrances were 61 percent higher (at 9,968) than they were in May 2011 (at 6,204). For transient vehicle entrances, which constitute much higher activity, the percentage increase was almost the same. By May 2013, transient entrances had increased by 59 percent (at 56,762) versus 35,780 in May 2011. Within Figure B-12 (bottom), the quarterly tax data began in 2Q2010, before the beginning of the evaluation period, and remained relatively flat the entire year. At the start of the 2011, it grew steadily to the end of 2012 and continued more modest growth through 3Q2013. Still, parking tax receipts for non-SFMTA garages appeared to increase 4-fold, which is impressive for such a short period. For perspective, the more general measure of sales tax receipts grew more modestly, albeit to a level 50 percent higher than where it started in 2010. Broadly, the data in Figure B-12 show that garage activity increased in garages and lots both belonging and not belonging to SFMTA, which is consistent with the SF*park* objective of shifting parking to off-street garages.



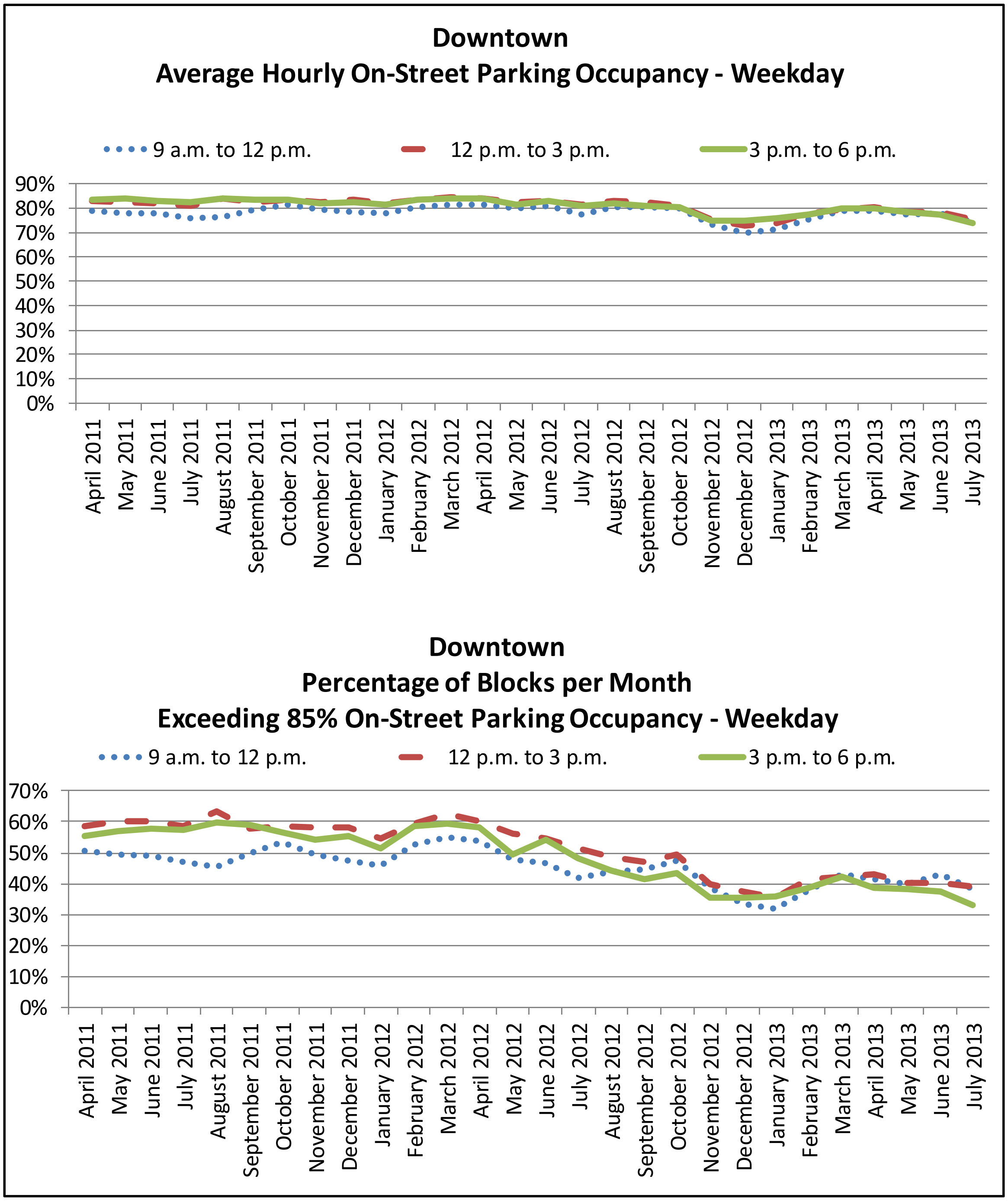
Source: Elliot Martin, 2014.

Figure B-12. Civic Center Parking Garage and Lot Activity

This concludes the analysis of the Civic Center. The sections that follow present analysis of the other pilot and control areas using the same chart format and presentation of data. Each parking area is briefly introduced and discussed in the context of the data and figures that follow. Where appropriate, reference is made to the Civic Center discussion for more details. The results of all sections are discussed within a final synopsis of the overall analysis in Section B.4.5.

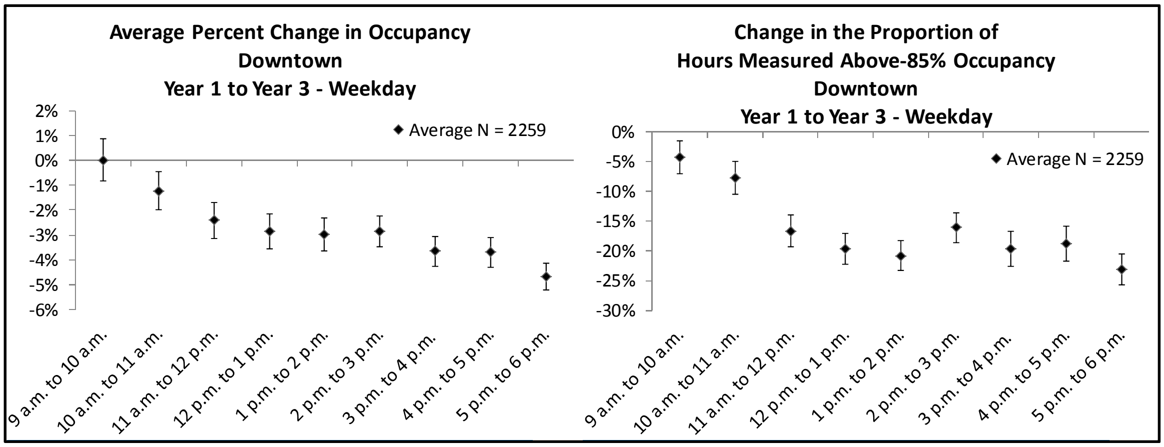
B.4.3.2 Downtown Pilot Results

The Downtown pilot area, which is the primary employment center of San Francisco, exhibited results similar to the Civic Center. Figure B-13 (top) shows the trend in average occupancy for on-street parking during the weekday, while Figure B-13 (bottom) shows the trend in the percentage of blocks exceeding 85 percent on-street parking occupancy over the two-year evaluation period. Figure B-13 (top) shows that average occupancy remained high but did decline modestly. The decline ranged from 0 percent in the early morning to upwards of 5 percent in the late afternoon. As shown in Figure B-13 (bottom), the Downtown area exhibited stronger declines in the percentage of blocks above 85 percent occupancy. In the afternoon hours, nearly 60 percent of blocks in Downtown registered hourly occupancies above 85 percent at the beginning of the evaluation, while towards the end of the evaluation period, the percentage of blocks exceeding 85 percent occupancy had fallen to just above 40 percent. Figure B-14 shows similar results for the statistical significance of the paired t-tests for the year-over-year changes of weekday occupancies using both metrics.



Source: Elliot Martin, 2014.

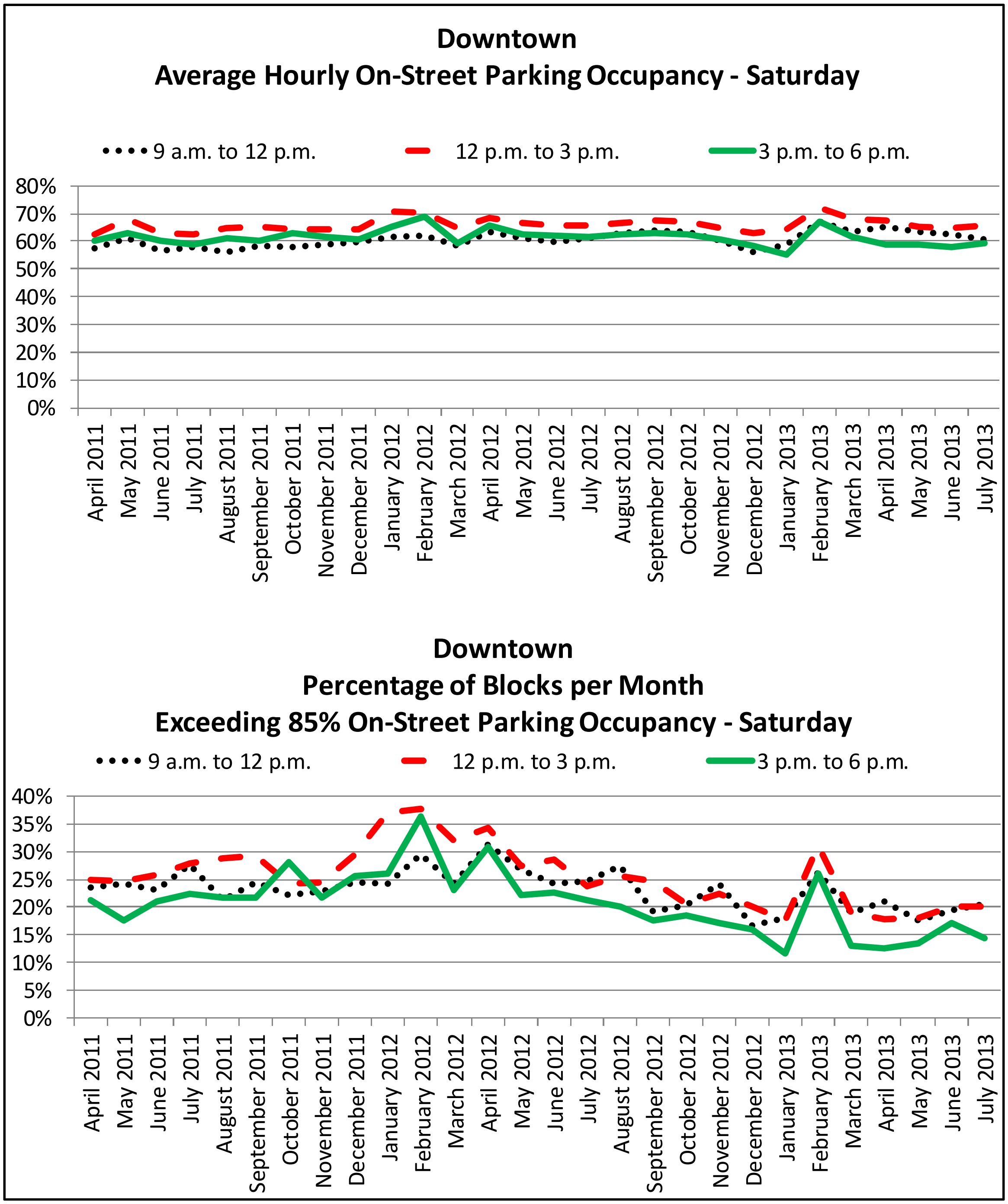
Figure B-13. Weekday Parking Activity in Downtown during the Evaluation Period



Source: Elliot Martin, 2014.

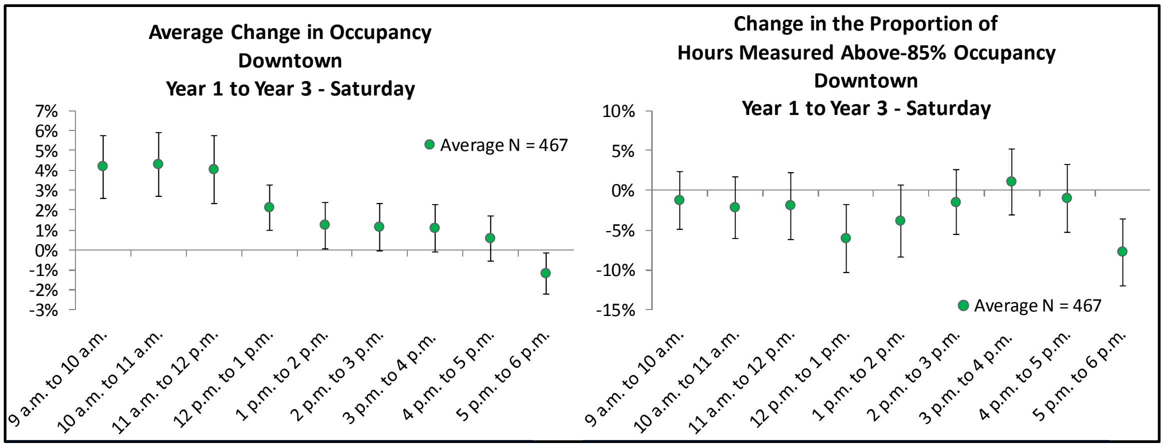
Figure B-14. Paired T-Test of Downtown Weekday Parking Occupancy

Figure B-15 shows the trends in the average occupancy on Saturdays as well as the proportion of blocks that exceeded 85 percent during an hour. During Saturdays in the Downtown pilot area, average on-street occupancy increased slightly. But as with weekdays, the proportion of blocks exceeding 85 percent occupancy declined at the end of two years. Figure B-16 shows the results of the paired t-test on occupancy, illustrating an increase in average occupancy and decrease in the proportion. The changes for Saturday were not as large as those found during the weekday, and, thus, coupled with the smaller sample sizes of these measurements, a fair number of the paired differences were not statistically significant even though they were negative. Overall, however, the data in both figures show a general decline in the proportion of blocks exceeding 85 percent parking occupancy, even as overall average parking occupancy rose slightly in the Downtown on Saturdays.



Source: Elliot Martin, 2014.

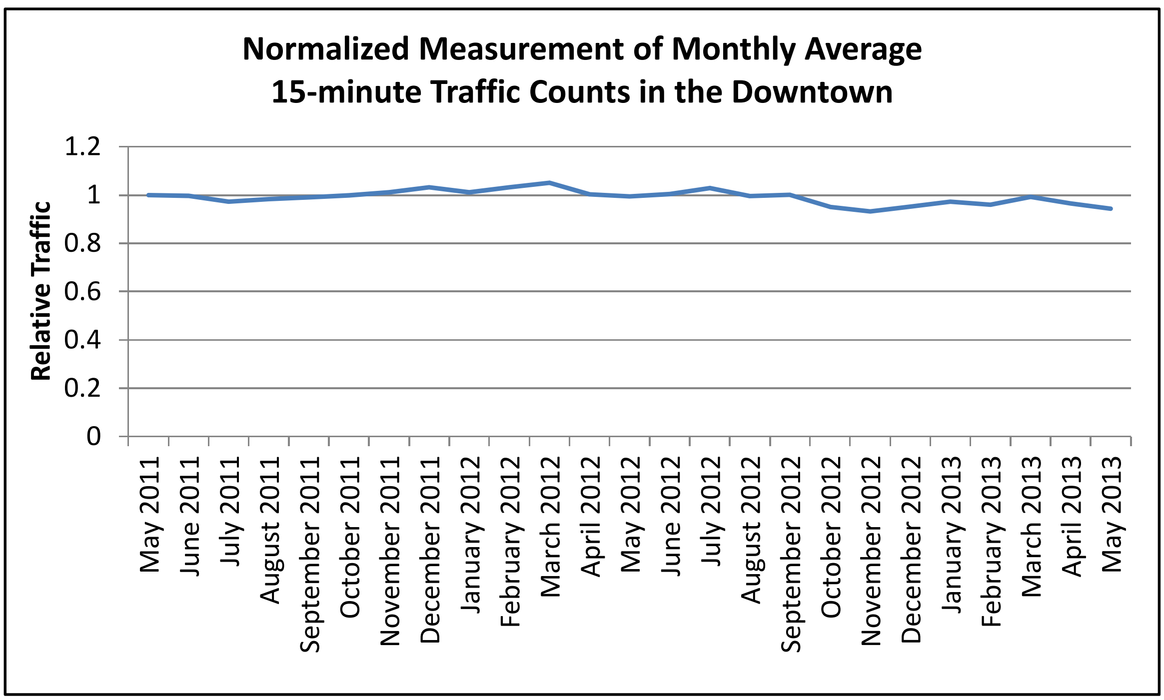
Figure B-15. Saturday Parking Activity in Downtown during the Evaluation Period



Source: Elliot Martin, 2014.

Figure B-16. Paired T-Test of Downtown Saturday Parking Occupancy

Figure B-17 shows the normalized plot of traffic counts within the Downtown area during the evaluation. A slight decline was measured by eight sensors within the area toward the end of the evaluation period. However, this decline was very small, and, thus, Figure B-17 shows that, based on available data, traffic volumes stayed flat during the evaluation period within the Downtown pilot area.



Source: Elliot Martin, 2014.

Figure B-17. Normalized Measurement of Traffic in Downtown Pilot

The regression analysis was conducted with the activity data for the Downtown area. The results indicated that price was most influential on parking activity during the morning hours. Between 9 a.m. and noon, the price coefficients ranged from -0.089 to -0.051, suggesting that every dollar increase in cost lowered average occupancy by between 9 percent (9 a.m.) to 5 percent (11 a.m.). During the lunch and early afternoon hours, the price coefficient became statistically insignificant. During the later hours, the price coefficient was of the expected sign and significant again, albeit reducing occupancy less, by 2 percent to 3 percent for every dollar increase in cost. The results are shown in Table B-20. It should be noted that the adjusted R^2 values are lower than those presented with the Civic Center. This means that, although the coefficients remain significant outside the lunch hour, the overall model is less effective in explaining the variance in parking occupancy over time. This may be due to greater volatility within-month and across-block parking occupancy that occurs within the Downtown region.

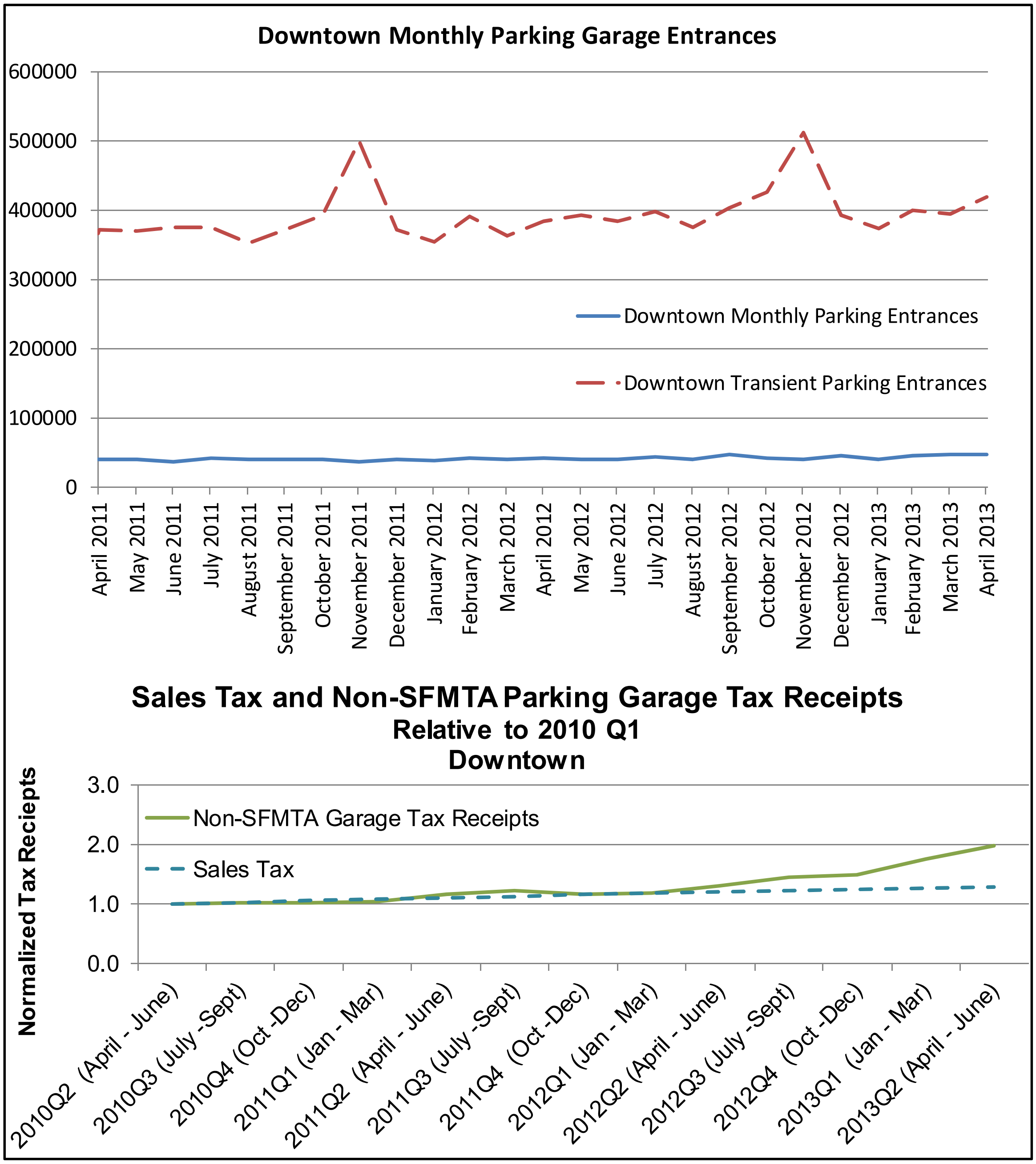
Table B-20. Regression Analysis of Parking Occupancy during GMP Hours in Downtown Pilot

Parking Rate Model	Parking Rate Coefficient	p-value*	Adjusted R-squared	Total Number of Variables	# Observations
9 a.m. to 10 a.m.	-0.089	**0.000**	0.39	65	994
10 a.m. to 11 a.m.	-0.081	**0.000**	0.32	65	992
11 a.m. to 12 p.m.	-0.051	**0.000**	0.38	65	984
12 p.m. to 1 p.m.	-0.012	0.259	0.35	65	984
1 p.m. to 2 p.m.	-0.011	0.266	0.36	65	984
2 p.m. to 3 p.m.	-0.015	0.130	0.46	65	984
3 p.m. to 4 p.m.	-0.024	**0.018**	0.34	62	901
4 p.m. to 5 p.m.	-0.030	**0.002**	0.40	62	900
5 p.m. to 6 p.m.	-0.020	**0.021**	0.51	62	901

*Values in bold are statistically significant at 95 percent confidence level.

Source: Elliot Martin, 2014.

Figure B-18 shows the trend in SFMTA garage entrances as well as a plot of normalized tax receipts of non-SFMTA garages and sales tax within the Downtown pilot area. SFMTA garage entrances grew gradually except for rapid seasonal peaks in the fall. However, owing to the large size of the Downtown garages the gradual change meant that from April 2011 to April 2013, transient parking rose by 28,417 entrances to SFMTA parking garages. Also evident in Figure B-18 is the rather steady rise in tax receipts from non-SFMTA garages and parking lots in the Downtown area. This rise grew commensurately with sales tax receipts, but then accelerated to grow faster during the second year of the evaluation.



Source: Elliot Martin, 2014.

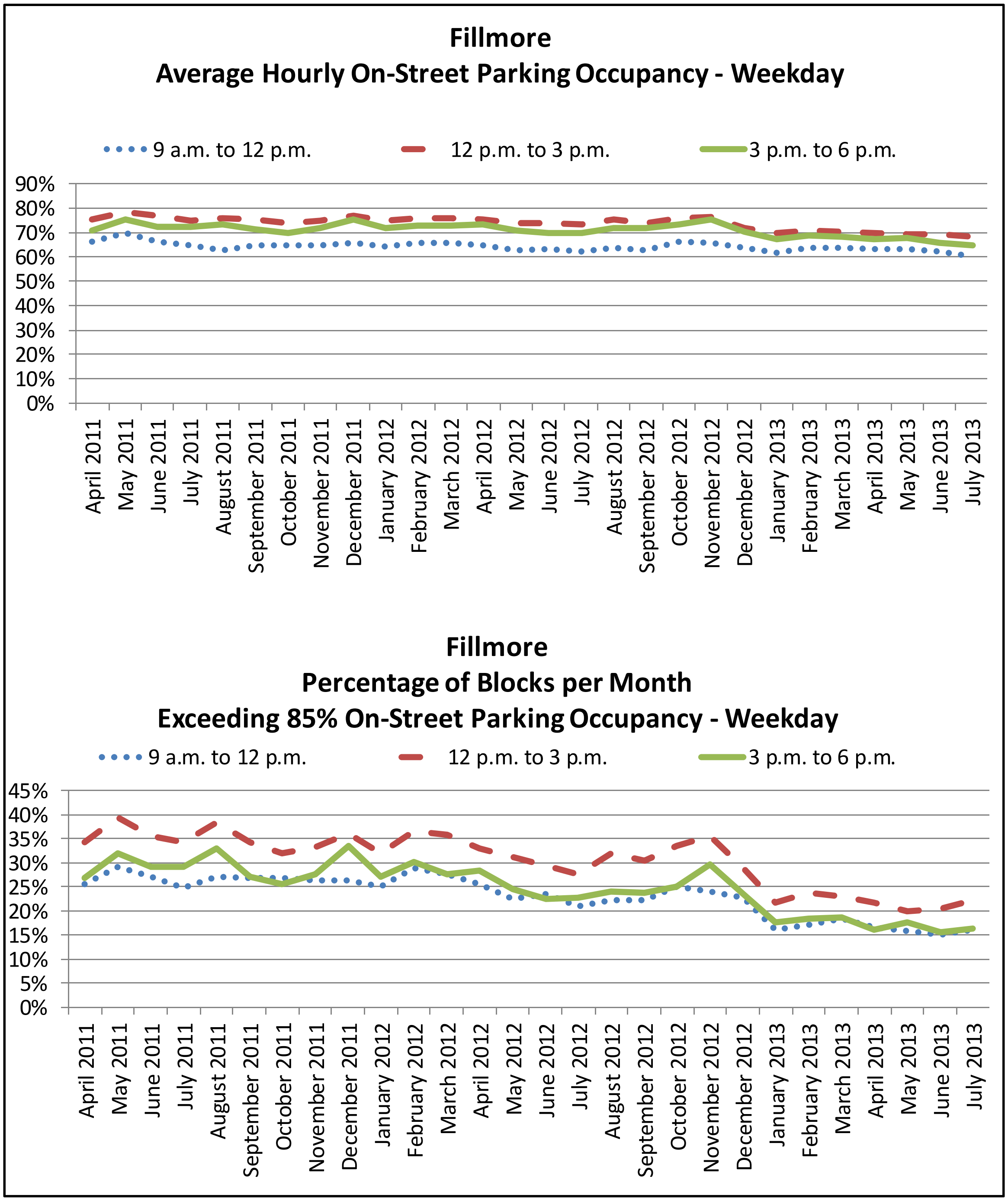
Figure B-18. Downtown Parking Garage and Lot Activity

Overall, SF*park* pricing actions in Downtown appeared to achieve the goal of increasing parking availability. On-street parking occupancy declined slightly during the weekdays and increased slightly during the weekends. During all days, the proportion of hours in which blocks exceeded 85 percent occupancy fell and in most cases the paired year-over-year decline was statistically significant. Regression analysis showed that consumers were most responsive to price in the morning and least responsive during lunch hour. Finally, an evaluation of parking activity in garages through entrance counts and tax receipts suggested that the area simultaneously experienced an increase in the use of off-street parking capacity.

B.4.3.3 Fillmore Pilot Results

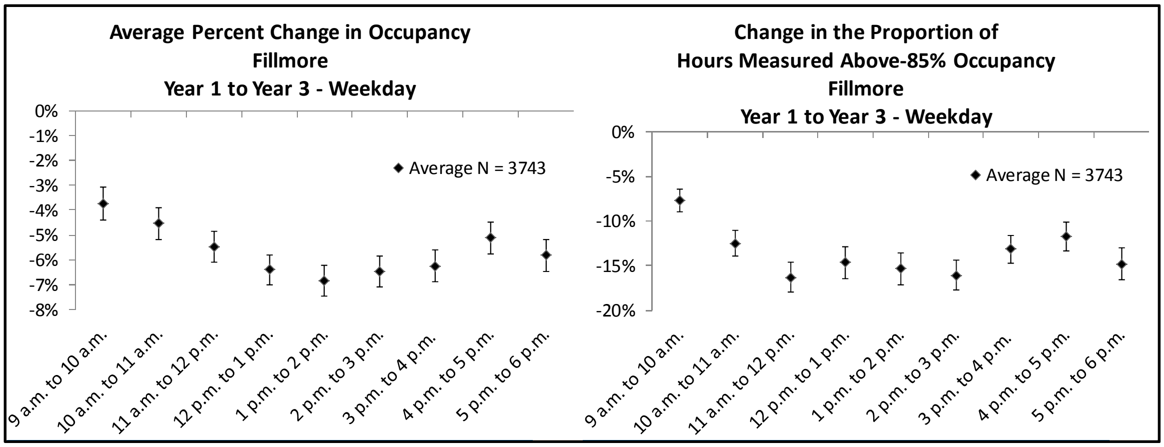
Changes in Parking Occupancy within the Fillmore Area

The Fillmore pilot area exhibited reduced parking occupancy and increasing availability through pricing actions. Figure B-19 shows the trends in average on-street parking occupancy and in the percentage of blocks exceeding 85 percent occupancy on weekdays during the evaluation period. By both measures, parking occupancy declined, but the decline in the percentage of blocks exceeding 85 percent occupancy was more pronounced. Figure B-20 shows the results of the paired t-test on the change in parking occupancy and the change in the proportion of block hours above 85 percent occupancy and corroborates that changes observed in Figure B-19 are part of a statistically significant downward trend. Figure B-20 also shows that the proportion of blocks with occupancies higher than 85 percent experienced a reduction in magnitude that was larger than the reduction in overall occupancy. These two figures point to increasing parking availability in the Fillmore pilot area during the evaluation period.



Source: Elliot Martin, 2014.

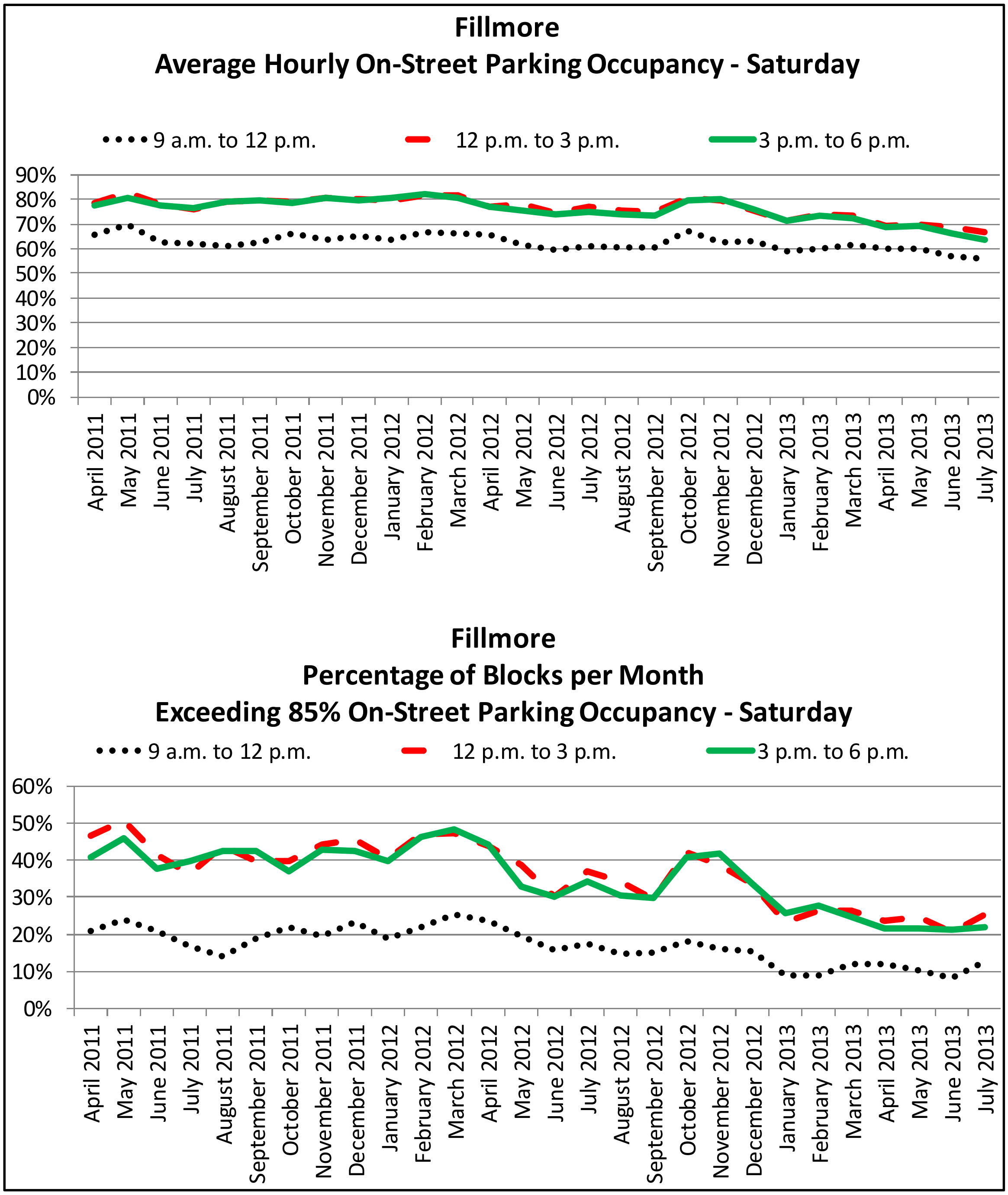
Figure B-19. Weekday Parking Activity in Fillmore during the Evaluation Period



Source: Elliot Martin, 2014.

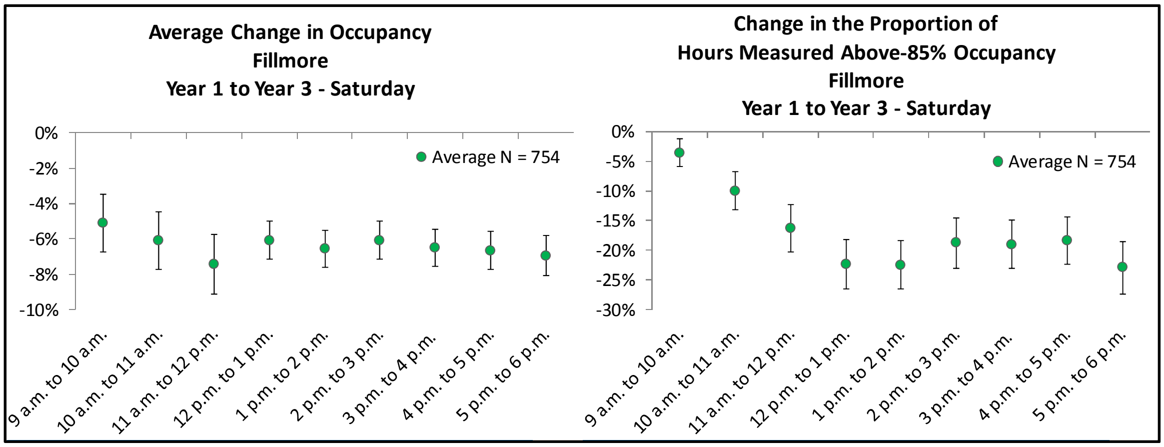
Figure B-20. Paired T-Test of Fillmore Weekday Parking Occupancy

Weekend parking in the Fillmore pilot area exhibited a trend similar to that found during weekdays. Figure B-21 shows levels of average on-street occupancy held steady during much of the first year, and then declined. The percentage of blocks exceeding 85 percent occupancy exhibited a similarly steady decline starting in early 2012. Figure B-22 shows the results of the paired t-test on occupancies for Saturdays in the Fillmore pilot. The average reductions in all occupancy measures were statistically significant, and in patterns and in magnitudes are consistent with the changes in weekday parking activity in the Fillmore pilot.



Source: Elliot Martin, 2014.

Figure B-21. Saturday Parking Activity in the Fillmore Pilot Area during the Evaluation Period

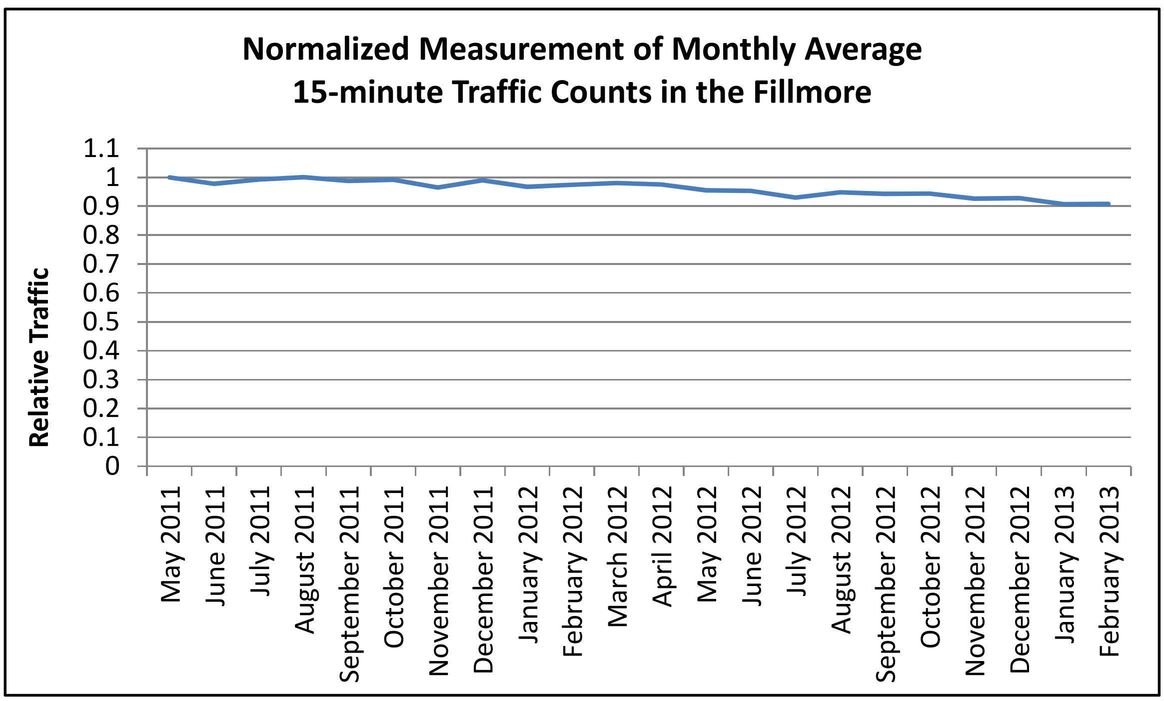


Source: Elliot Martin, 2014.

Figure B-22. Paired T-Test of Fillmore Saturday Parking Occupancy

Fillmore Pilot Traffic Analysis

As shown in Figure B-23, the thirteen sensors in the Fillmore pilot area registered a steady reduction in traffic activity that was on the order of 10 percent. This reduction was consistent in all but one sensor in the pilot area. The reduced traffic noted in the Fillmore pilot may be an indication of reduced parking demand in the area and could, thus, be a contributing factor in the observed reduction in average on-street parking occupancy in the Fillmore pilot area.



Source: Elliot Martin, 2014.

Figure B-23. Normalized Measurement of Traffic in the Fillmore Pilot

Fillmore Pilot Regression Analysis

While traffic activity appeared to fall in the Fillmore pilot area, the regression analysis of average parking occupancy on blocks within the area found that travelers were responsive to parking price. The summary of regression analysis results is shown in Table B-21. The parking rate was a statistically significant variable for all hours in the nine models estimated. The models also exhibited relatively high adjusted R-squared values, suggesting that the estimated indicator and rate coefficients explained from 69 percent to 85 percent of the variability in the dependent variable (average monthly occupancy on a given block). The models estimated in the Fillmore pilot also suggested that price was more impactful on parking during the latter hours of the day. The models suggest that a one dollar increase in the parking rate lowered average monthly occupancy on a Fillmore block by 3 percent to 4 percent in the morning hours, and by up 5.5 percent in the evening hours. Overall, the models estimated for the Fillmore pilot strongly suggest that travelers were responsive to the parking rate in making choices with respect to parking.

Table B-21. Regression Analysis of Occupancy during GMP Hours in the Fillmore Pilot

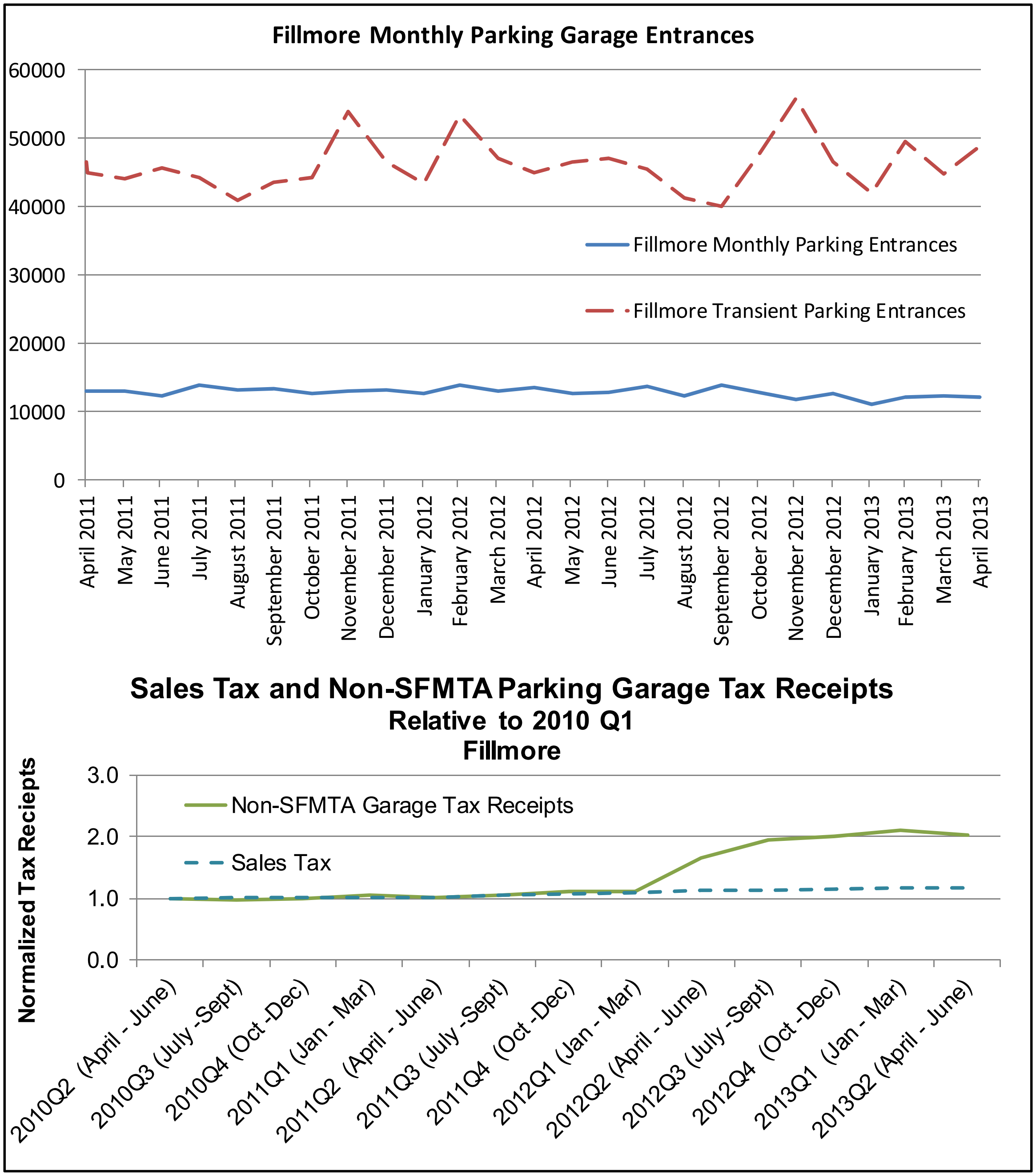
Parking Rate Model	Parking Rate Coefficient	p-value	Adjusted R-squared	Total Number of Variables	# Observations
9 a.m. to 10 a.m.	-0.035	**0.000**	0.85	72	1229
10 a.m. to 11 a.m.	-0.041	**0.000**	0.80	72	1230
11 a.m. to 12 p.m.	-0.042	**0.000**	0.77	72	1230
12 p.m. to 1 p.m.	-0.031	**0.000**	0.70	72	1230
1 p.m. to 2 p.m.	-0.032	**0.000**	0.72	72	1230
2 p.m. to 3 p.m.	-0.036	**0.000**	0.74	72	1230
3 p.m. to 4 p.m.	-0.050	**0.000**	0.75	72	1230
4 p.m. to 5 p.m.	-0.053	**0.000**	0.73	72	1230
5 p.m. to 6 p.m.	-0.055	**0.000**	0.69	72	1230

*Values in bold are statistically significant at 95 percent confidence level.

Source: Elliot Martin, 2014.

Fillmore Parking Garage and Parking Lot Activity

Trends in SFMTA parking garage and lot entrances did not exhibit a major shift towards off-street parking in the Fillmore pilot area, as shown in Figure B-24. The SFMTA Fillmore garages experienced an increase in entrance activity during the year-end holiday, as well as an additional surge at the beginning of the year peaking in February. But overall, little to no upward trend is revealed in the use of SFMTA garages in the Fillmore pilot. The normalized plot of tax receipts from non-SFMTA garages in the Fillmore pilot in Figure B-18 does show a notable increase in use of private lots beginning the first quarter of 2012. This increase was rather sharp and sudden, resulting in a doubling of tax revenue in the area. At this point, it departs from the trend in sales tax. It is possible, that this discrete shift in doubling of tax revenue over two quarters was strictly attributable to the collective pricing actions taken by SF*park*. But this increase may have also been the result of another discrete event, such as the opening of new lot or garage or some other event that altered tax revenue collection in the Fillmore district.



Source: Elliot Martin, 2014.

Figure B-24. Fillmore Pilot Parking Garage and Lot Activity

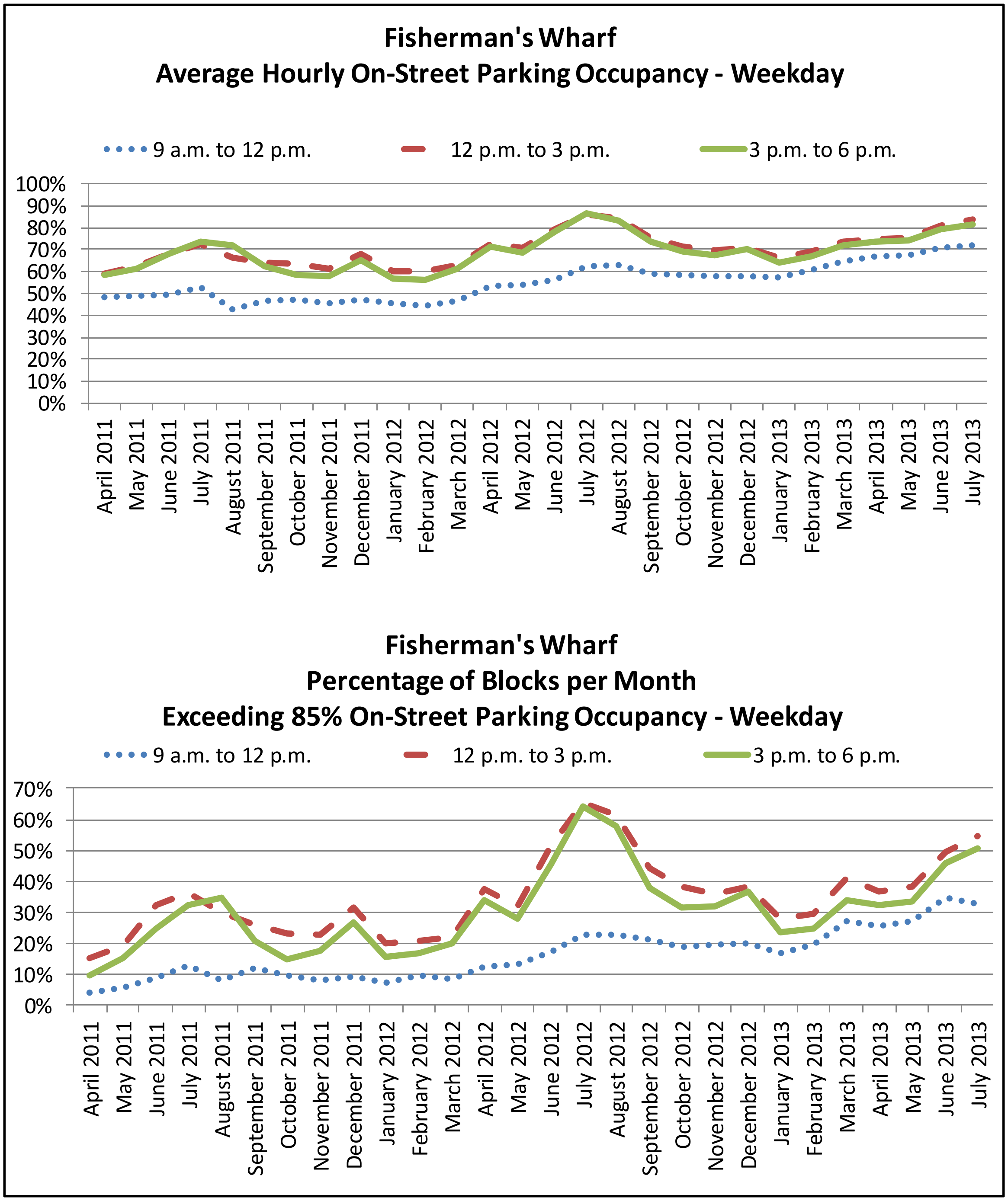
Fillmore Pilot Area Summary

Overall, the Fillmore pilot area experienced a gradual decline in on-street parking occupancy and commensurately the percentage of blocks exceeding 85 percent occupancy. The regression analysis also demonstrated relatively well-fitted models and statistically significant parking rate coefficients that became more influential with later hours in the day. These indicators suggest that SF*park* was influencing parking behavior, and parking was becoming more available. At the same time, some of the decline in parking occupancy may have been the result of declining activity in the area. This contributing factor cannot be ruled out as part of the reason average on-street occupancy fell in the Fillmore pilot area. But, it is clear from the strong indicators in the regression analysis that SF*park* was dissuading people from parking on blocks with higher prices, thus increasing availability on those blocks.

B.4.3.4 Fisherman's Wharf Pilot Results

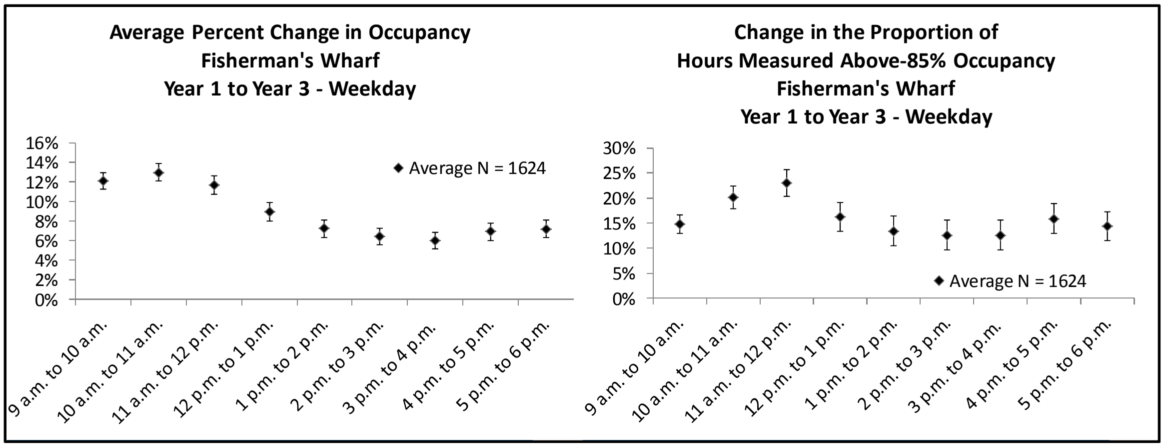
Changes in Parking Occupancy within Fisherman's Wharf

Fisherman's Wharf is a well-known tourist attraction on the north-end of the city, abutting the San Francisco Bay, containing restaurants, gift shops, and a number of theatres, museums, and other tourist attractions. Figure B-25 (top) and (bottom) shows the trend in average on-street parking occupancy and in the percentage of blocks with hourly occupancy exceeding 85 percent over the evaluation period. Both these measures of on-street occupancy increased steadily throughout the evaluation period. Partly because Fisherman's Wharf is a tourist zone, weekday parking occupancy levels exhibited more cyclical activity than other zones. The rise in parking occupancy within the Fisherman's Wharf pilot area may have been partly the result of economic growth during the broader economic recovery that occurred during the evaluation period. Also, average on-street parking occupancy was not at capacity, and this pilot area was not congested. Notably, only 15 percent of blocks during the 12 p.m. to 3 p.m. pricing period exceeded 85 percent at the outset of the evaluation. Thus, the Fisherman's Wharf pilot already had available uncongested on-street parking. Figure B-26, illustrating the paired t-test on weekday occupancy values, supports the trend shown in Figure B-25, with widespread statistically significant increases in the parking occupancy measures.



Source: Elliot Martin, 2014.

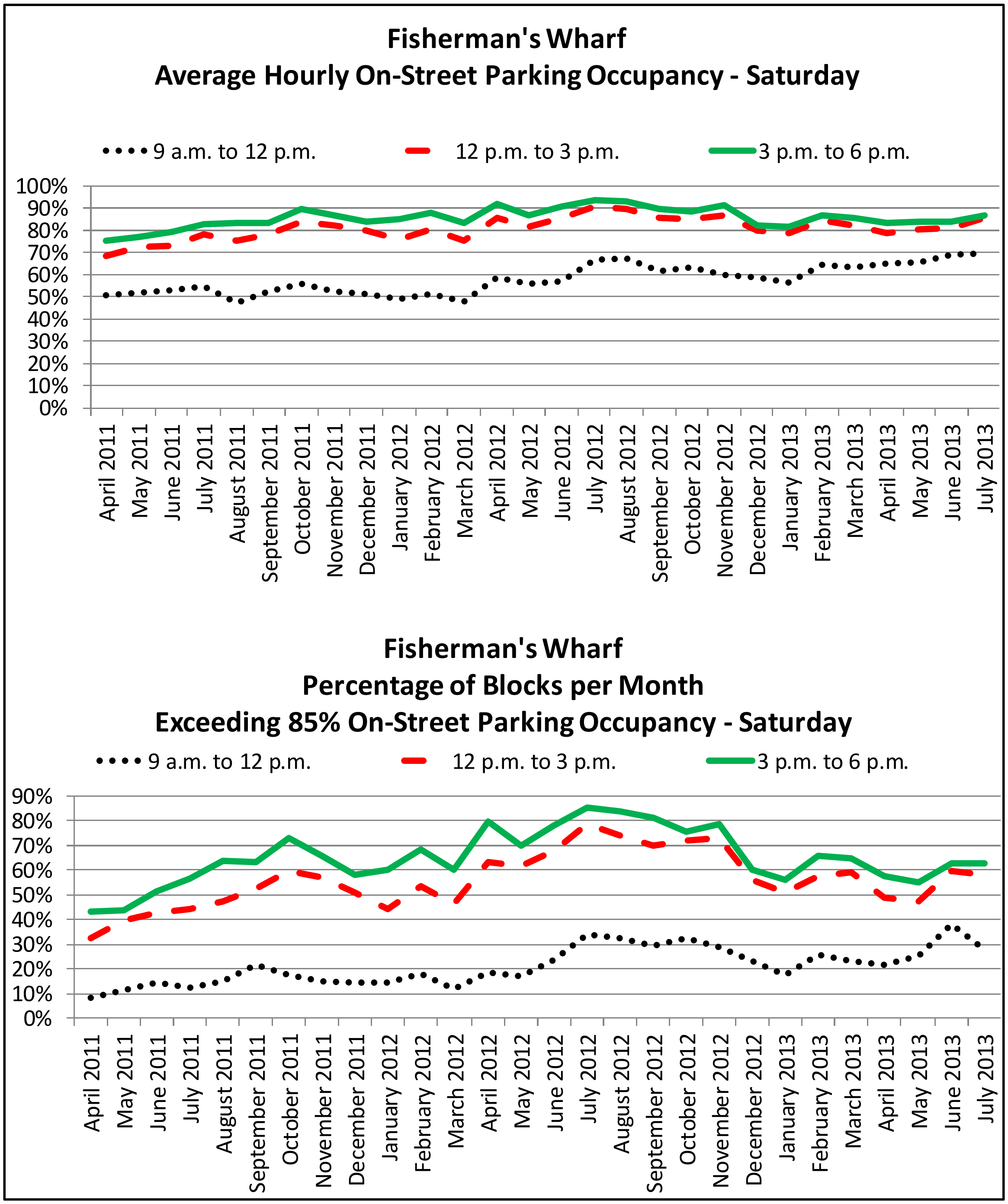
Figure B-25. Weekday Parking Activity in Fisherman's Wharf Pilot during the Evaluation Period



Source: Elliot Martin, 2014.

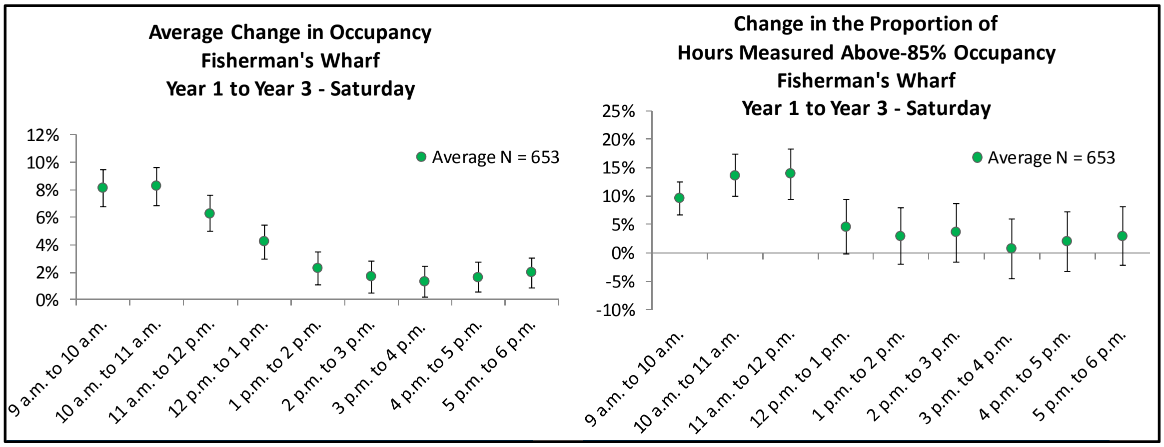
Figure B-26. Paired T-Test of Fisherman's Wharf Pilot Weekday Parking Occupancy

Parking occupancy measures on Saturday also exhibited an upward trend of growth, as shown in Figure B-27. Parking occupancy in the Fisherman’s Wharf pilot was generally higher on Saturdays than on the average weekday. Figure B-28 shows the year-over-year average change in the parking occupancy measures. In general, all changes are above zero. Only the afternoon values in the Year 1 to Year 3 comparison of Figure B-28 (right) demonstrated statistically insignificant increases.



Source: Elliot Martin, 2014.

Figure B-27. Saturday Parking Activity in Fisherman's Wharf Pilot during the Evaluation Period

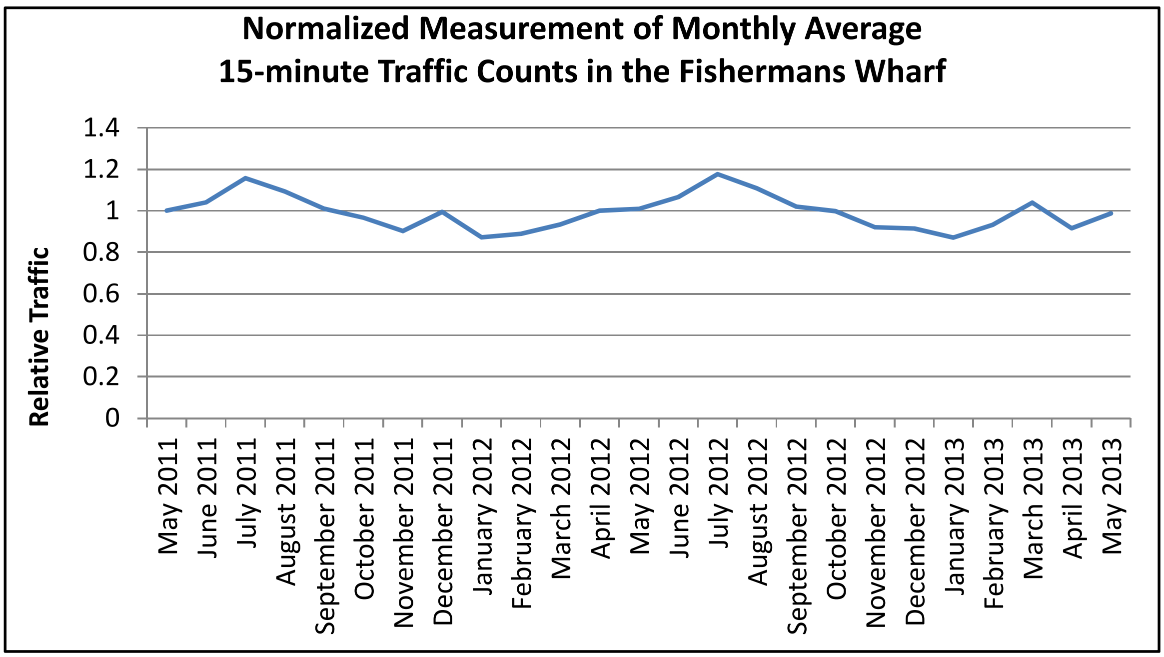


Source: Elliot Martin, 2014.

Figure B-28. Paired T-Test of Fisherman's Wharf Saturday Parking Occupancy

Fisherman's Wharf Pilot Traffic Analysis

As with parking occupancy, traffic in the Fisherman's Wharf pilot exhibited very cyclical behavior with peaks occurring in the summer time. Figure B-29 shows the trend in traffic data collected from six sensors that reported throughout the evaluation period. The figure shows that traffic in the Fisherman's Wharf pilot fluctuated upwards of 20 percent above its baseline value and 10 percent below it. Notably, however, Figure B-29 does not reveal an increase in traffic by the sensors deployed, even though it does show peaks in traffic activity that coincided with the peaks observed in the occupancy data. That the sensors showed the peaks in traffic coinciding with peaks in parking occupancy suggests traffic sensors were positioned to capture key movements in traffic within the region. However, unlike the parking occupancy sensors, the traffic sensors were not comprehensively positioned on all streets within any region, but rather a subset of streets within the region. Thus, there is a possibility that the streets containing the traffic sensors were not among those that would have detected growing traffic activity that is commensurate with the growth trend in on-street parking. Another possibility is that, with its relatively low initial occupancy, on-street parking in the Fisherman's Wharf pilot was simply used more due to changes in pricing. Further discussion of factors that would contribute to an increase in on-street parking from SF*park* is provided in Section B.4.6.



Source: Elliot Martin, 2014.

Figure B-29. Normalized Measurement of Traffic in the Fisherman's Wharf Pilot

Fisherman's Wharf Pilot Regression Analysis

Despite the noted increase in parking occupancy shown in Figure B-25 through Figure B-28, the regression analysis found that the parking rate coefficients were statistically significant during all hours at levels of at least 95 percent or greater. The parking rate coefficients suggest that in the morning, a one dollar increase in price lowered average on-street parking occupancy by about 2 percent. During early afternoon hours, the impact of price on block-occupancies increased, with each dollar in parking rate lowering occupancy by 4 percent to 5 percent. Toward the latter part of the afternoon, the influence of price on parking occupancy appeared to decline, lowering occupancy by 2 percent to 3 percent per dollar of parking rate increase. The regression analysis showed that the pricing differentiation imposed by SF*park* on blocks within the Fisherman's Wharf pilot appears to have influenced block occupancy levels, even in an environment in which overall on-street parking occupancy was found to be consistently increasing. The adjusted R^2 values show a better fit to the model, in that included variables explain between 55 percent and 66 percent of the variance in average monthly parking on a block-by-block basis.

Table B-22. Regression Analysis of Parking Occupancy during GMP Hours in Fisherman's Wharf Pilot

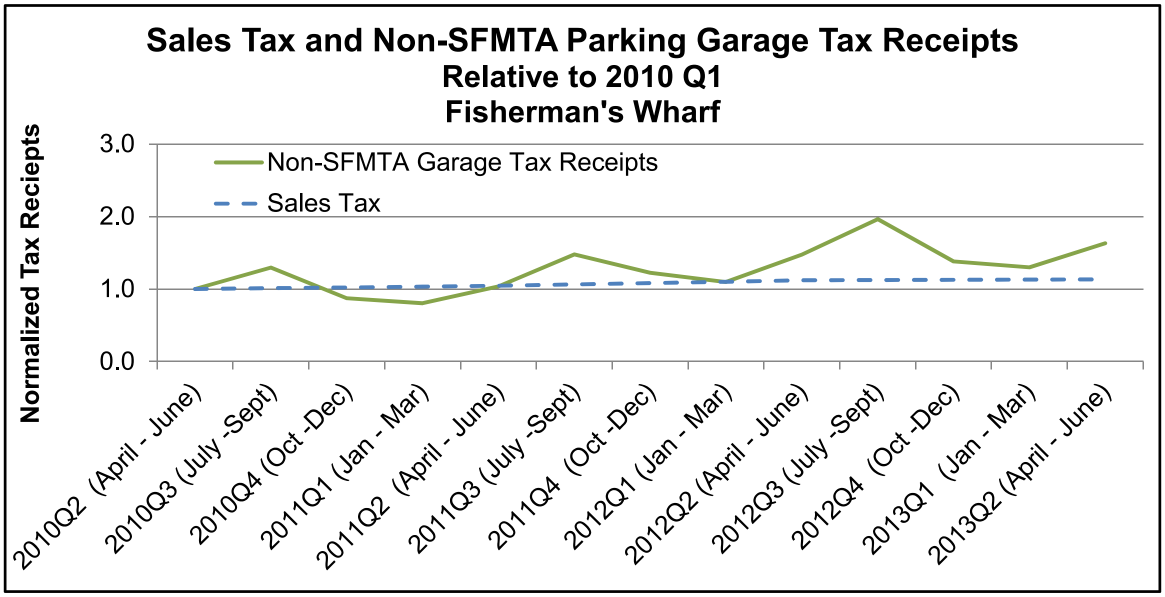
Parking Rate Model	Parking Rate Coefficient	p-value*	Adjusted R-squared	Total Number of Variables	# Observations
9 a.m. to 10 a.m.	-0.022	**0.000**	0.59	60	845
10 a.m. to 11 a.m.	-0.022	**0.023**	0.62	60	845
11 a.m. to 12 p.m.	-0.025	**0.008**	0.65	60	845
12 p.m. to 1 p.m.	-0.045	**0.000**	0.66	60	845
1 p.m. to 2 p.m.	-0.049	**0.000**	0.64	60	845
2 p.m. to 3 p.m.	-0.044	**0.000**	0.64	60	845
3 p.m. to 4 p.m.	-0.024	**0.003**	0.66	60	845
4 p.m. to 5 p.m.	-0.029	**0.001**	0.57	59	817
5 p.m. to 6 p.m.	-0.030	**0.001**	0.55	59	817

*Values in bold are statistically significant at 95 percent confidence level.

Source: Elliot Martin, 2014.

Fisherman's Wharf Pilot Parking Garage and Parking Lot Activity

There are no SFMTA controlled garages in the Fisherman's Wharf. Thus, the only indication of changes in off-street parking activity in the area was from the taxes received from private garages and parking lots. Figure B-30 shows the normalized trend in taxes received by the City of San Francisco from private parking lots.



Source: Elliot Martin, 2014.

Figure B-30. Fisherman's Wharf Parking Pilot Garage and Lot Activity

Parking receipts in the Fisherman's Wharf pilot from the 2Q2010 show a similar growth and degree of cyclical activity as found in the parking occupancy data. The data within Figure B-30 also supports the perspective that Fisherman's Wharf experienced a period of economic growth starting in early 2011. While 2010 shows a cyclical increase in tax receipts, the upward trend in the tax receipt series does not experience the "rising bottoms" until after 1Q2011. By tracking these bottoms, it can be seen that tax receipts nearly doubled during the evaluation period. This could be influenced by lots raising prices, but the near doubling of tax receipts by lots in the Fisherman's Wharf pilot area over this two year period suggests that Fisherman's Wharf was experiencing a surge in economic activity as related to parking. The comparative trend in sales tax receipts is also upward, but more modest than that of the parking garage tax receipts. Overall, the data suggests some increasing shift towards off-street parking.

Fisherman's Wharf District Pilot Summary

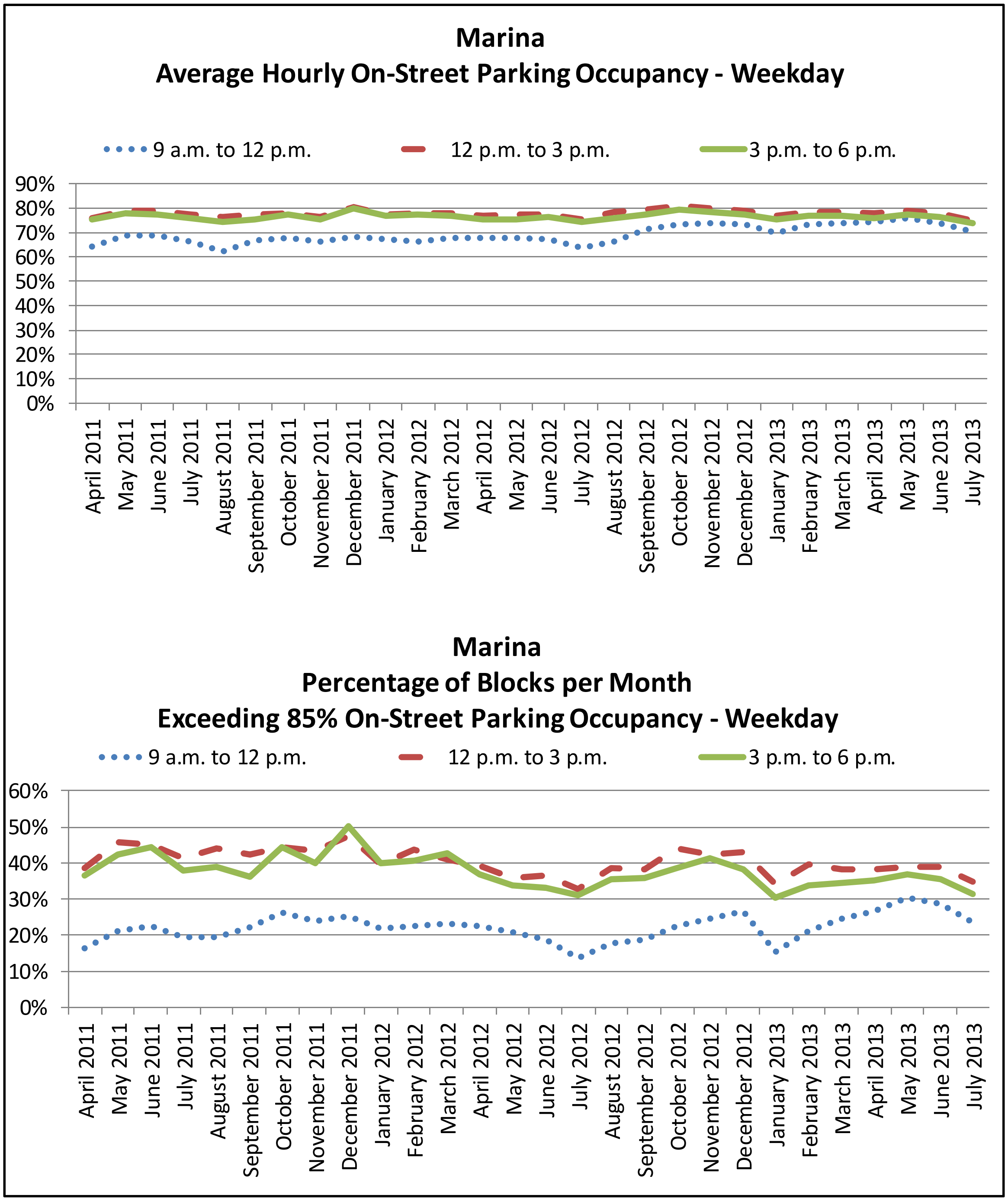
As a tourist and entertainment zone, a large share of temporary visitors populates Fisherman's Wharf. As such, the data support the notion that those parking in the Fisherman's Wharf are less likely to be responsive to price than in other areas, which have more of an employment or residential focus. In this sense, Fisherman's Wharf is among the more unique pilot areas, with consumers responsive to the differentiated parking rates set by SF*park,* but to an apparently lesser extent than in other areas. Another feature of the Fisherman's Wharf is that average prices fell in the area, as shown in Figure B-5. Falling prices coupled with low initial occupancy and an improving economy would help explain the rising occupancy levels in response to SF*park* pricing actions.

B.4.3.5 Marina Pilot Results

Changes in Parking Occupancy within the Marina

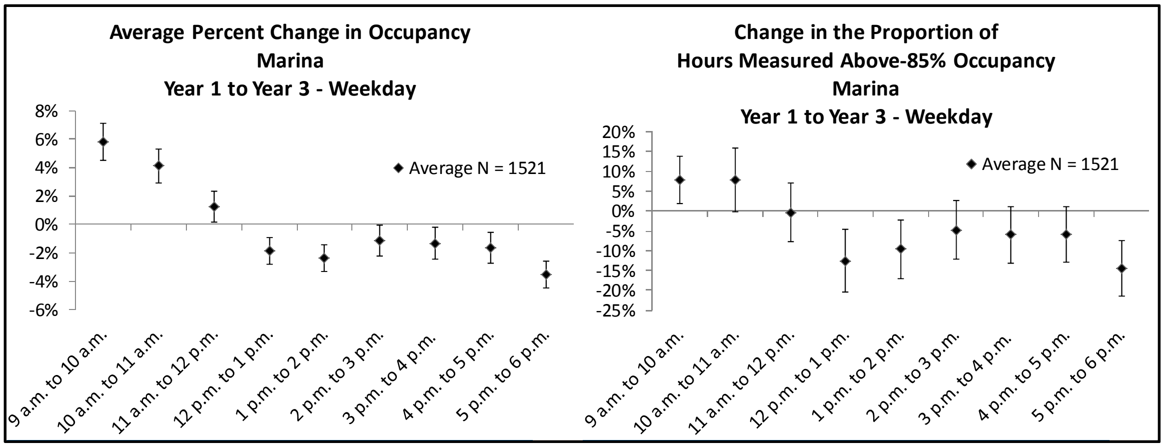
As shown in Figure B-31 weekday on-street parking was relatively congested at the beginning of the evaluation in the Marina area. Average on-street hourly occupancy maintained levels close to 80 percent during the afternoon throughout much of the evaluation. During the morning hours, average on-street occupancy started lower in the mid-60 percent range, and steadily increased to match afternoon occupancy levels by the end of the evaluation. The percentage of blocks exceeding 85 percent occupancy also began the period with higher values for the afternoon hours. A steady decline in blocks exceeding 85 percent occupancy occurred over the evaluation period for the afternoon pricing hours, while increasing during the morning hours.

Figure B-32 shows the statistical evaluation of the change in year-over-year occupancy for both parking metrics. It shows that over two years (Figure B-32 (left)), increases in average occupancy were statistically significant in the morning hours, while decreases in average occupancy were statistically significant during the afternoon hours. While the percentage of blocks exceeding 85 percent average occupancy is somewhat modest, there are statistically significant declines from Year 1 to Year 3 throughout the day, except between 2 and 5 p.m., where the declines were not statistically significant due to the smaller sample size and, thus, wider confidence intervals.



Source: Elliot Martin, 2014.

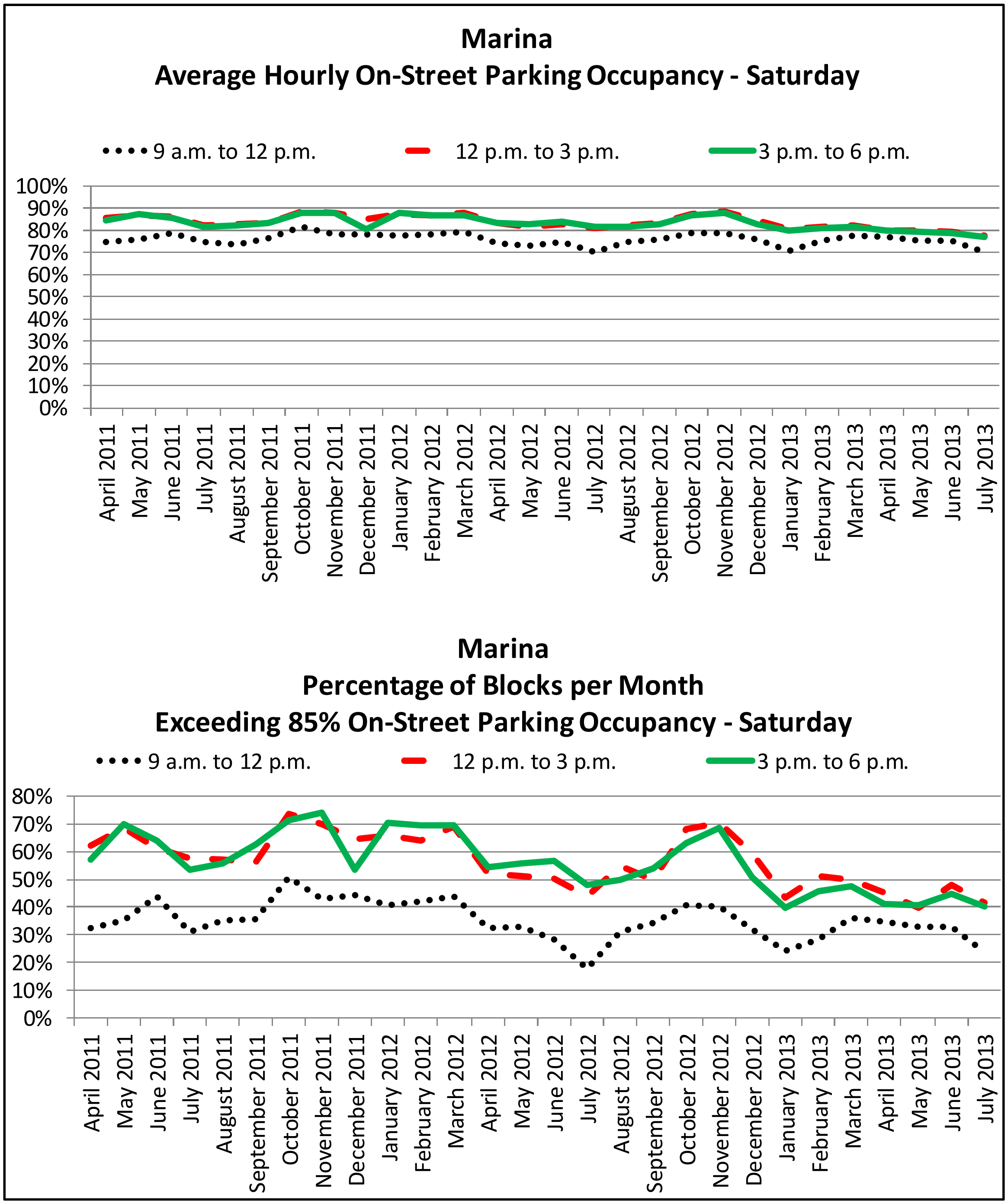
Figure B-31. Weekday Parking Activity in Marina Pilot during the Evaluation Period



Source: Elliot Martin, 2014.

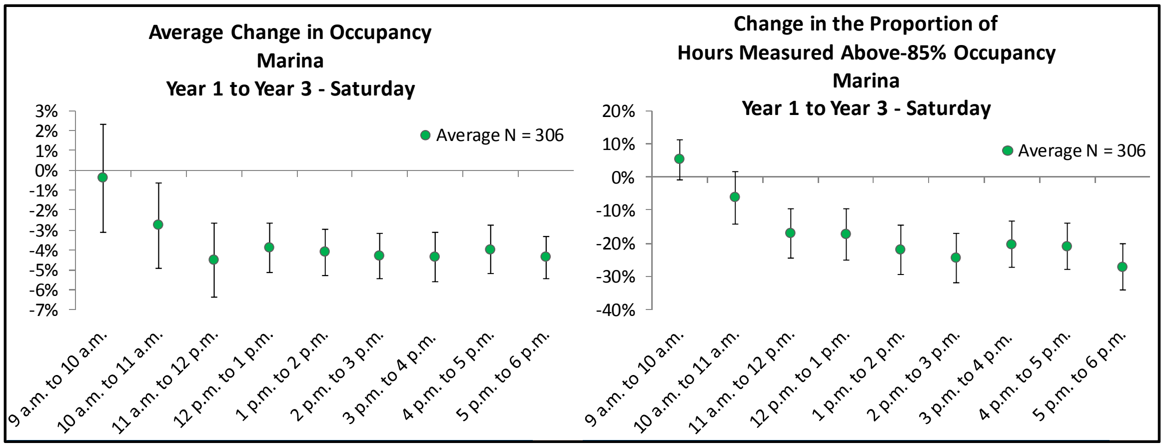
Figure B-32. Paired T-Test of Marina Pilot Weekday Parking Occupancy

Saturday parking within the Marina was also characterized by high occupancy at the outset of the evaluation period. In Figure B-33 (top), average on-street occupancies ranged between 80 percent and 90 percent during the afternoon, but they steadily declined to just fewer than 80 percent towards the end of the evaluation. Similar to weekday parking in the district, occupancies in the morning were lower, but, unlike weekday parking trends, they did not increase during the evaluation period. Figure B-33 (bottom) shows a more precipitous decline in the percentage of blocks per month exceeding 85 percent for on-street parking occupancy. The trend in afternoon hours fluctuated between 60 percent and 70 percent at the outset of the evaluation period, and it steadily fell towards 40 percent by the end. During the morning hours, the metric fluctuated between 20 percent and 50 percent, but it ends the evaluation period at levels similar to which it started. Figure B-34 confirms these movements as statistically significant reductions in all parking metrics. Only 9 a.m. parking levels appear to have remained statistically unchanged after two years.



Source: Elliot Martin, 2014.

Figure B-33. Saturday Parking Activity in the Marina Pilot during the Evaluation Period

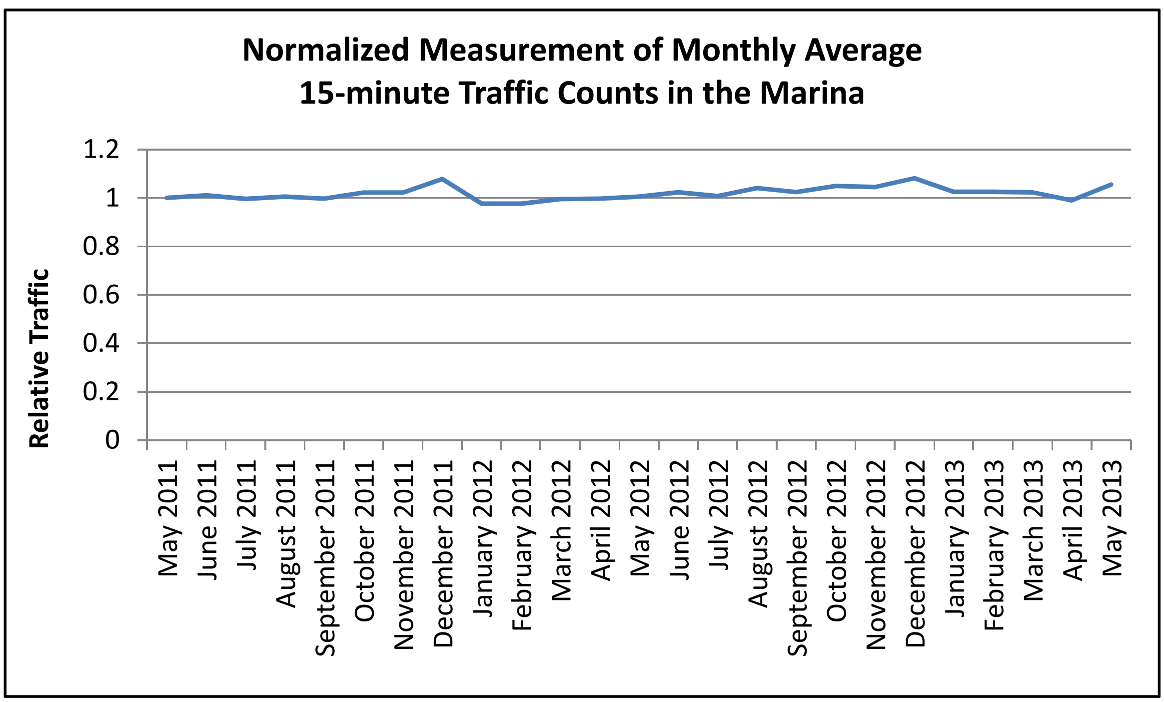


Source: Elliot Martin, 2014.

Figure B-34. Paired T-Test of Marina Pilot Saturday Parking Occupancy

Marina Pilot Traffic Analysis

Four out of eleven sensors provided continuous traffic information within the Marina pilot throughout the evaluation period. The normalized average traffic counts from these sensors did not show much fluctuation or change in traffic activity within the pilot area. They presented no evidence of major disruptions to typical traffic levels during the evaluation period.



Source: Elliot Martin, 2014.

Figure B-35. Normalized Measurement of Traffic in the Marina Pilot

Marina Pilot Regression Analysis

The regression analysis on the average block occupancies within the Marina pilot revealed strong and statistically significant negative relationships between price and the parking rate at all hours of the day. During the morning hours, the model estimates suggest that an increase in price of one dollar lowered occupancy on a given block by 10 to 11 percent. During the afternoon hours, the impact of raising a dollar in the parking rate was less, but it still signified a relatively strong 5 to 7 percent reduction in parking occupancy for every additional dollar in the parking rate. The adjusted R^2 values show that consistently the model explained between 50 and 60 percent of the variance.

Table B-23. Regression Analysis of Parking Occupancy during GMP Hours in the Marina Pilot

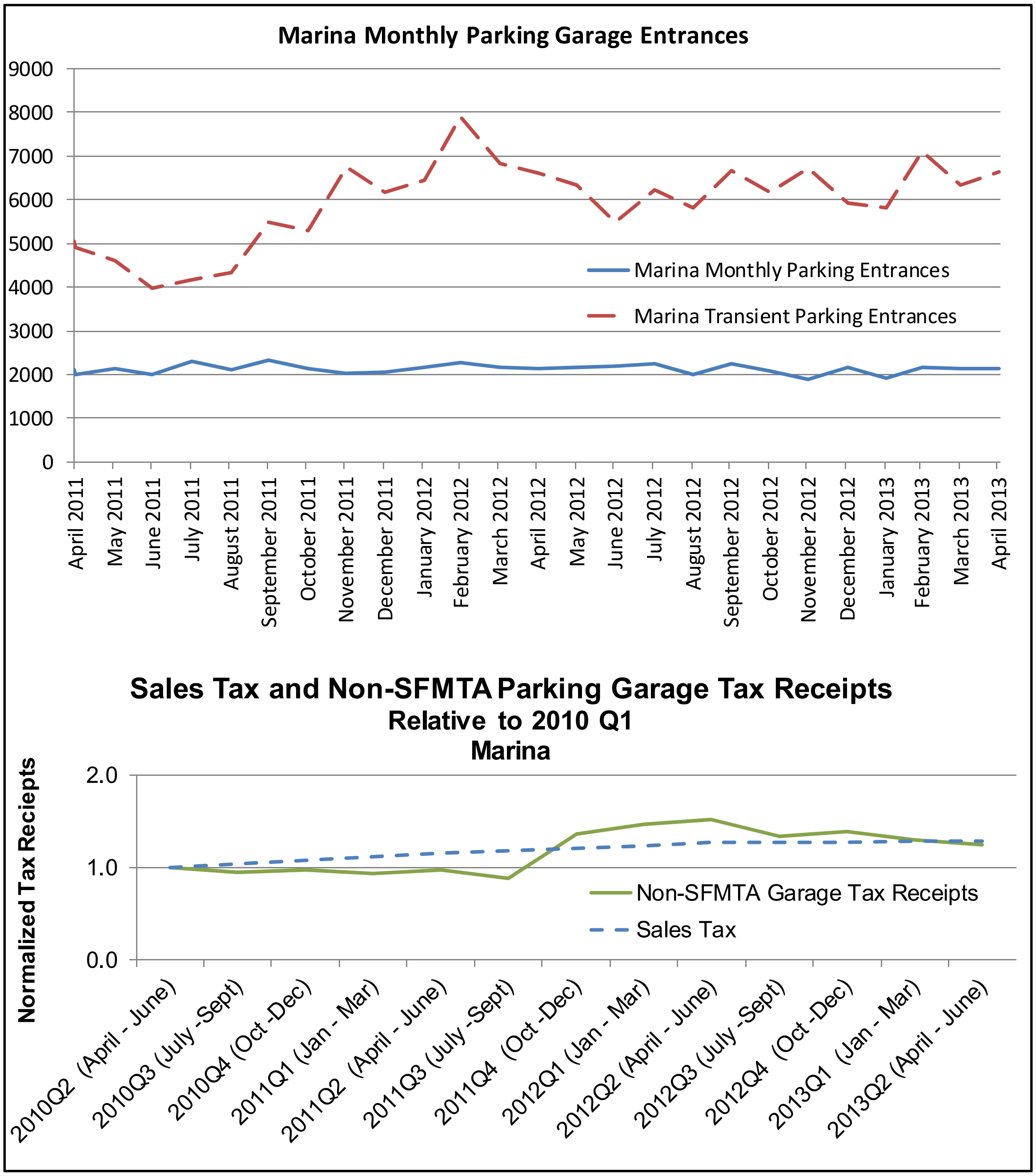
Parking Rate Model	Parking Rate Coefficient	p-value*	Adjusted R-squared	Total Number of Variables	# Observations
9 a.m. to 10 a.m.	-0.114	**0.000**	0.59	47	531
10 a.m. to 11 a.m.	-0.113	**0.000**	0.65	47	531
11 a.m. to 12 p.m.	-0.107	**0.000**	0.66	47	531
12 p.m. to 1 p.m.	-0.063	**0.000**	0.58	47	531
1 p.m. to 2 p.m.	-0.063	**0.000**	0.58	47	531
2 p.m. to 3 p.m.	-0.065	**0.000**	0.61	47	531
3 p.m. to 4 p.m.	-0.068	**0.000**	0.68	47	531
4 p.m. to 5 p.m.	-0.072	**0.000**	0.62	47	531
5 p.m. to 6 p.m.	-0.057	**0.000**	0.60	47	531

*Values in bold are statistically significant at 95 percent confidence level.

Source: Elliot Martin, 2014.

Marina Pilot Parking Garage and Parking Lot Activity

Analysis of the trend in entrances to the SFMTA controlled garages and lots within the Marina showed a steady increase in use of off-street parking in Figure B-36. Similarly, usage of non-SFMTA parking lots and garages as measured by normalized tax receipts also exhibited an increase. Although the tax receipts and the activity data from the SFMTA garages do not vertically align on the graph, the data from both suggest an increase in off-street parking activity was happening at about the same time. Sales tax revenue grew steadily during this time as well. An increase in transient parking activity at SFMTA garages began in earnest starting in August 2011 and continued through February 2012, rising about 80 percent. This coincided with an initial 40 percent surge in tax receipts reported in 4Q2011, which ultimately rose to a 60 percent increase, before tapering off. The co-timing of these trends suggests that the utilization of off-street parking increased within the Marina, and notably this increase started to occur at about the time SF*park* had completed a few of its initial pricing actions.

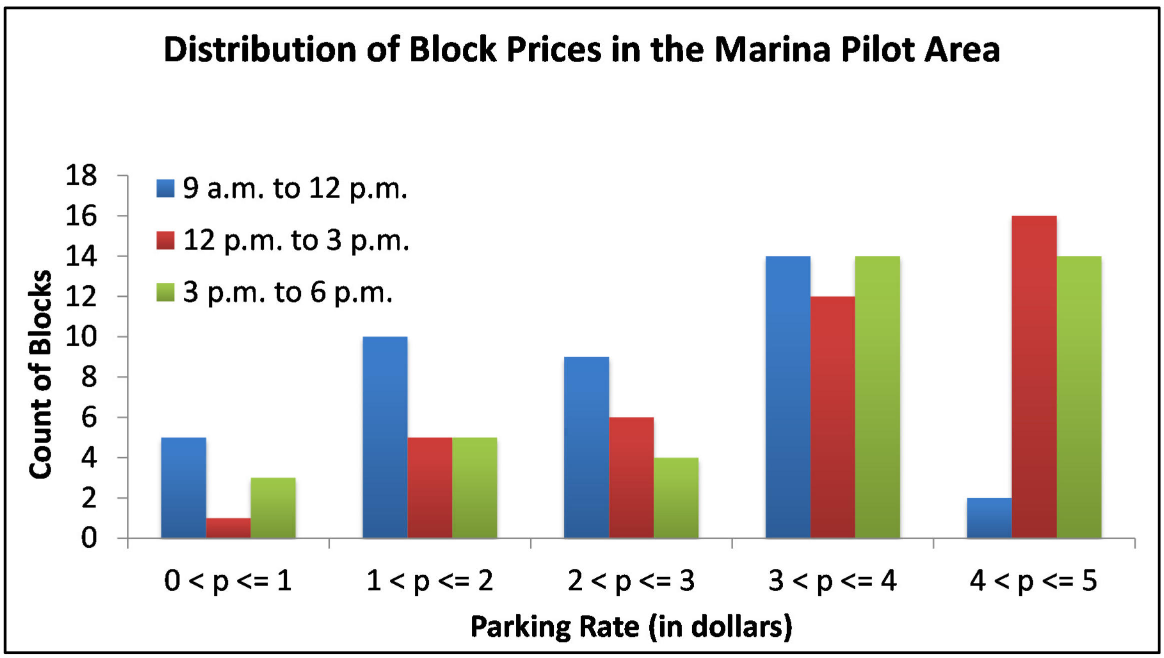


Source: Elliot Martin, 2014.

Figure B-36. Marina Parking Garage and Lot Activity

Marina District Pilot Summary

Overall, the Marina pilot area exhibited high utilization of on-street parking, particularly in the afternoon. The percentage of blocks exceeding 85 percent hourly occupancy dropped more precipitously (in the afternoon hours), than the more modest reduction in average occupancy. Results for the weekday morning hours presented somewhat of a different dynamic, in which average on-street occupancy levels increased, while the regression analysis suggested that price had considerable influence on block-by-block parking behavior within the area. While these show contrasting trends, they reflect divergent pricing actions taken by SFMTA across pricing periods during the day. In the Marina district, the parking rate during the morning hours was subject to a greater number of price reductions relative to the afternoon hours. This increased the spread among the parking rates within the morning pricing period, and also made parking in the morning relatively cheaper to parking in the afternoon. In the Marina pilot area, it appears that the price adjustments successfully shifted parking dynamics among the blocks, as desired. Figure B-37 shows the distribution of parking rates on the blocks within the Marina pilot area after the tenth rate adjustment. The distribution shows that morning parking rates (blue or first of three bars) were shifted towards lower values, while afternoon prices were shifted towards higher values. This helps in part to explain the convergence of morning and afternoon on-street occupancy observed in Figure B-31 as a result of SFMTA pricing actions.



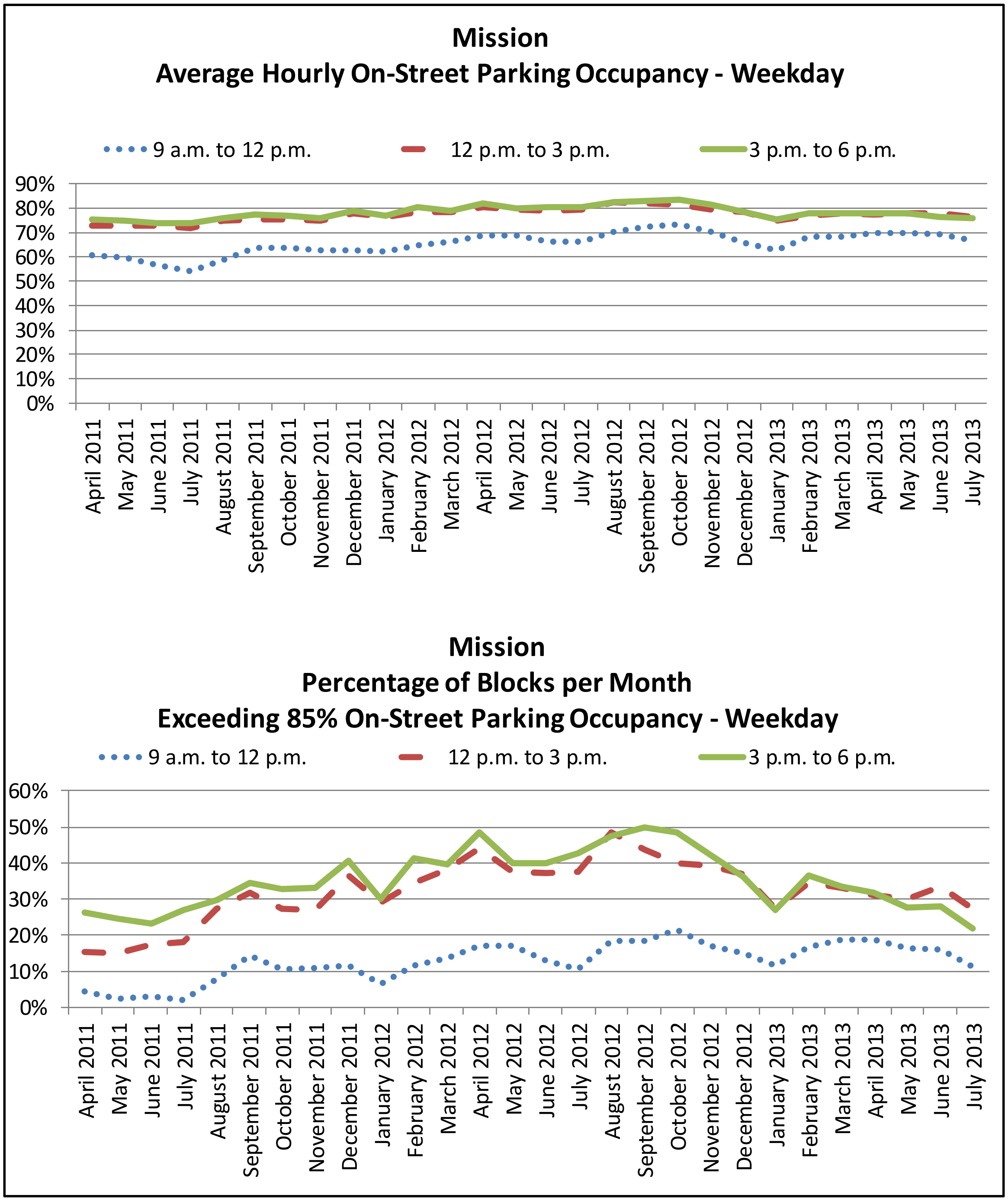
Source: Elliot Martin, 2014.

Figure B-37. Parking Rate Distribution in the Marina Pilot after 10th Adjustment

B.4.3.6 Mission Pilot Results

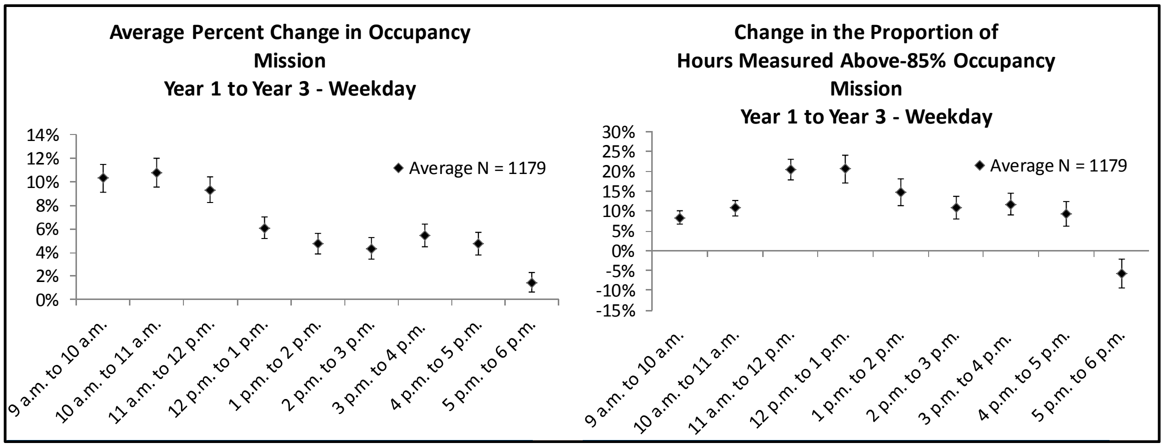
The results for the Mission area show very little evidence of impacts from the pricing actions of the SF*park* project. Figure B-38 (top) presents the trend in average block occupancy, and Figure B-38 (bottom) presents the trend in the percentage of blocks exceeding 85 percent on-street parking occupancy. As with many of the pilot areas, Figure B-38 (top) shows a distinction between the morning levels of occupancy versus afternoon occupancy. In the Mission pilot, the afternoon average occupancies are were high to begin with, initially ranging between 70 percent and 80 percent, and rose through much of the evaluation period. The average occupancies in the morning hours started at 60 percent and also increased throughout the evaluation period, before finishing at about 70 percent.

Figure B-38 (bottom) illustrates that in the blocks exceeding 85 percent parking occupancy rose from the start of the evaluation period. It is remarkable that highly congested blocks were found to be rare within an area that otherwise began with relatively high occupancy. The lack of congestion might suggest that parking occupancy may have already been well distributed in the Mission pilot at the outset of the evaluation period. Figure B-39 further shows that almost all weekday parking occupancy measures rose to a degree that was statistically significant.



Source: Elliot Martin, 2014.

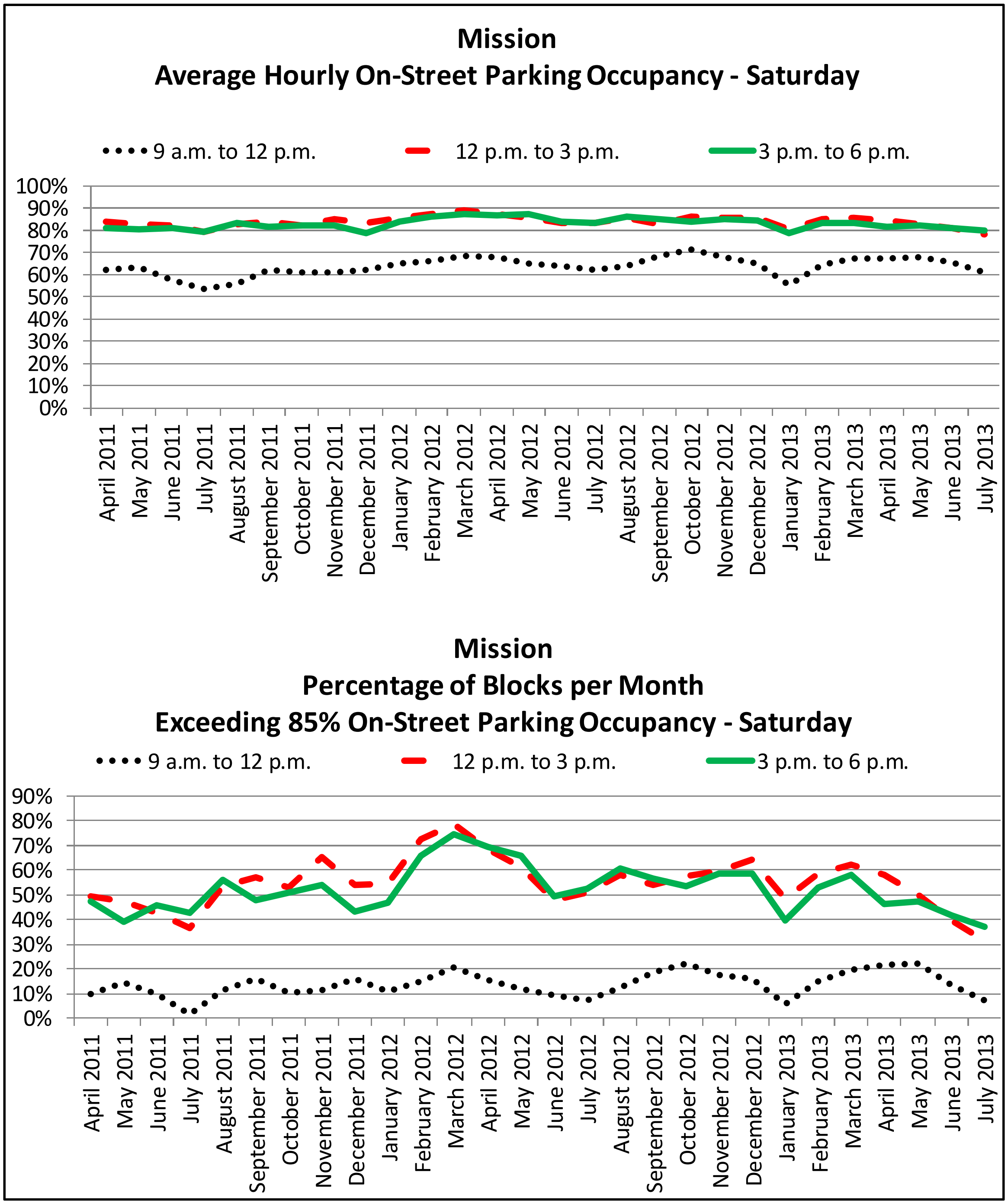
Figure B-38. Weekday Parking Activity in the Mission Pilot during the Evaluation Period



Source: Elliot Martin, 2014.

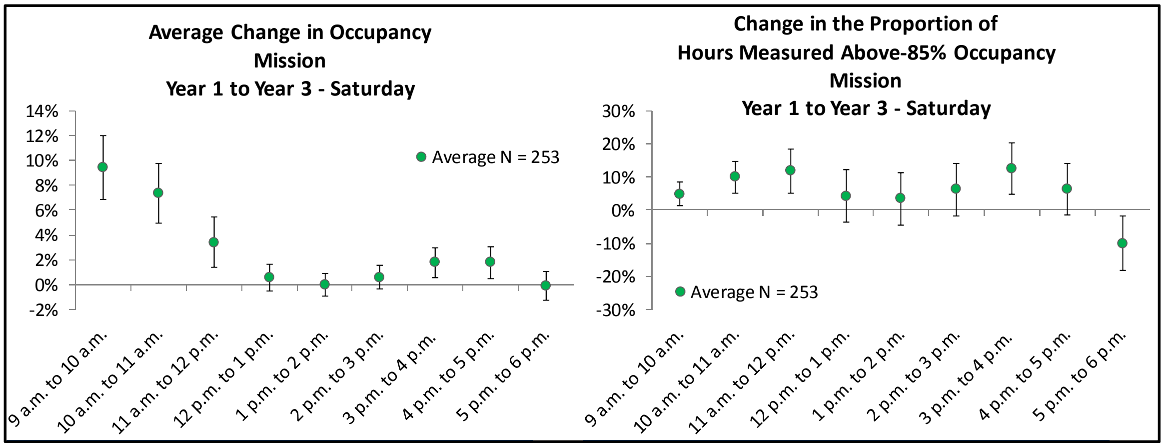
Figure B-39. Paired T-Test of Mission Weekday Parking Occupancy

Figure B-40 shows for Saturday parking activity in the Mission pilot a higher percentage of blocks exceeding the 85 percent occupancy threshold, and as with most pilot areas, there was considerable fluctuation during the evaluation period. In the morning, this trend was rather low, and it stayed flat throughout the period. Figure B-41 confirms limited statistical significance in the year-over-year differences in the occupancy metrics, and those values that are significant generally registered an increase.



Source: Elliot Martin, 2014.

Figure B-40. Saturday Parking Activity in the Mission Pilot during the Evaluation Period

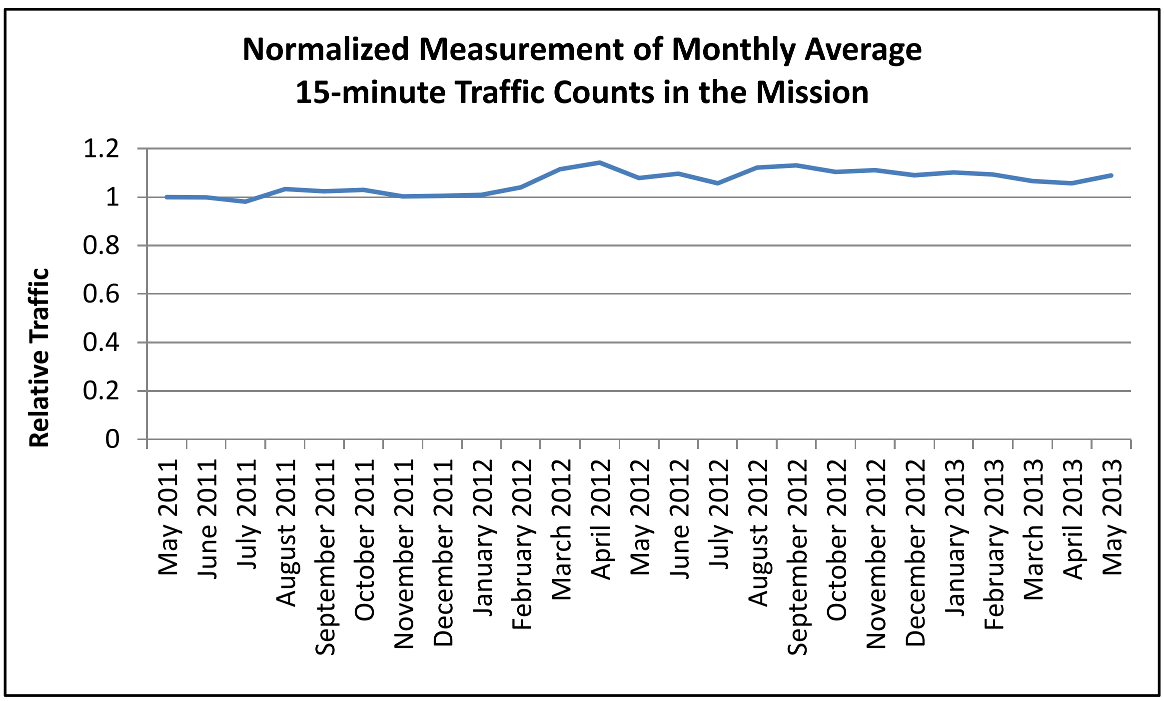


Source: Elliot Martin, 2014.

Figure B-41. Paired T-Test of Mission Pilot Saturday Parking Occupancy

Mission Pilot Traffic Analysis

The traffic data from the Mission pilot could be drawn from six out of 47 sensors that reported continuously through the evaluation period. The normalized average volume count was relatively flat until February 2012, at which point the sensors detected a 10 percent increase in traffic that remained for the rest of the evaluation period. A similar increase occurred in other sensors covering this time, which were not included in the average due to other gaps in the data. The cause of this increase in traffic is unclear.



Source: Elliot Martin, 2014.

Figure B-42. Normalized Measurement of Traffic in the Mission Pilot

Mission Pilot Regression Analysis

The regression analysis of occupancy on the Mission pilot blocks found little impact of price on the occupancy rate of the blocks. Nearly all the parking rate coefficients were statistically insignificant. Only the rates between 10 a.m. and 12 p.m. were statistically significance. Otherwise, the regression analysis suggested that travelers were not influenced by parking price in the Mission pilot. This result is remarkable in that such widespread insignificance in the parking rate variable only occurred in this pilot area. As with models generated in regions previously presented, the adjusted R^2 shows the model explains roughly 60 percent of the variance in the dependent variable data.

Table B-24. Regression Analysis of Parking Occupancy during GMP Hours in the Mission Pilot

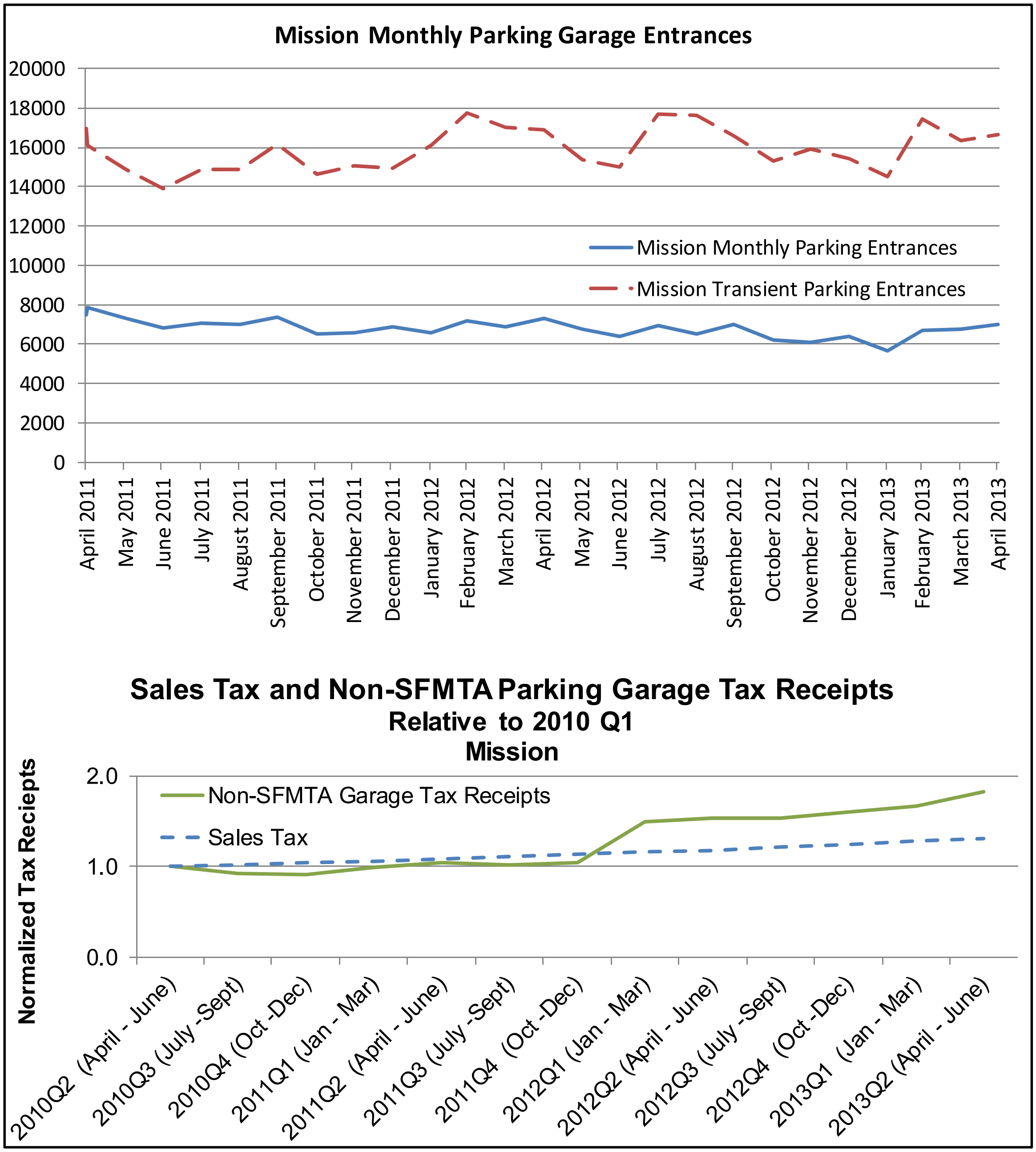
Parking Rate Model	Parking Rate Coefficient	p-value*	Adjusted R-squared	Total Number of Variables	# Observations
9 a.m. to 10 a.m.	-0.005	0.634	0.58	45	463
10 a.m. to 11 a.m.	-0.031	**0.003**	0.58	45	467
11 a.m. to 12 p.m.	-0.022	**0.015**	0.56	45	468
12 p.m. to 1 p.m.	-0.010	0.162	0.57	45	468
1 p.m. to 2 p.m.	-0.001	0.874	0.63	45	467
2 p.m. to 3 p.m.	0.002	0.801	0.64	45	467
3 p.m. to 4 p.m.	0.001	0.866	0.58	45	467
4 p.m. to 5 p.m.	0.000	0.988	0.58	45	456
5 p.m. to 6 p.m.	-0.003	0.657	0.58	45	457

*Values in bold are statistically significant at 95 percent confidence level.

Source: Elliot Martin, 2014.

Mission Pilot Parking Garage and Parking Lot Activity

The analysis of the garage activity in the Mission pilot showed little change in overall use outside of seasonal fluctuations. The data for normalized tax receipts showed a modest increase in taxable receipts during 1Q2012, and surge slightly past the trend in sales tax. This is notably the same period in which traffic volume exhibited a permanent increase of about 10 percent. Outside of this change, there is limited evidence that major shifts from on-street parking to off-street parking occurred within the Mission pilot area.



Source: Elliot Martin, 2014.

Figure B-43. Mission Pilot Parking Garage and Lot Activity

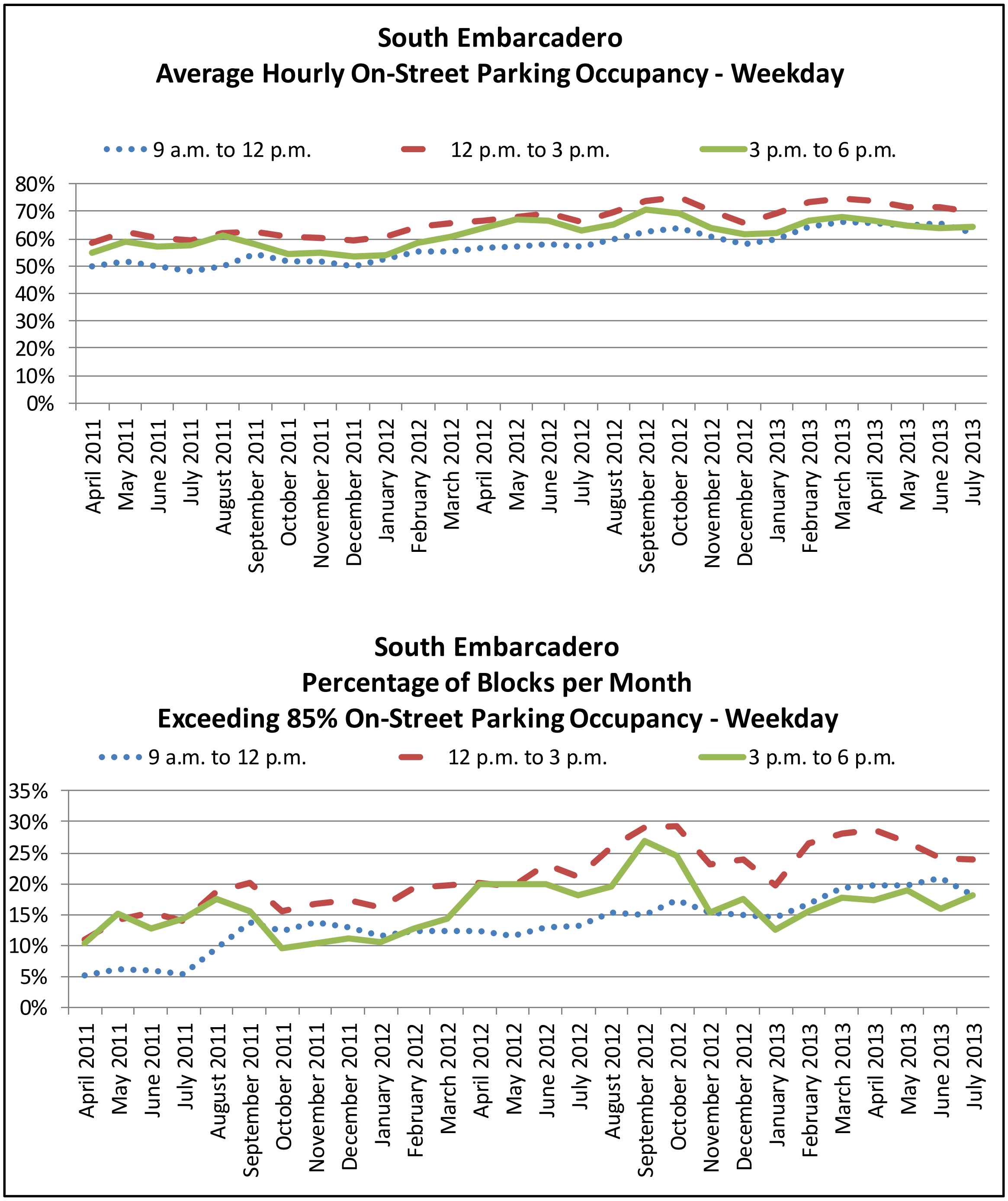
Mission Pilot Area Summary

The trends and data observed within the Mission district provided very limited evidence of any impact from SF*park* pricing. Average occupancies appear to have risen slightly across all hours of the day, and the percentage of blocks exceeding 85 percent also rose during the evaluation period. It is notable that the Mission pilot had a relatively low share of blocks with occupancies exceeding 85 percent to begin with, particularly in the morning. It is also notable that the regression analysis did not find significance in the parking rate for most of the hours of the day.

The explanation partly stems from the fact that the Mission district was subject to a large construction project during the 2-year evaluation period. This eliminated 9 of 28 blocks from the pilot area beginning in March 2012. They were never returned to service. Price changing rules were still applied to remaining operational blocks, but their effect was more limited due to the removal of 1/3 of the Pilot area blocks from pricing actions. Further reductions of blocks capable of receiving pricing actions occurred through the overall degradation of parking sensors experienced in all pilot areas. As a result of these factors, SFMTA actions in the Mission were far more limited and hindered by degraded sensing infrastructure. These limitations showed in the data, in that the Mission is the one pilot area in which the data showed very little evidence of any impact on occupancies. Neither the trends in occupancy, nor the results from the regression offer much evidence that parking occupancy was responsive to pricing. While this may have been unfortunate for the Mission pilot area, it at least provides a contrary case against the other pilot areas by illustrating what does not happen with active price management. Notably, the Mission pilot area is the only pilot area in which SFMTA was forced by circumstances to limit its pricing actions, and the only area that presented such ambiguous impacts.

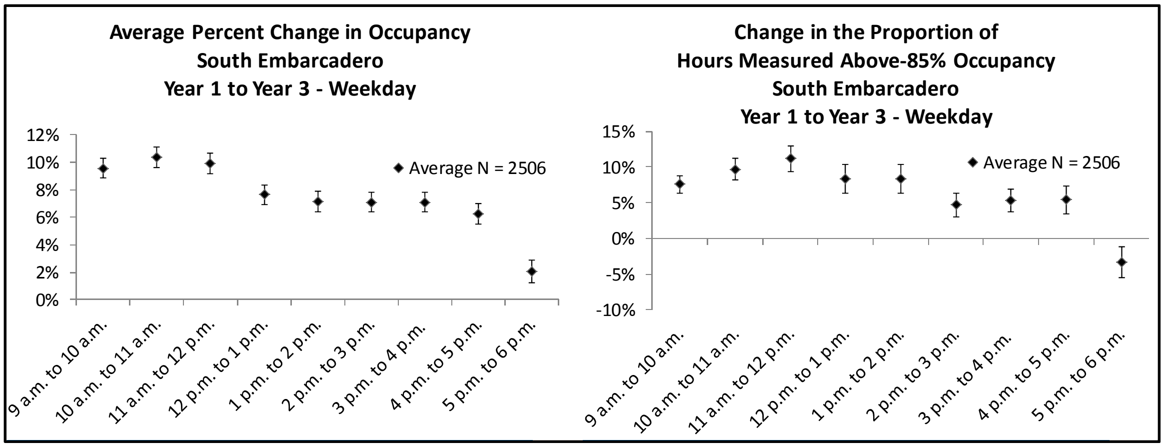
B.4.3.7 South Embarcadero Pilot Results

The South Embarcadero pilot area comprises an area adjacent to the Downtown pilot with a mix of employment, residential, and industrial land uses. Figure B-44 (top) shows that average occupancy levels increased within the South Embarcadero pilot throughout the evaluation period starting from averages of 50 percent to 60 percent and finishing at averages between 60 percent and 70 percent. Figure B-44 (bottom) shows a similar trend with blocks exceeding 85 percent percentage occupancy. In the South Embarcadero pilot, there were relatively few blocks with congested on-street parking. At the start of the evaluation, the percentage of blocks exceeding this occupancy threshold constituted no more than 15 percent of all blocks within any given pricing time frame. The rise in both parking occupancy metrics is reflected in Figure B-45. The figure shows that nearly all hours across both weekday parking metrics experienced a statistically significant increase in parking.



Source: Elliot Martin, 2014.

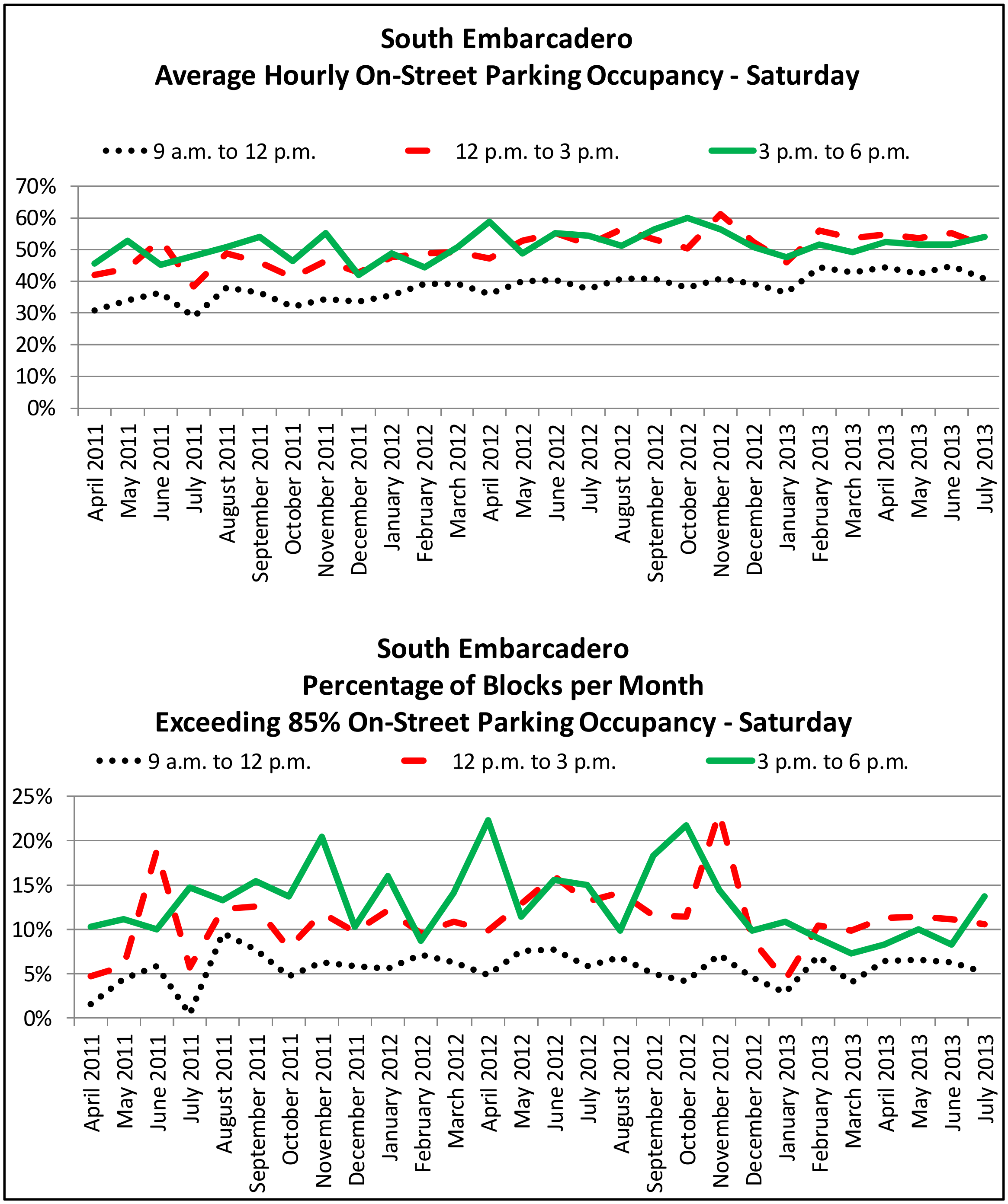
Figure B-44. Weekday Parking Activity in the South Embarcadero Pilot during the Evaluation Period



Source: Elliot Martin, 2014.

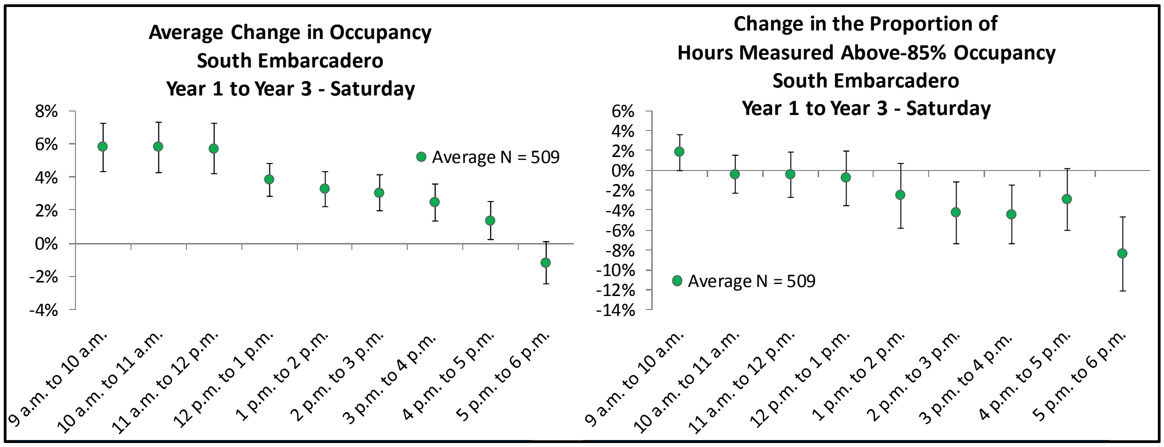
Figure B-45. Paired T-Test of South Embarcadero Pilot Weekday Parking Occupancy

Figure B-46 (top) shows trends in parking occupancy within the South Embarcadero pilot during Saturday parking. Average on-street parking occupancy increased on Saturdays as it did on weekdays, but the increase was subtler. Parking in the South Embarcadero pilot also began the evaluation as relatively uncongested. Figure B-47 indicates that these increases in average occupancy on Saturday were statistically significant except in the 5 p.m. to 6 p.m. period. Figure B-46 (bottom) shows that the percentage of blocks with over 85 percent occupancy barely exceeded 10 percent for any of the three pricing periods at the start of the evaluation. Further, the percentage of blocks over 85 percent maintained a flat growth trend with periodic peaks no higher than 25 percent of all blocks within a given pricing period. Figure B-47 indicates that the average changes were generally not statistically significant except in some of the afternoon time periods. Broadly, the South Embarcadero pilot displayed levels of parking occupancy that were relatively uncongested, as compared to other pilot areas within SF*park*.



Source: Elliot Martin, 2014.

Figure B-46. Saturday Parking Activity in the South Embarcadero Pilot during the Evaluation Period

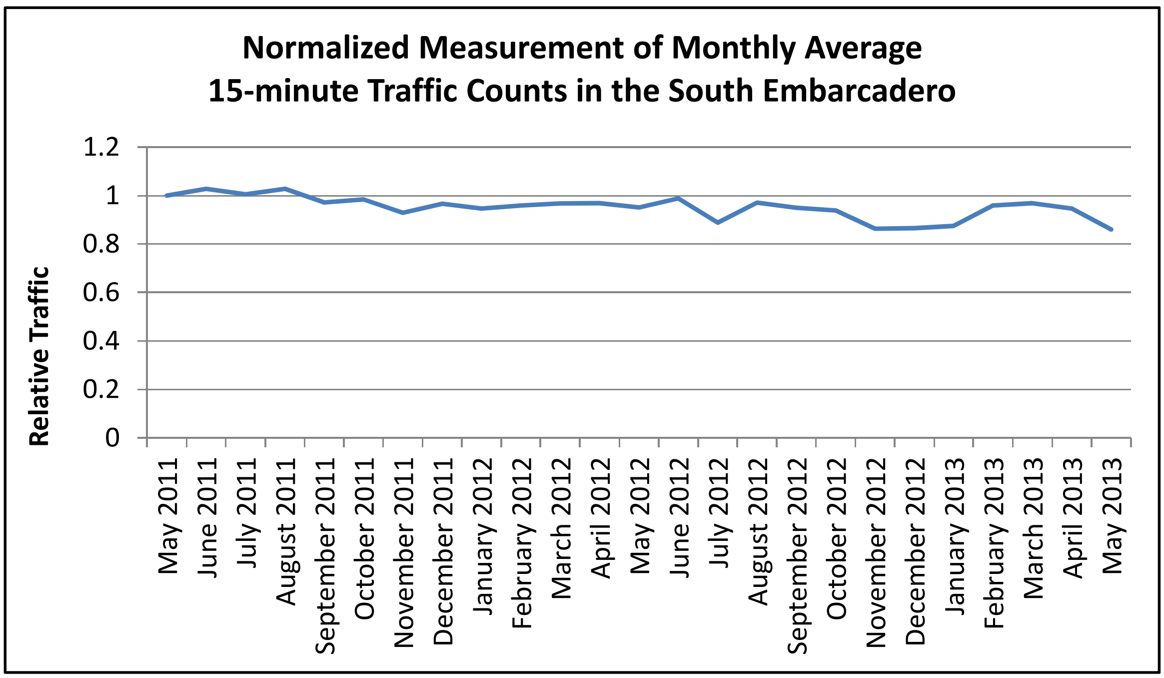


Source: Elliot Martin, 2014.

Figure B-47. Paired T-Test of South Embarcadero Pilot Saturday Parking Occupancy

South Embarcadero Pilot Traffic Analysis

Thirteen out of 31 traffic sensors provided information on traffic activity continuously within the South Embarcadero pilot area. The normalized average of traffic counts in Figure B-48 showed some fluctuation but little overall change in traffic activity as detected by the sampled sensors.



Source: Elliot Martin, 2014.

Figure B-48. Normalized Measurement of Traffic in the South Embarcadero Pilot

South Embarcadero Pilot Regression Analysis

The results of the regression analysis on average parking occupancy in Table B-25 showed that despite the upward trend in occupancy observed across most of the hours, travelers were responsive to the parking rates within the South Embarcadero pilot at all hours during the day. The parking rate coefficients suggested that every additional dollar of parking rate lowered average occupancy by 2 to 3 percent. The adjusted R^2 values show the models explain between 53 and 74 percent of the variance in the dependent variable.

Table B-25. Regression Analysis of Parking Occupancy during GMP Hours in the South Embarcadero Pilot

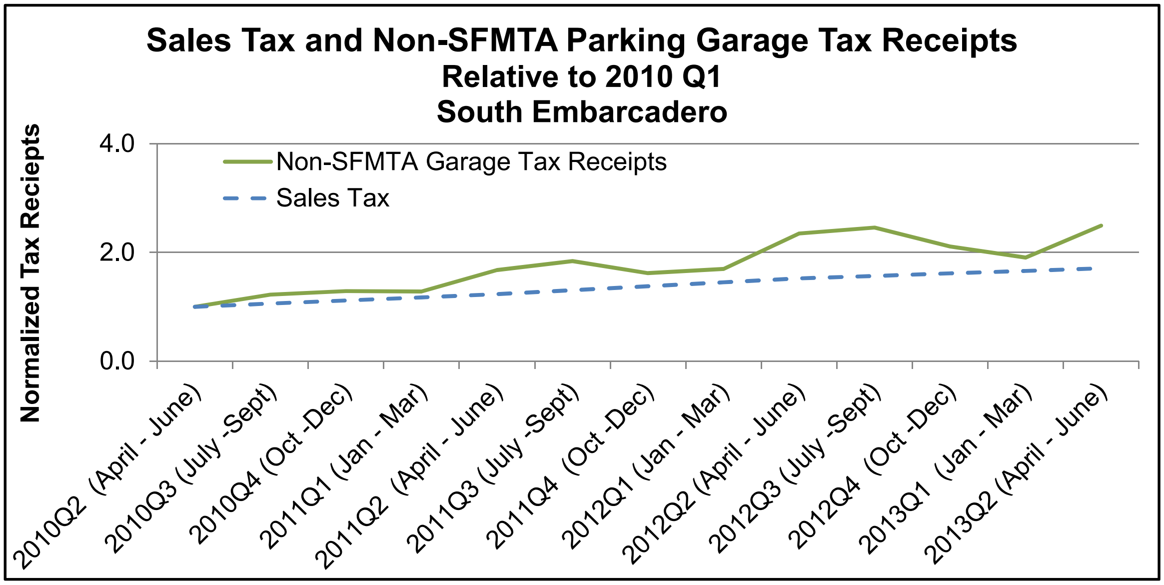
Parking Rate Model	Parking Rate Coefficient	p-value*	Adjusted R-squared	Total Number of Variables	# Observations
9 a.m. to 10 a.m.	-0.024	**0.000**	0.74	66	1080
10 a.m. to 11 a.m.	-0.031	**0.000**	0.67	66	1080
11 a.m. to 12 p.m.	-0.033	**0.000**	0.61	66	1080
12 p.m. to 1 p.m.	-0.023	**0.000**	0.55	66	1080
1 p.m. to 2 p.m.	-0.022	**0.000**	0.53	66	1080
2 p.m. to 3 p.m.	-0.021	**0.000**	0.57	66	1080
3 p.m. to 4 p.m.	-0.026	**0.000**	0.62	66	1080
4 p.m. to 5 p.m.	-0.028	**0.000**	0.59	65	998
5 p.m. to 6 p.m.	-0.014	**0.019**	0.59	65	1007

*Values in bold are statistically significant at 95 percent confidence level.

Source: Elliot Martin, 2014.

South Embarcadero Pilot Parking Garage and Parking Lot Activity

There are no SFMTA parking garages in the South Embarcadero pilot area. Figure B-49 shows a general rise in the normalized plot of tax receipts from non-SFMTA garages and parking lots. The sales tax series rises at about the same rate. The rise in non-SFMTA parking occupancy appears commensurate with the rise in on-street parking occupancy, which may point to increased economic activity in the area.



Source: Elliot Martin, 2014.

Figure B-49. South Embarcadero Pilot Parking Garage and Lot Activity

South Embarcadero Pilot Area Summary

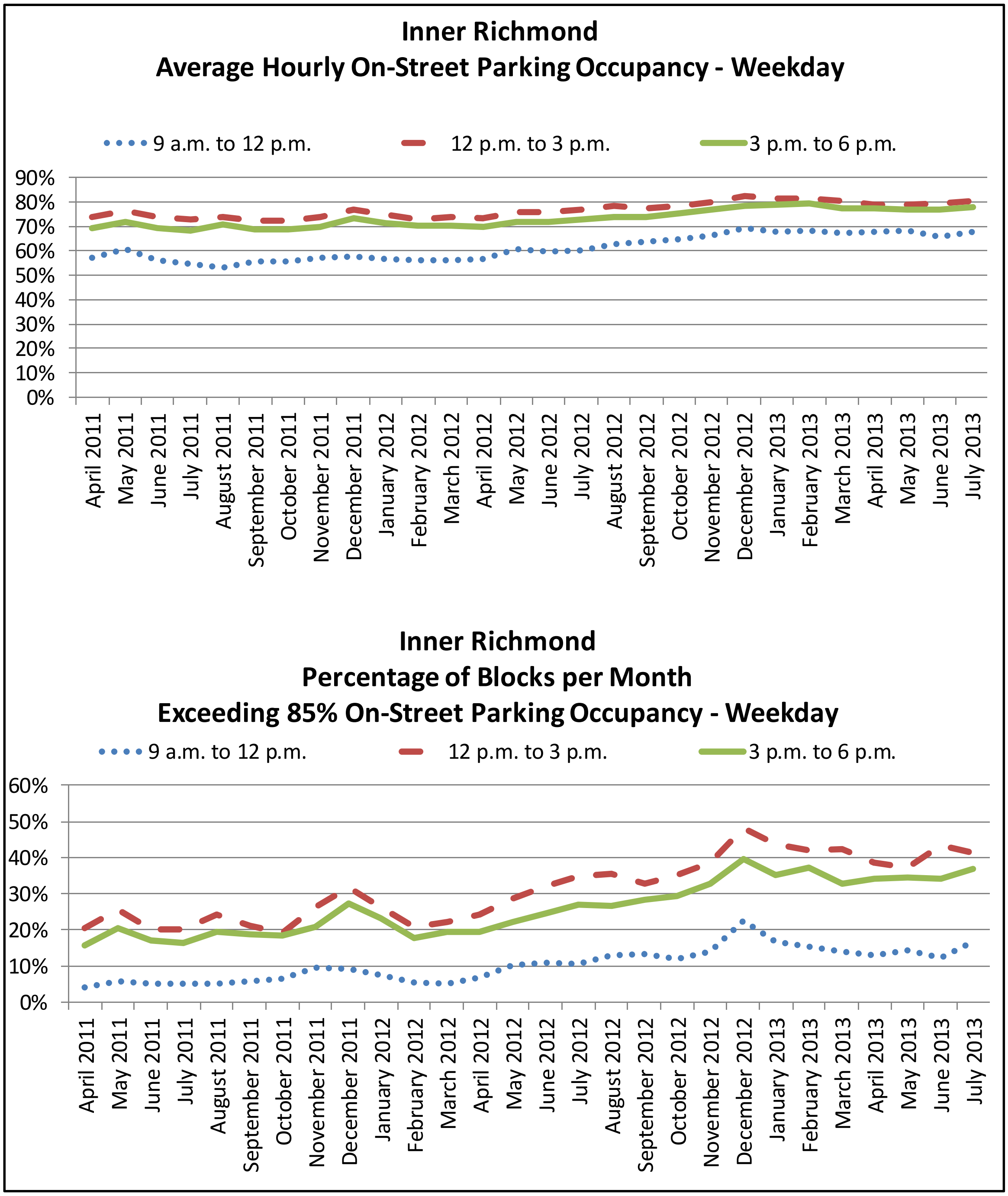
The South Embarcadero pilot area exhibited an overall increase in parking occupancy and activity during the evaluation period. Compared to other areas, the South Embarcadero pilot was not highly congested, and in fact prices declined on many of the blocks within the pilot area. For example, by the tenth rate adjustment, the South Embarcadero had 106 parking rates set at a price of $0.25 / hour. This was out of a total of 320 rates set for the entire pilot area. Thus, almost precisely 1/3 of all parking rates in the South Embarcadero pilot were set at the lowest possible rate. This likely explains the broad upward shift in parking occupancy observed within the area. In effect SF*park* pricing sought to increase parking use in this area, by enticing more on-street parking, in an area that had spare capacity. Even though parking activity seemed to increase, the regression analysis indicated that travelers were responsive to parking rates, avoiding blocks with higher relative prices.

B.4.4 Results by Control Area

An analysis of occupancy data was performed for two of the three control areas: Inner Richmond and Union. SFMTA recommended not using occupancy data for the third control area – West Portal – due to numerous technical difficulties related to parking sensors in that area. Thus, findings for West Portal are not presented in the sections below.

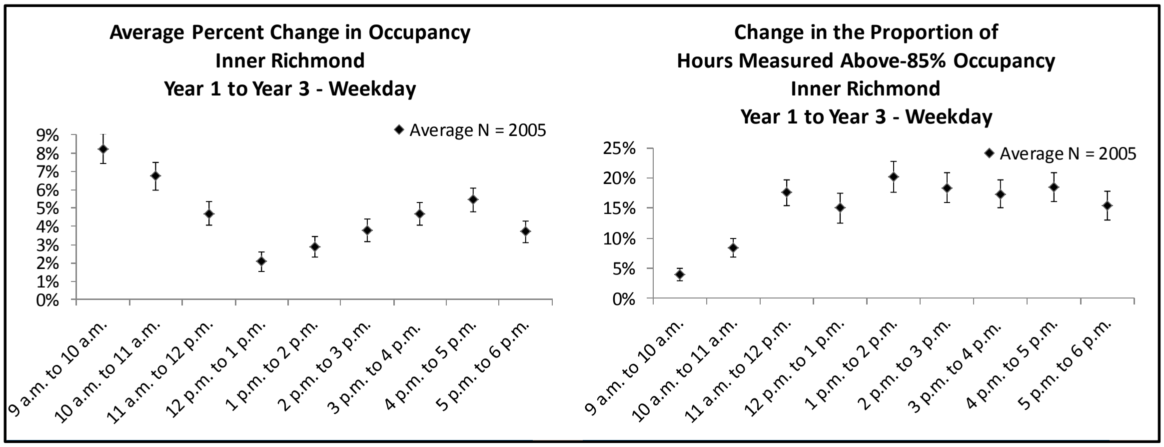
B.4.4.1 Inner Richmond Control Area Results

The Inner Richmond control area was one of two control areas included in the SF*park* project. Control areas had fewer smart meters, no roadway sensors, and no dynamic adjustment of pricing during the evaluation. However, parking sensors were deployed in the control areas to monitor how parking occupancy changed within the area over time. Figure B-50 (top) shows the trend in average occupancy for the Inner Richmond control area, and Figure B-50 (bottom) displays the trend in the percentage of blocks measuring hourly occupancy over 85 percent. Both series exhibited a relative increase in occupancy over the evaluation. Figure B-51 shows the statistical significance of the average paired change in parking occupancy, effectively showing a statistically significant increase in all metrics.



Source: Elliot Martin, 2014.

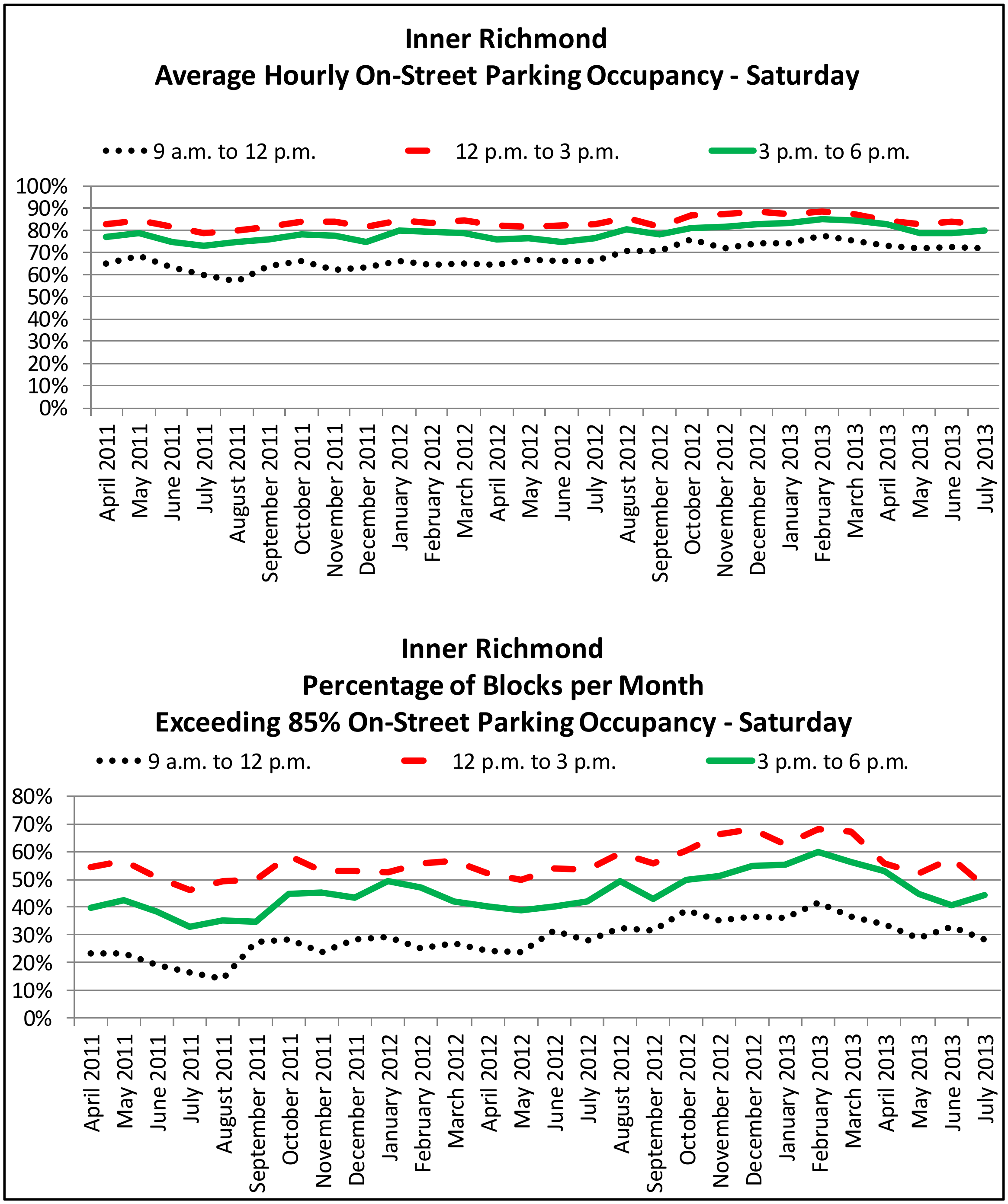
Figure B-50. Weekday Parking Activity in the Inner Richmond Control Area during the Evaluation Period



Source: Elliot Martin, 2014.

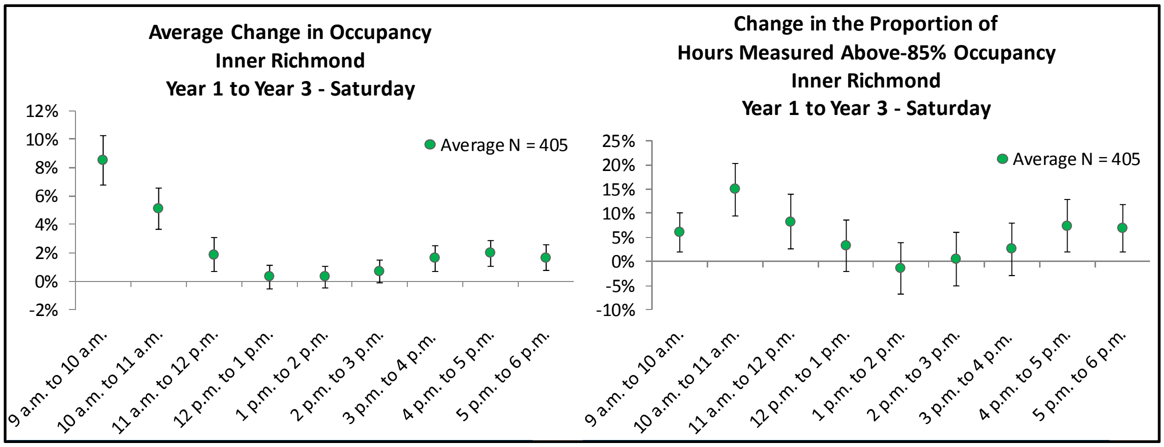
Figure B-51. Paired T-Test of Inner Richmond Control Area Weekday Parking Occupancy

Figure B-52 (top) shows the trend in parking activity within the Inner Richmond control area on Saturdays. Saturday average parking occupancy in the Inner Richmond was relatively stable, but increasing slightly, during the evaluation. Figure B-52 (bottom) shows a modest increase in the percentage of blocks with occupancies exceeding 85 percent. The year-over-year changes shown in Figure B-53 indicate the increase was largest during the morning hours, and it was less significant during the afternoon hours.



Source: Elliot Martin, 2014.

Figure B-52. Saturday Parking Activity in the Inner Richmond Control Area during the Evaluation Period

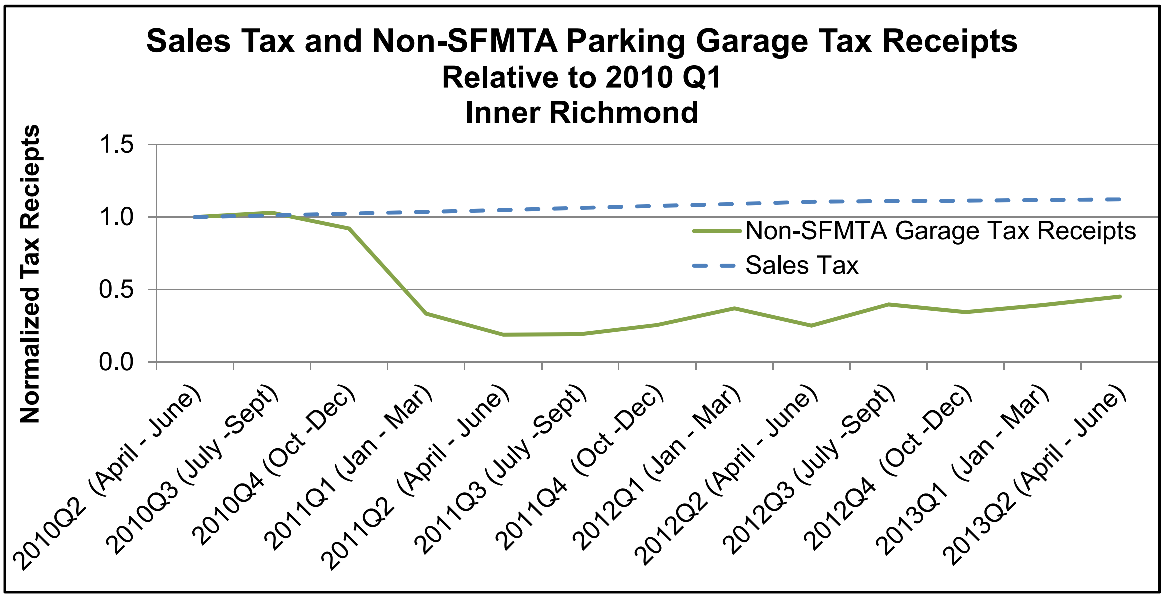


Source: Elliot Martin, 2014.

Figure B-53. Paired T-Test of Inner Richmond Control Area Saturday Parking Occupancy

Other Control Area Data

Traffic sensors were not available for control areas and because there was no change in price, parking rate could not be used as a variable in the regression analysis. In addition, there were no SFMTA managed garages in the Inner Richmond control area. Thus, tax receipts were the only other data point available with which to evaluate trends in parking. Figure B-54 shows the normalized plot of tax receipts from garages and lots within the Inner Richmond control area. Parking tax receipts declined at the outset of the series to 20 percent of their initial value. A slow and gradual recovery ensued, reaching about 40 percent of the original value by the end of the evaluation period. Notably, the Inner Richmond was the only area (out of pilots and controls) to experience a precipitous and sustained fall in parking-related tax receipts. All other areas experienced at least some net increase in tax revenue during the evaluation period. The decline in Inner Richmond was large in relative magnitude and a stark departure from the sales tax series that steadily increased. The likely explanation for this change was a discrete event, such as a lot or facility closure. Following this event, parking tax receipts resumed an upward trend, but never recovered.



Source: Elliot Martin, 2014.

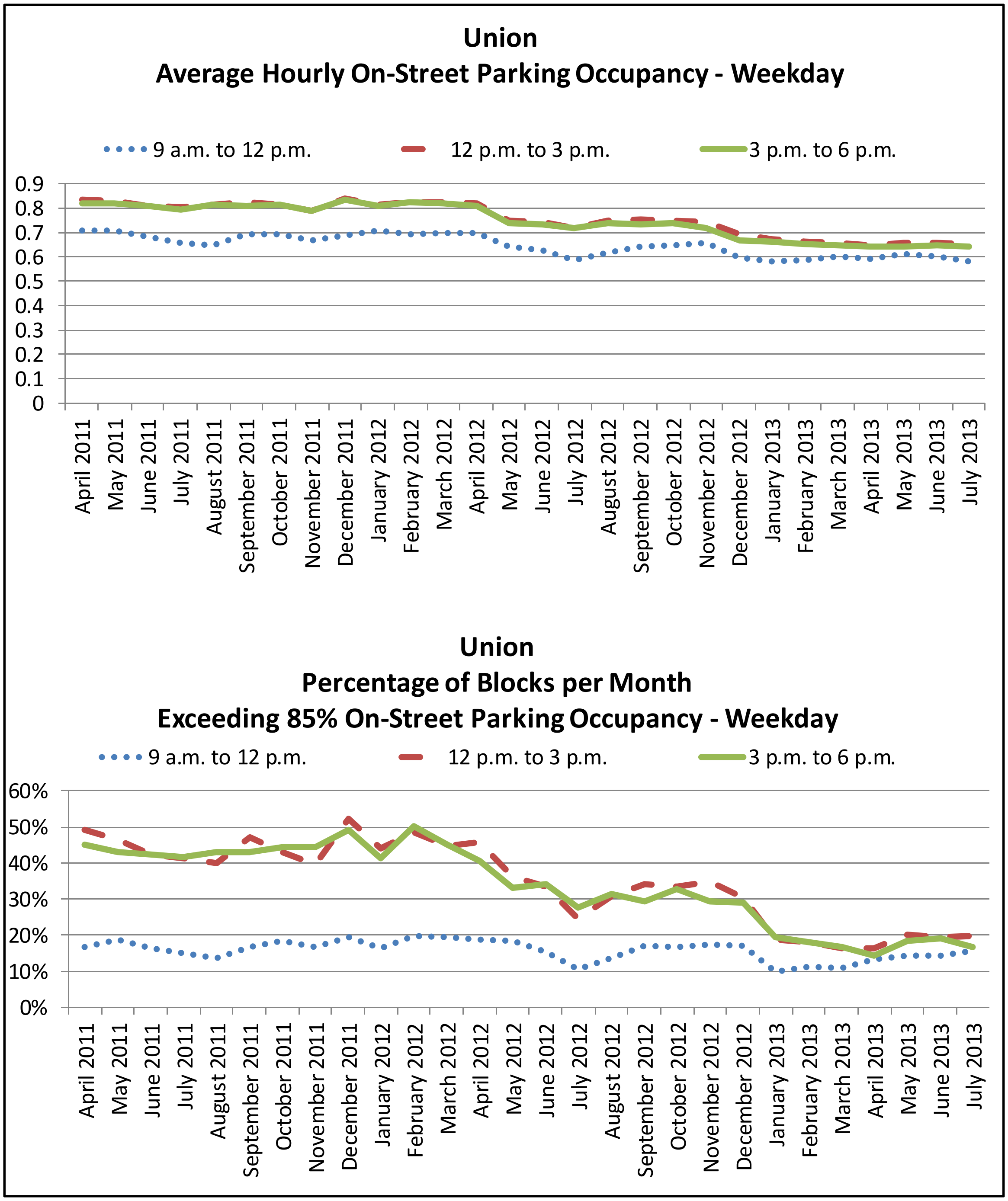
Figure B-54. Inner Richmond Control Area Parking Garage and Lot Activity

Inner Richmond Control Area Summary

The Inner Richmond control area experienced a gradual increase in parking occupancy during the weekday and slightly rising parking occupancy during the weekend. Parking rates within this area were unchanged. As with the South Embarcadero pilot, weekday parking occupancies exceeding 85 percent were not as high as some of the more congested areas. Hence, there was room for parking occupancy to grow within the Inner Richmond control area. The decline in the tax receipts from off-street parking activity was unusual, as tax receipts were expected to be their lowest at the start of the evaluation. This may have been the result of a business shut down in the area followed by a steady economic recovery. Overall, since prices were not influential on parking activity in the control areas, the results from the Inner Richmond control area may suggest that steady economic growth resulted in rising parking occupancy within a relatively uncongested area.

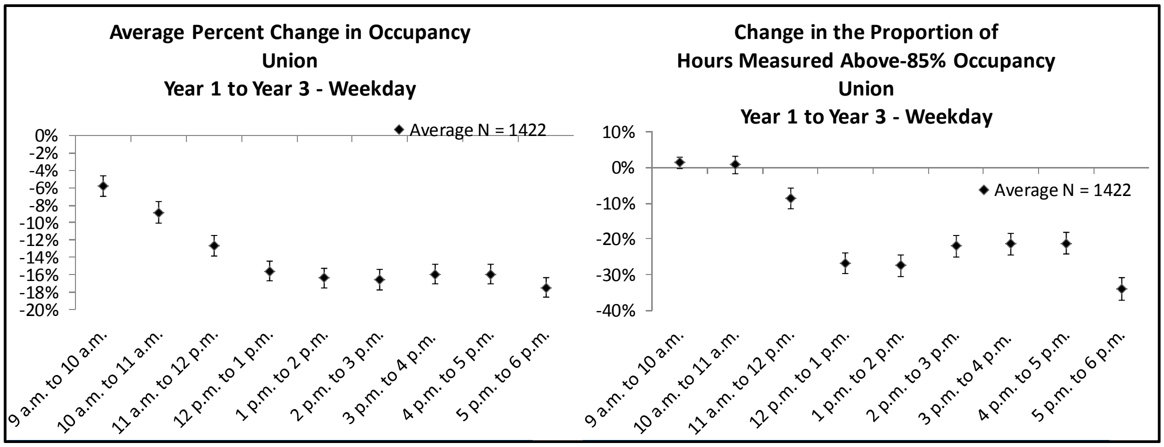
B.4.4.2 Union Control Area Results

The Union control area was the other control site that had data available for analysis. As with the Inner Richmond, the data available for the Union control area was restricted to that provided by the sensors and parking tax receipts. Figure B-55 shows the trend in the occupancy measures that occurred in the Union control during the evaluation. Figure B-55 shows that the average occupancy stayed level during the first year, but it then declined. The afternoon hours declined from 80 to under 65 percent, and similar declines from 70 to 60 percent were observed in the morning hours. Commensurate declines in the percentage of blocks exceeding a parking occupancy of 85 percent occurred during the same time. The declines in occupancy were large, and they were statistically significant for almost all hours, as shown in Figure B-56. Hence, although prices were not adjusted in the Union control district, something happened in the area that caused a decline especially during the second year of the evaluation.



Source: Elliot Martin, 2014.

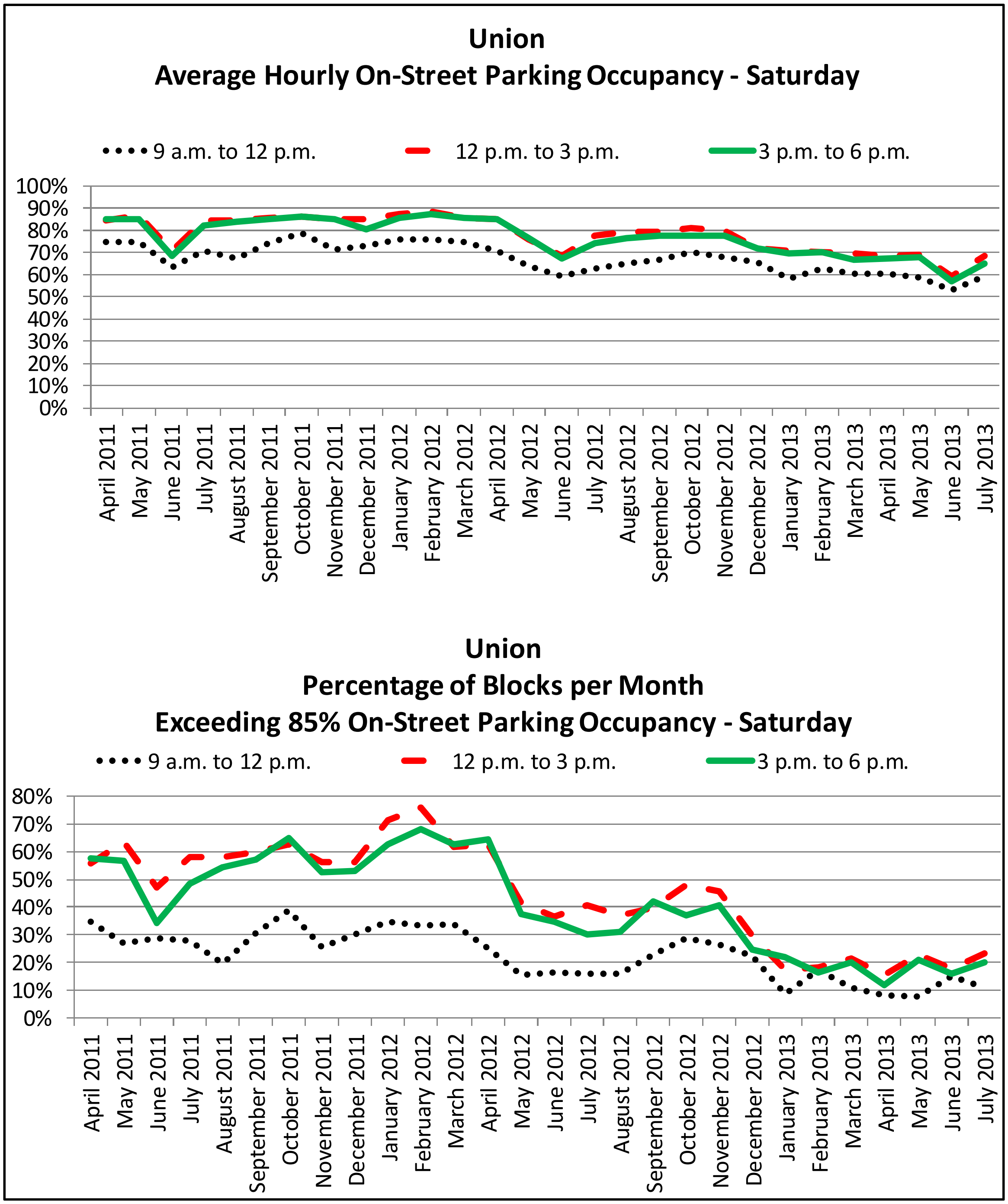
Figure B-55. Weekday Parking Activity in the Union Pilot during the Evaluation Period



Source: Elliot Martin, 2014.

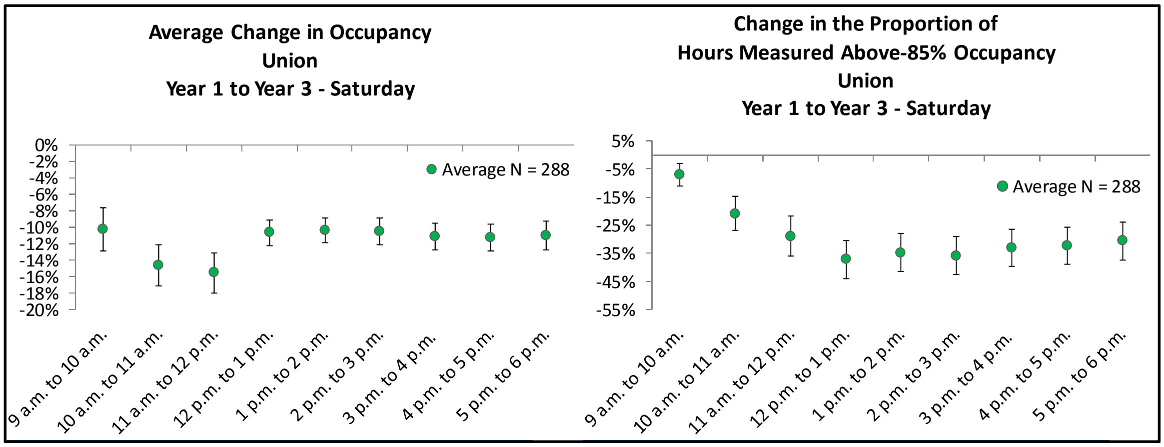
Figure B-56. Paired T-Test of Union Control Area Weekday Parking Occupancy

Analysis of the Saturday data in the Union control area showed the same pattern as with the weekday data. Figure B-57 shows relatively stable occupancy values (for a Saturday), and then, starting the second year of the evaluation, occupancy dropped, and continued a gradual decline. Because the drop in occupancy occurred across all days of the week, and as no price adjustments were made in the area, the movement in the data suggests an exogenous event impacting on-street parking occupancy in a sustained fashion. Figure B-58 confirms that these changes are large and statistically significant.



Source: Elliot Martin, 2014.

Figure B-57. Saturday Parking Activity in the Union Control Area during the Evaluation Period

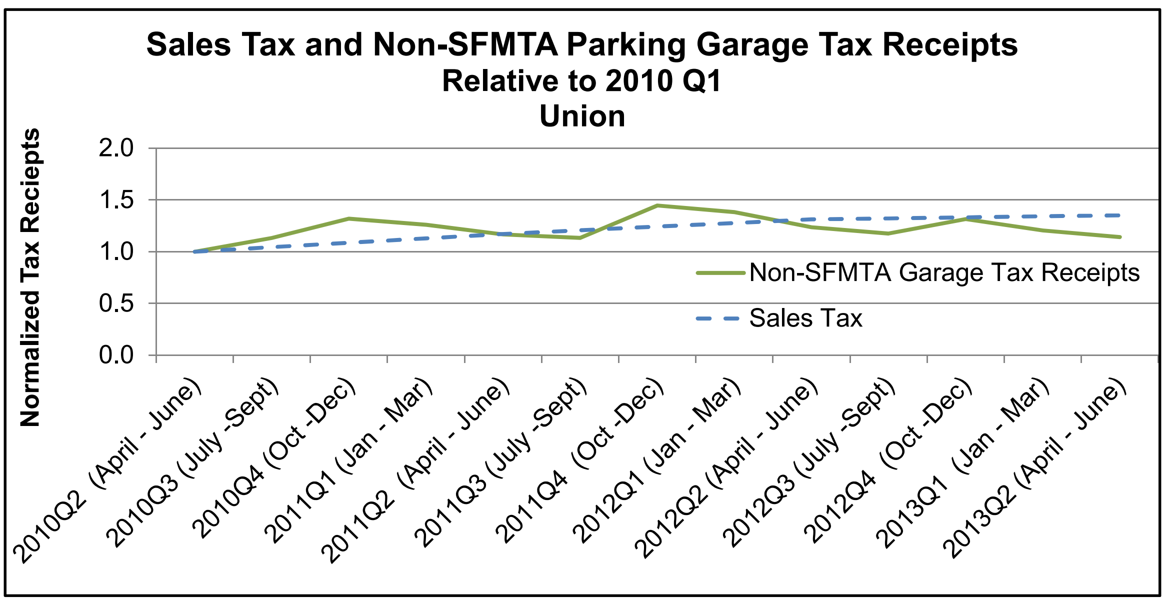


Source: Elliot Martin, 2014.

Figure B-58. Paired T-Test of Union Control Area Saturday Parking Occupancy

Other Control Area Data

As with the Inner Richmond, the Union Control area had less data available with which to analyze impacts. There were no SFMTA garages in the Union area, so the only information on off-street parking within the district was the tax receipts from non-SFMTA garages. These receipts, plotted in Figure B-59, showed cyclical activity on a slightly upward trend. The series noticeably peaked in 4Q2011, which immediately preceded the drop in on-street occupancy observed in Figure B-55 and Figure B-57. After this point, tax receipts declined to levels near where they were at the start of the evaluation (1Q2011). This similar time frame of decline in tax receipts further points to an exogenous event influencing overall parking demand within the Union control area. Furthermore, parking tax data shows almost no departure from the trend in sales tax growth.



Source: Elliot Martin, 2014.

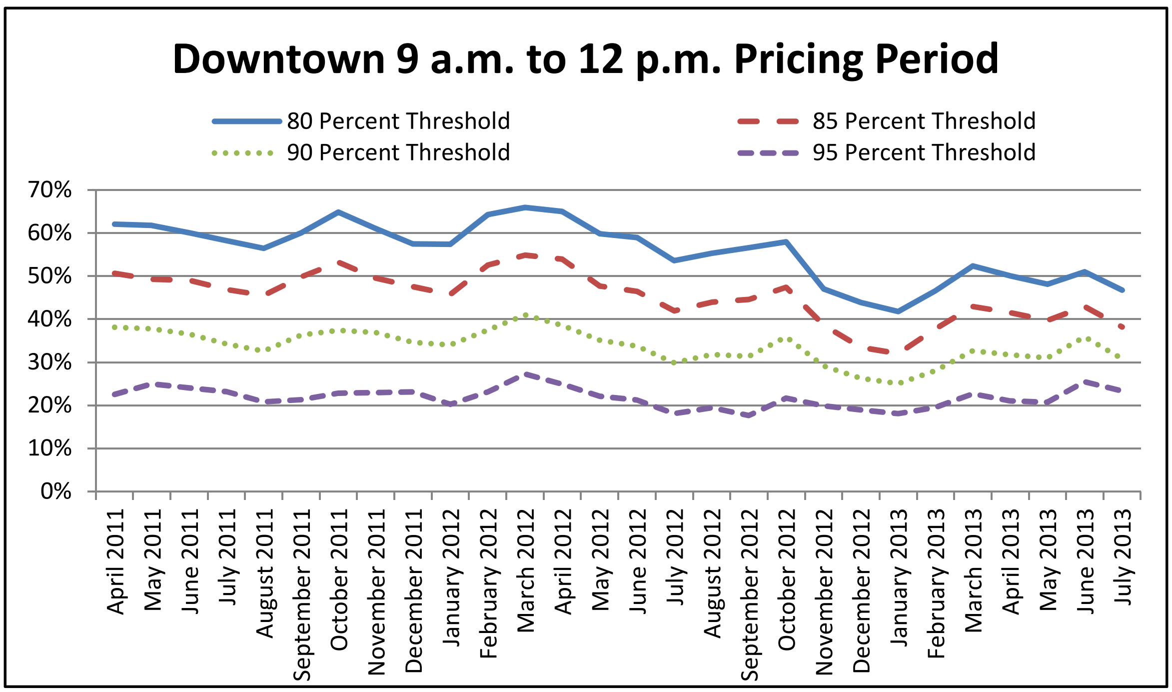
Figure B-59. Union Control Area Parking Garage and Lot Activity

Union Control Area Summary

The Union control area experienced a decline in traffic and parking occupancy during the evaluation. The timing of this decline was rather clear. Starting in April 2011, on-street occupancies across all six days of GMP pricing started to fall. The decline was most apparent in the afternoon hours, but it also was observed in the mornings and was statistically significant for most hours of the day. A similar movement was observed within the garage data, although it was not quite as dramatic. The reasons for these changes are unclear given the available data on activity within the area.

B.4.5 Sensitivity Analysis on the Occupancy Threshold

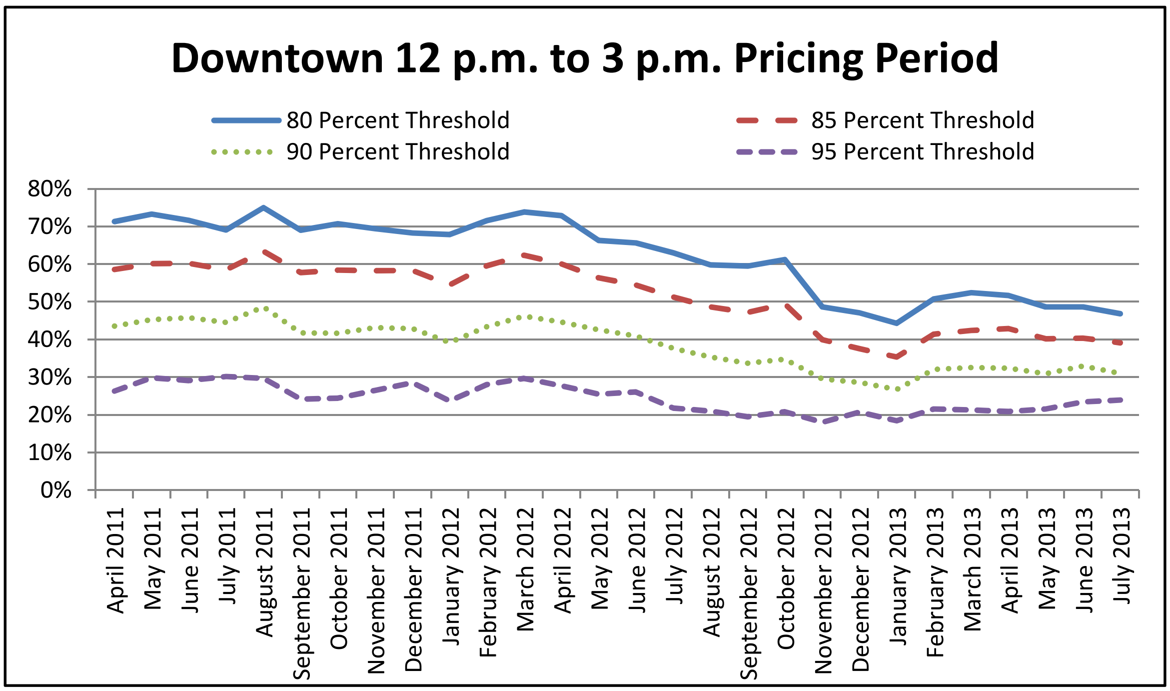
With the implementation of the parking pricing, a number of different occupancy thresholds could have been used to evaluate the change in proportion of blocks exceeding the given threshold. In this analysis, the threshold of 85 percent was chosen as a benchmark due to its citation by Professor Donald Shoup as the approximate target for on-street parking occupancy when it is appropriately priced. But other occupancy thresholds could have been used, including 80 percent, 90 percent and 95 percent. To gain some insight on the impact of these thresholds on the results, a sensitivity analysis was done for the Downtown region. This analysis recalculated the trends in proportion of blocks exceeding the four different thresholds 80 percent, 85 percent, 90 percent, and 95 percent for each of the three pricing periods. The results for the morning pricing period of 9 a.m. to 12 p.m. are shown in Figure B-60.



Source: Elliot Martin, 2014.

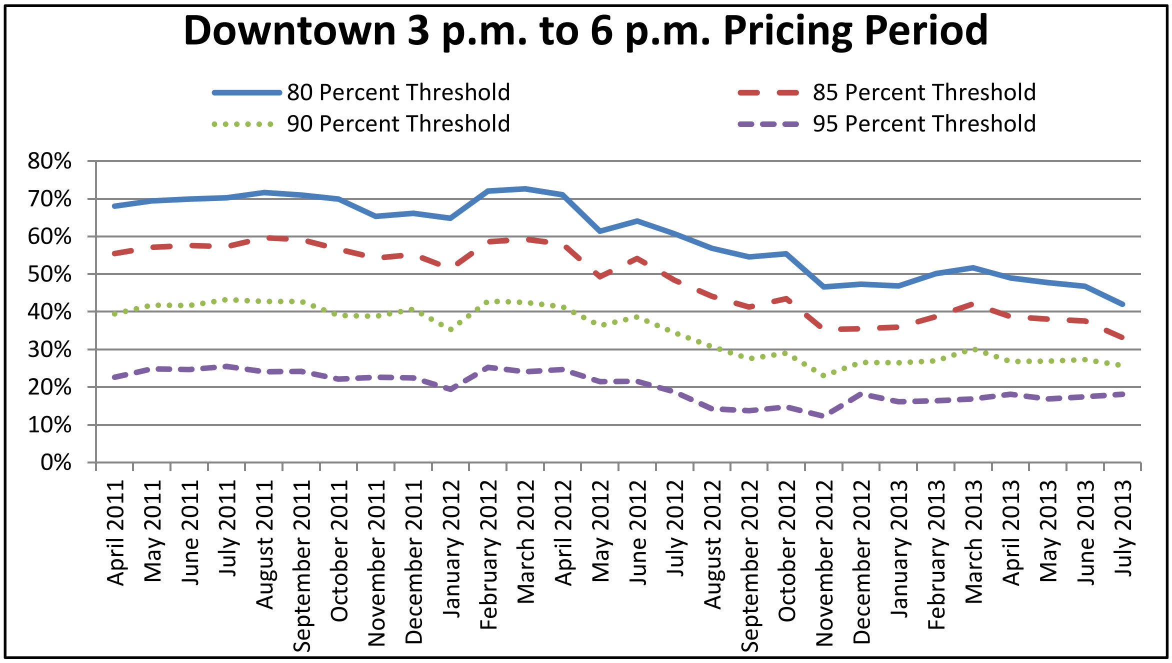
Figure B-60. Sensitivity of Proportion of Blocks Exceeding an Occupancy Threshold to the Level of that Occupancy Threshold – Morning

Figure B-60 shows a tiered structure of trends across the different thresholds. The top trend is that of the 80 percent threshold, and the bottom trend is of the 95 percent threshold. This ordering is consistent with the fact that any block exceeding 95 percent occupancy must also exceed 80 percent occupancy. Thus, it is expected that some separation between the trends will most always exist (special rare cases aside, such as some blocks exceeding 95 percent, and the rest below 80 percent). Figure B-60 shows the trends with 80 percent, 85 percent, and 90 percent all decline with similar magnitudes. The decline from the first value to the last value of the 80 percent threshold is in fact slightly higher than the trend at 85 percent. The trend at 80 percent declined by 15 percent, whereas the trend at the 85 percent threshold declined by 12.5 percent. Yet a smaller decline of 8 percent was observed at the 90 percent threshold. At the 95 percent threshold, there was an increase of 0.8 percent between the first and last value. Beyond showing that the declines are larger at the lower thresholds, the sensitivity analysis suggests that occupancy values were far more stubborn on blocks with very high occupancies. In Figure B-61, the same dynamic is shown, with the greatest declines at the 80 percent threshold, and the lowest declines at the 95 percent threshold. This dynamic also held for Downtown during the late afternoon, as shown in Figure B-62. Possible explanations for this result include over-representation of free handicapped-placard parking in the highest occupancy blocks and the $6.00 hourly rate cap, which may have been too low to shift demand on such blocks.



Source: Elliot Martin, 2014.

Figure B-61. Sensitivity of Proportion of Blocks Exceeding an Occupancy Threshold to the Level of that Occupancy Threshold – Early Afternoon



Source: Elliot Martin, 2014.

Figure B-62. Sensitivity of Proportion of Blocks Exceeding an Occupancy Threshold to the Level of that Occupancy Threshold – Late Afternoon

B.4.6 Comparative Summary of Parking Occupancy Results

This analysis covered the seven pilot and two control areas operated by SF*park*. The results broadly showed that the dynamic pricing actions by SFMTA had detectable impacts on the distribution of on-street parking availability through the redistribution and in some cases reduction of on-street parking occupancy. SF*park* was a large real-world implementation of variable parking pricing. As with any new concept on the ground, the implementation was subject to exogenous factors that influenced block-by-block occupancies independent of pricing actions. Despite operating in environments with new construction and a growing economy, the impacts of SF*park* on parking occupancy (and availability) came through in the analysis.

The most consistent results across the pilot areas were found in the regression analysis. The regression analysis took the average monthly occupancy on a block as the dependent variable. Independent variables included block level indicator variables and monthly indicator variables, as well as the average parking rate that was charged. A separate model was generated for each hour of GMP parking (between 9 a.m. and 6 p.m.). These models consistently showed that the parking rate variable was negative and statistically significant in most cases. One pilot area was an exception, the Mission district, in which the parking rate variable was most often insignificant. Table B-26 shows a side-by-side comparison of the parking rate coefficients estimated for all seven pilot areas.

Table B-26. Parking Rate Coefficients for All Pilot Areas

Parking Rate Model	Civic Center Parking Rate Coefficient	Downtown Parking Rate Coefficient	Fillmore Parking Rate Coefficient	Fisherman's Wharf Parking Rate Coefficient	Marina Parking Rate Coefficient	Mission Parking Rate Coefficient	South Embarcadero Parking Rate Coefficient	Hourly Average of Coefficients
9 a.m. to 10 a.m.	-0.042***	-0.089***	-0.035***	-0.022***	-0.114***	-0.005^{NS}	-0.024***	-0.047
10 a.m. to 11 a.m.	-0.043***	-0.081***	-0.041***	-0.022*	-0.113***	-0.031**	-0.031***	-0.052
11 a.m. to 12 p.m.	-0.041***	-0.051***	-0.042***	-0.025**	-0.107***	-0.022*	-0.033***	-0.046
12 p.m. to 1 p.m.	-0.045***	-0.012^{NS}	-0.031***	-0.045***	-0.063***	-0.01^{NS}	-0.023***	-0.033
1 p.m. to 2 p.m.	-0.041***	-0.011^{NS}	-0.032***	-0.049***	-0.063***	-0.001^{NS}	-0.022***	-0.031
2 p.m. to 3 p.m.	-0.032***	-0.015^{NS}	-0.036***	-0.044***	-0.065***	0.002^{NS}	-0.021***	-0.030
3 p.m. to 4 p.m.	-0.018**	-0.024*	-0.05***	-0.024**	-0.068***	0.001^{NS}	-0.026***	-0.030
4 p.m. to 5 p.m.	-0.009^{NS}	-0.03**	-0.053***	-0.029**	-0.072***	0^{NS}	-0.028***	-0.032
5 p.m. to 6 p.m.	-0.004^{NS}	-0.02*	-0.055***	-0.03***	-0.057***	-0.003^{NS}	-0.014*	-0.026
Pilot Area Average of Coefficients	-0.031	-0.037	-0.042	-0.032	-0.080	-0.008	-0.025	-0.0363
*** p-value < 0.001	** p-value < 0.01		* p-value < 0.05					NS = Not Significant

Source: Elliot Martin, 2014.

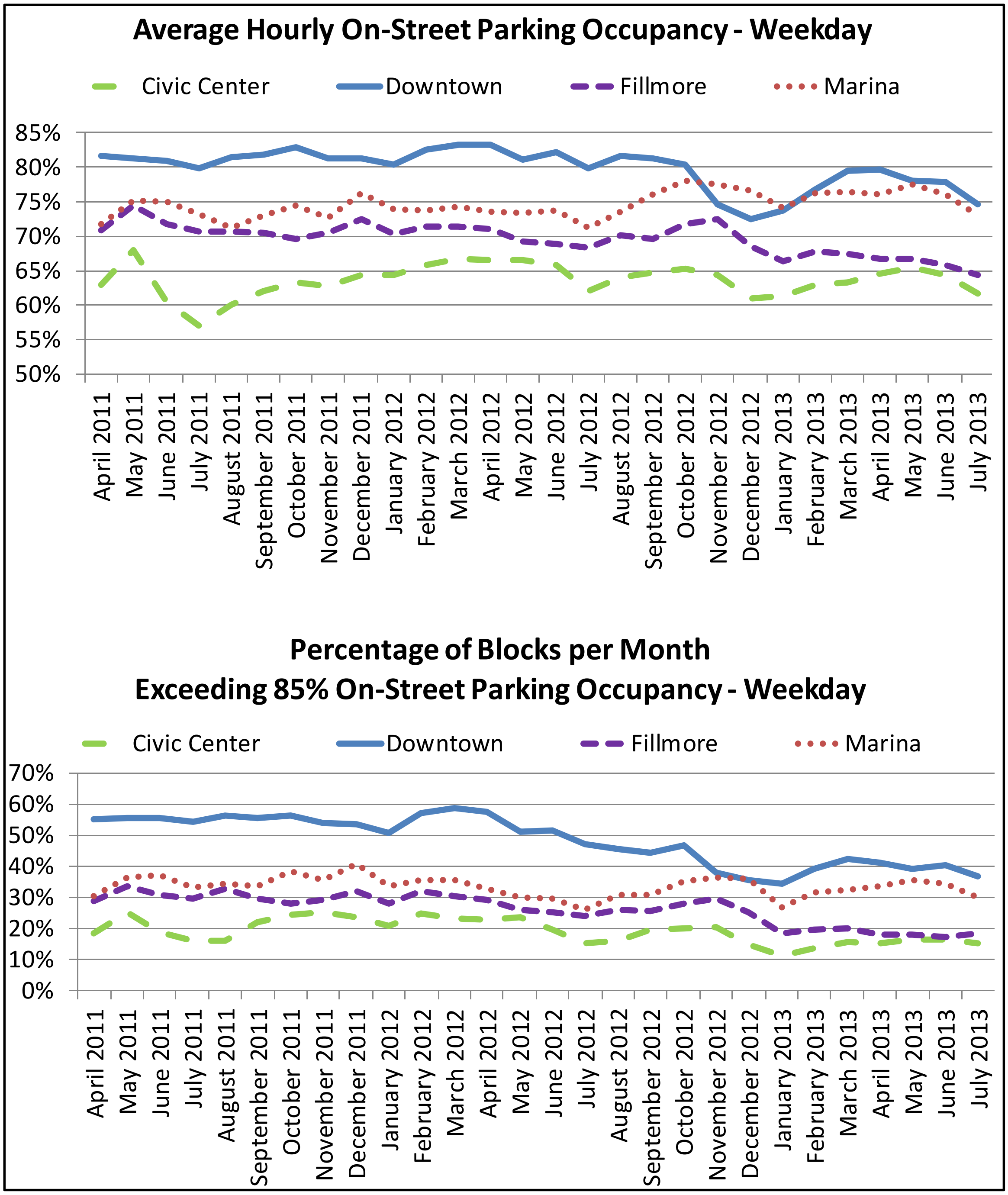
Table B-26 shows that, of the 63 independent models estimated, 51 of them contained statistically significant parking rate coefficients, all of which were negative, as expected. Table B-26 also shows the average parking rate coefficient for the entire pilot area as well as the average parking rate coefficient for each hour. These are unweighted averages of the coefficients in the table. The bottom row shows the average of all coefficients within each pilot area. The far-right column shows the average of all coefficients within each hour. The lower-right hand corner shows an average of all the coefficients.

The impact of parking rate on parking occupancy naturally changes by pilot area and across the GMP hours of the day. The parking rate appeared to have the greatest average influence on blocks within the Marina district. In the Downtown pilot area, the rate was most influential during the morning hours and insignificant during lunch time. In contrast, the parking rate was most influential during the lunch hour in Fisherman's Wharf tourist area and statistically significant during other hours.

The parking rate coefficients were statistically significant and of the expected negative sign even in environments where parking occupancy generally rose during the evaluation. In addition, these were often environments in which the parking rate commensurately fell. That is, increased parking occupancy of blocks with reductions in price also produced a negative parking rate coefficient.

SFMTA implemented variable pricing in areas that experienced different directional trends in parking congestion. In the Civic Center, Downtown, Fillmore, and Marina pilot areas, average parking occupancy remained relatively flat over the course of the evaluation period. At the same time, the proportion of blocks exceeding the threshold of 85 percent occupancy declined in these four pilot areas. Figure B-63 shows the trend in average occupancy and the trend in the proportion of blocks exceeding 85 percent occupancy for these four pilot areas. Unlike their presentation in the sections above, the trends are averaged across all GMP hours. The pilot area that saw the most reduction in parking occupancy (and was the greatest increase in average availability), was the Downtown, in which there was a visually apparent decline in both average occupancy and the proportion of blocks exceeding the 85 percent threshold. The Fillmore also exhibited a decline in both trends. The Civic Center exhibited a relatively constant average occupancy over the evaluation period, but a drop in the proportion of blocks exceeding 85 percent occupancy. The changes observed in the Marina were notably slight at this level of aggregation. This was due to the fact that in the morning, parking occupancies rose due to reductions in prices within this period. In the afternoon hours, the Marina experienced modest declines in parking occupancy. When aggregated together, the overall impact on the Marina appeared negligible and unseen unless disaggregated by hour.

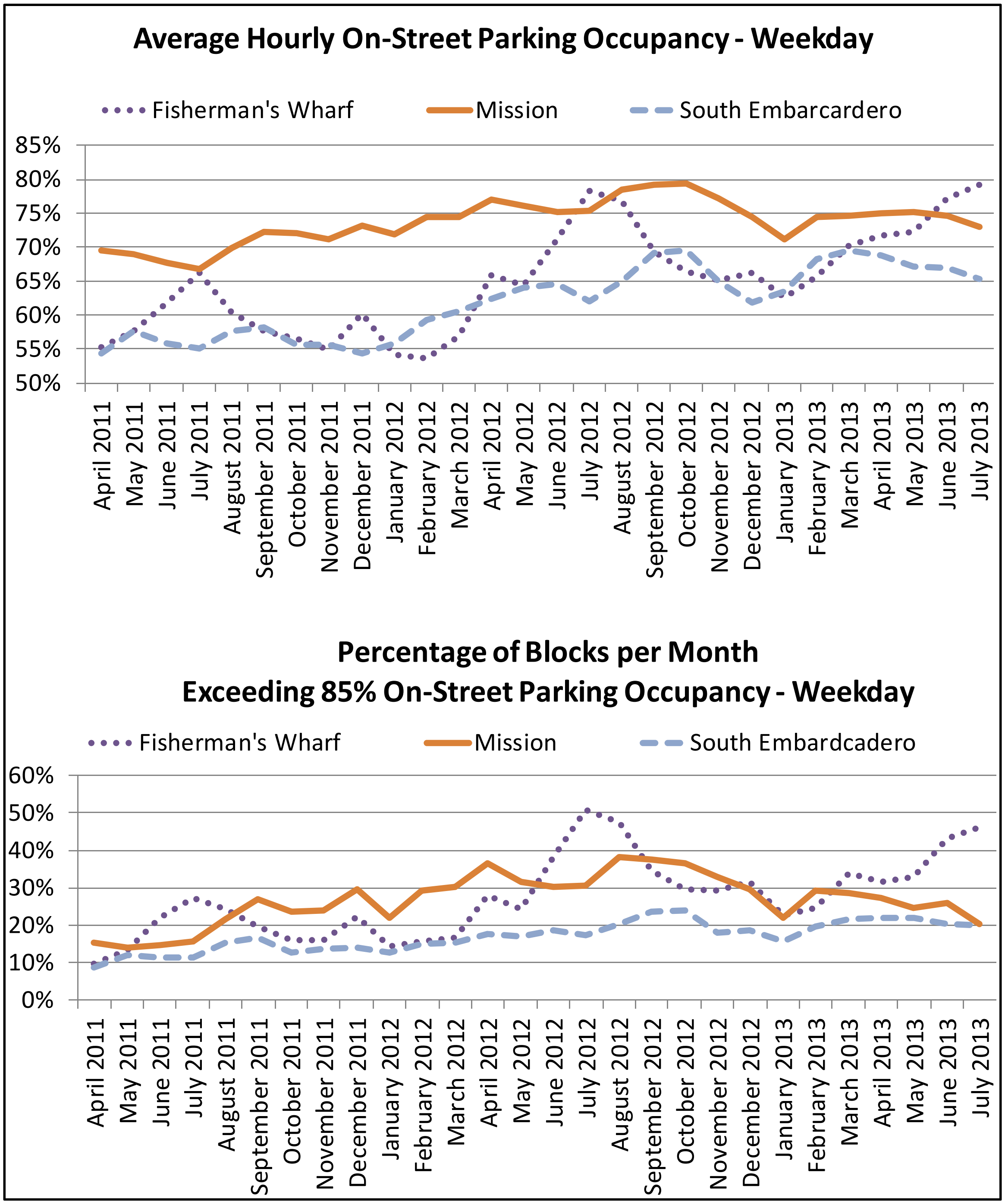
Broadly, Figure B-63 shows the pilot areas in which SFMTA dynamic pricing actions generally increased parking availability by lowering parking occupancy. In particular, the prevalence of highly congested blocks declined in these areas. Notably, all of the areas began with high average occupancies above at least 60 percent. This contrasts with the other three pilot areas shown in Figure B-64 that follows.



Source: Elliot Martin, 2014.

Figure B-63. Weekday Parking Occupancy Trends in Pilot Areas with Declines in Parking Occupancy

Figure B-64 shows the same trends for the other pilot areas. Two of the pilot areas, the Fisherman's Wharf and South Embarcadero, exhibited a clear increasing trend in the average hourly parking occupancy and the percentage of blocks exceeding 85 percent. Notably, both of these areas were more vacant than pilot areas described above, as average hourly occupancies began at 55 percent and stayed below 60 percent for much of the first year. A gradual and steady increase in parking occupancy then occurred in both of areas during the second year of the evaluation. The third pilot area on the graph, the Mission, was more of an anomaly. Parking occupancies in the Mission started at 70 percent, in line with the pilot areas presented in Figure B-63 above. But a massive construction effort on the key arterial of Mission Street occurred during the middle of the evaluation period starting about March of 2012. This construction removed the sensors for 9 of the 28 blocks in the pilot area, and those blocks were never reintroduced into the system during the evaluation. This elimination of nearly 1/3 of the blocks in the pilot area along a central arterial may have affected the ability of other pricing actions impact parking occupancy as effectively as observed elsewhere. Unlike its similarly congested peer pilot areas shown in Figure B-63, the Mission did not move substantively with occupancies and in fact increased slightly. Another issue was the fact that the construction reduced on-street parking supply from what was considered normal for the area. This may have caused occupancies on remaining blocks to rise artificially, and perhaps also may have caused people to be less responsive to price during the construction period. This latter result was also reflected in the lack of statistical significance of most price coefficients in the Mission pilot area.

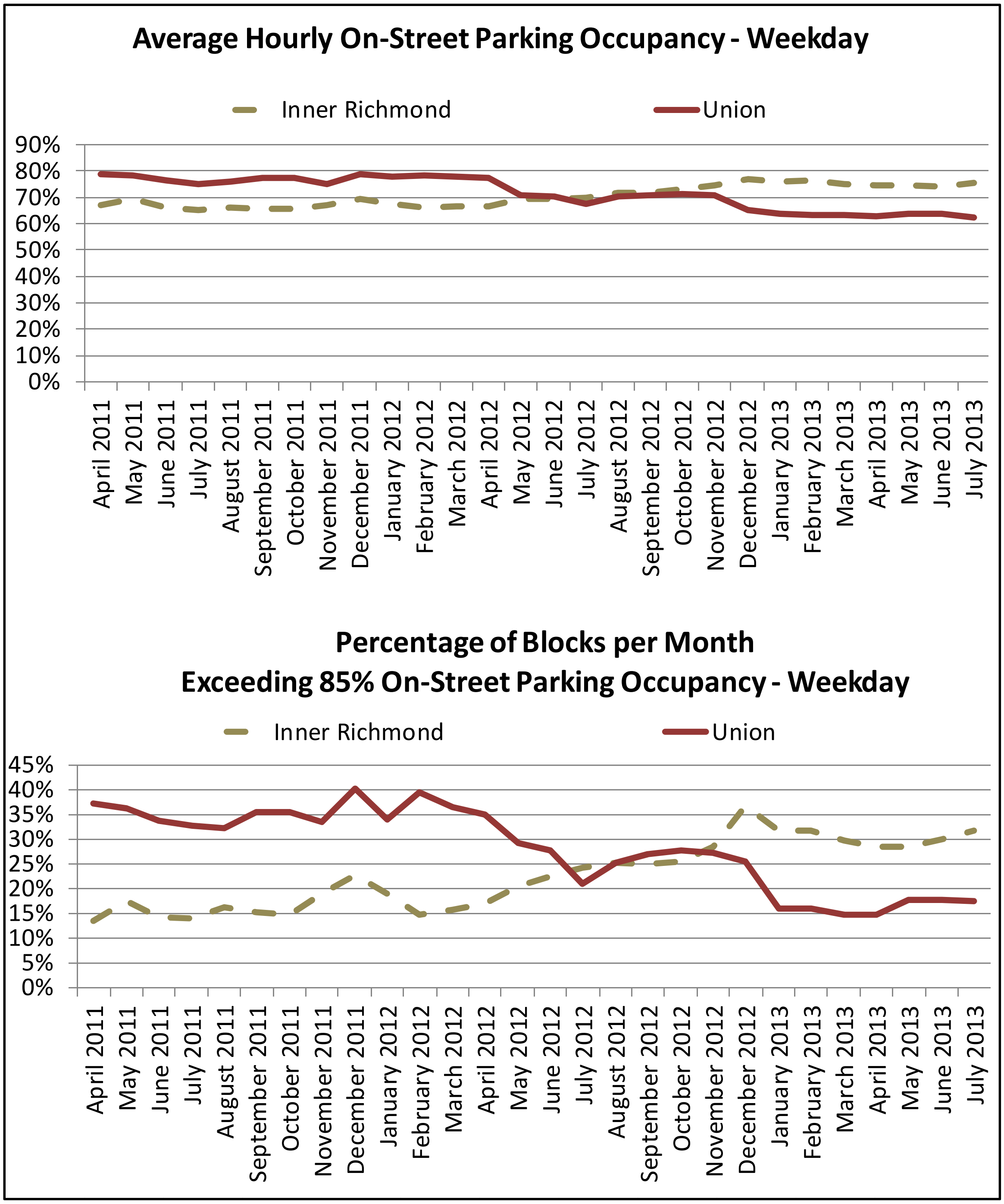


Source: Elliot Martin, 2014.

Figure B-64. Weekday Parking Occupancy Trends in Pilot Areas with Increases in Parking Occupancy

Finally, Figure B-65 shows the trends for the two occupancy metrics for the control areas. These areas, the Inner Richmond and Union, behaved entirely opposite each other. The Inner Richmond, which began the evaluation period at an average occupancy of 67 percent, had flat occupancy and then rose continuously towards the latter half of the evaluation period. By contrast, the Union control area began at occupancies upwards of 80 percent, followed by flat and then declining occupancies.

The proportion of blocks exceeding 85 percent occupancy exhibited the same opposing trends. Within this trend, the Union exhibited two discrete periods of precipitous decline in parking occupancy. The first began in March of 2012, and lasted until July 2012, while the second began in December 2012, and ended in January 2013. Parking price was not changed in the Union during the evaluation period, so the movements cannot have been the result of SFMTA pricing actions (hence they were not included in the regression analysis). The Inner Richmond similarly did not experience any pricing actions and exhibited a steady rise in the proportion of blocks exceeding 85 percent occupancy. Taken together, the control areas do not show a single trend of activity in absence of managed parking pricing. Rather, other dynamics were at play, particularly in the Union, which is a small area adjacent to the Marina pilot area. The Inner Richmond, which is a residential area in the western part of the city, conveyed a trend synonymous with a growing economy and rising residential occupancies. The two control areas ultimately show that outside factors are present within the city, moving on-street parking occupancies in both directions to a sizable degree.



Source: Elliot Martin, 2014.

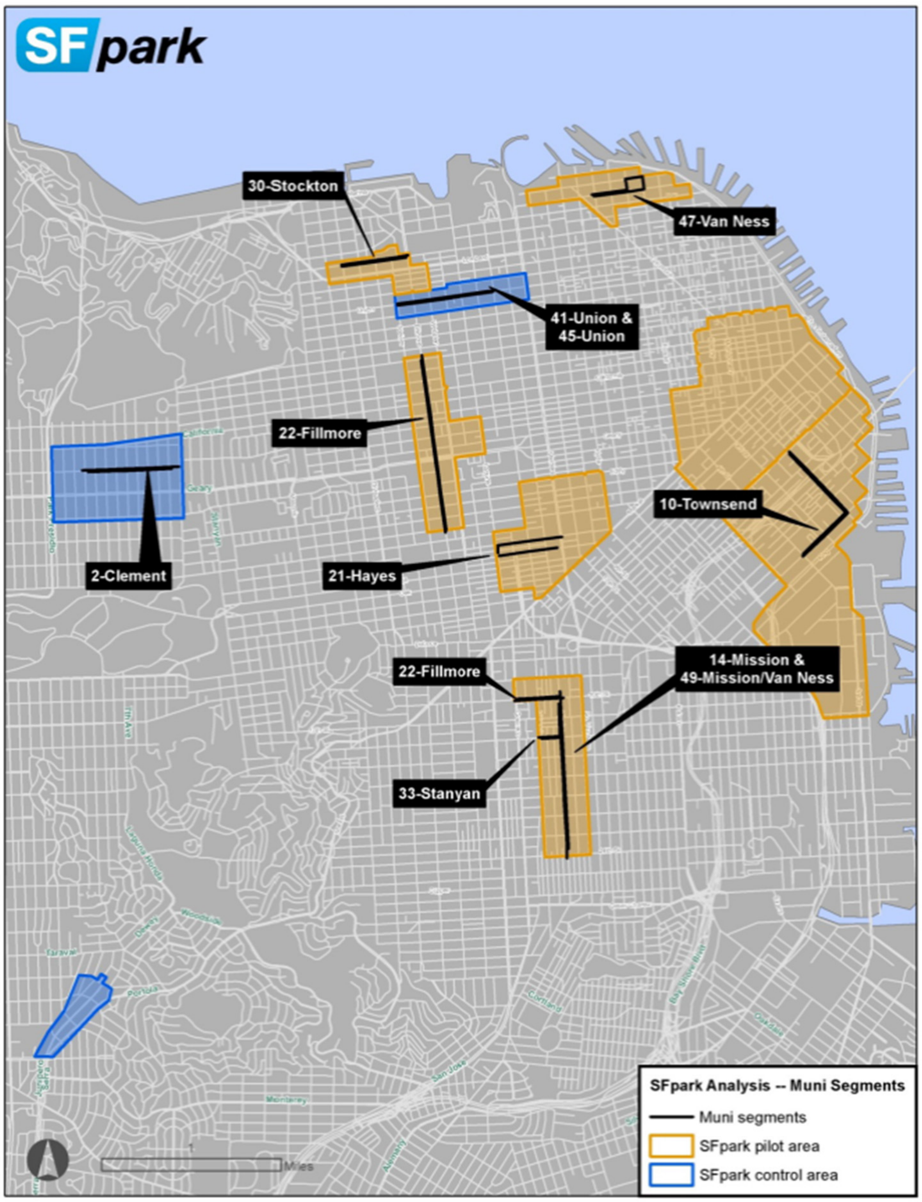
Figure B-65. Weekday Parking Occupancy Trends in Control Areas with Increases in Parking Occupancy

Overall, the cross-cutting results present evidence that the parking pricing actions taken by SFMTA in the SF*park* project were effective in reducing parking occupancies in the pilot areas with congested parking. The most consistent evidence to this effect is the 54 out 66 parking rate coefficients that were statistically significant and of the expected sign across all models estimated within the pilot areas during GMP hours. Notably, not one coefficient was statistically significant with a positive sign, indicating that people were responsive to individual block prices and that these block prices influenced average occupancy over time.

The trends in parking occupancy showed that pilot areas with higher initial parking occupancies experienced reductions in occupancy over time, whereas the pilot areas with lower initial occupancies experienced increases over time. These movements suggest that SFMTA's policy of lowering prices on under-utilized blocks was effective in producing higher utilization of existing on-street capacity. That is, SFMTA pricing activity was targeted at increasing parking availability where availability was scarce. Where parking availability was abundant, the data show that SFMTA pricing actions in SF*park* moved to raise parking occupancies, and that price reductions succeeded in advancing that goal. These simultaneous dynamics suggest that SF*park* was broadly successful in demonstrating that parking pricing management could be successfully used to better balance and distribute on-street parking utilization at the city scale.

B.5 Parking Pricing Effects on Public Transit

As part of the national evaluation, impacts of parking pricing on transit were examined. Specifically, it was hypothesized that parking pricing would improve reliability and speed of public transit. Appendix A – Congestion Analysis presented analysis of some transit data, including speed, and some of those findings are summarized in this section. This section also presents the effects of demand-based parking pricing on transit schedule adherence and on ridership. All the transit data were drawn from transit routes traversing SF*park* pilot and control areas shown in Figure B-66. Automatic passenger counters (APC) installed on a portion of the buses on these routes provided data for the analysis. Appendix A contains additional details about the APC data.

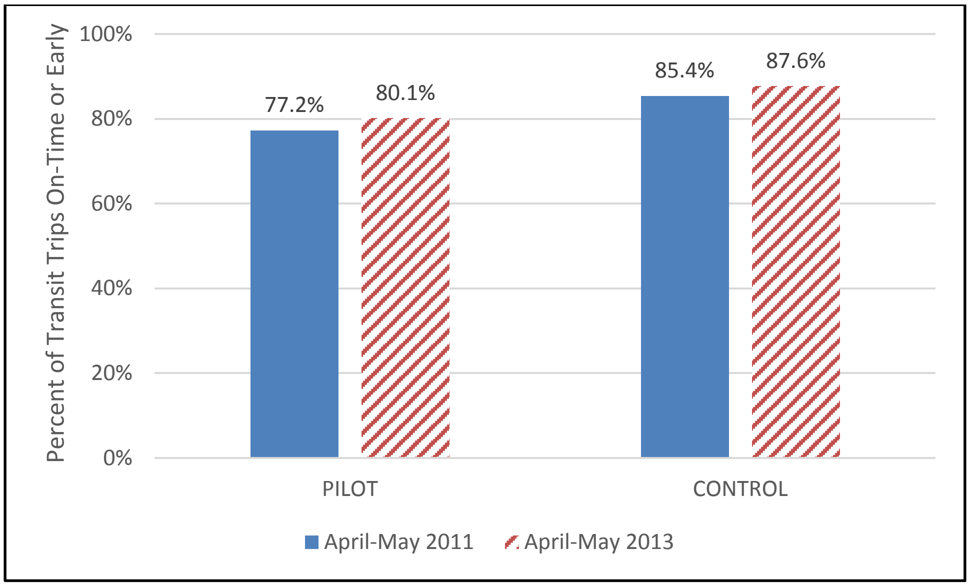


Source: SFMTA, 2013.

Figure B-66. Transit Routes Traversing SF*park* Pilot and Control Areas Used in the Evaluation

Transit Schedule Adherence

Transit bus schedule adherence data were used to determine whether parking pricing had any impact on transit reliability. Data were obtained from SFMTA's Muni buses for April 1-June 1 for 2011 and 2013 for the transit routes identified in Figure B-66 that traverse either the control or pilot areas. SFMTA defines on-time performance as the percentage of buses arriving at the designated time point between one-minute early and four-minutes late. Figure B-67 shows that schedule adherence for buses arriving either early or on-time increased by 2.9 percent for the pilot area and 2.3 percent for the control area. Each of these changes is significant at the 95 percent confidence level with a p-value less than 0.0001. However, the changes that occurred in the pilot and control areas over this time period were not statistically different from one another at the 95 percent confidence level (p-value = 0.4418).



Source: Battelle with data from SFMTA, 2014.

Figure B-67. Schedule Adherence for Transit Routes through Pilot and Control Areas for April and May in 2011 and 2013

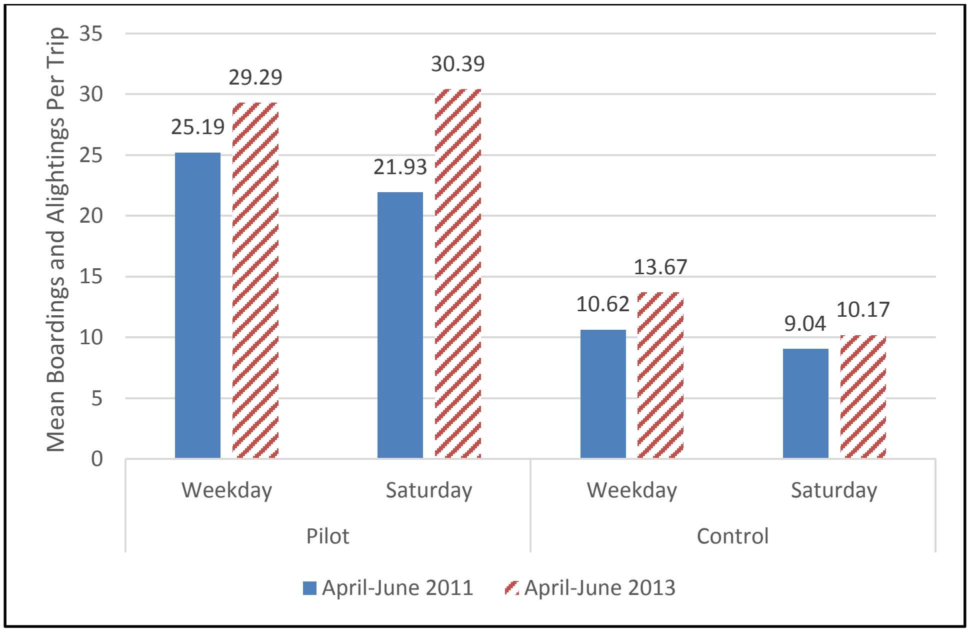
Transit Ridership

Transit ridership was analyzed using boardings and alightings data to identify any change in ridership on SF*park* pilot area transit routes compared to control routes. The total number of boardings and alightings for each transit trip for routes and areas identified in Figure B-66 were provided by SFMTA for April 1–June 30 (spring) in the baseline and post-deployment periods. To compare between areas and time periods, the mean number of boardings and alightings per transit trip was first calculated for spring 2011 and spring 2013, as shown in Table B-27. The change in ridership from spring 2011 to spring 2013 by area is shown in Figure B-68 for weekdays and Saturdays.

Table B-27. Summary Statistics for Boardings and Alightings (per trip) by Area

Area	Day of Week	Spring 2011 (Before)		Spring 2013 (After)	
		Transit Trips	Mean Boardings and Alightings per Trip (CI)	Transit Trips	Mean Boardings and Alightings per Trip (CI)
Pilot	Weekday	11974	25.20 (24.80, 25.60)	16487	29.29 (28.86, 29.71)
	Saturday	2103	21.93 (20.93, 22.92)	2395	30.39 (29.24, 31.54)
Control	Weekday	3204	10.62 (10.35, 10.89)	3392	13.67 (13.25, 14.10)
	Saturday	535	9.04 (8.54, 9.55)	396	10.17 (9.44, 10.90)

Source: Battelle based on SFMTA data, 2014.



Source: Battelle based on SFMTA data, 2014.

Figure B-68. Mean Boardings and Alightings per Trip by Area

To statistically compare changes that occurred from the baseline to post-deployment period, an ANOVA model was fitted to the data with fixed effects for time period and area (pilot/control). An interaction term was added to test whether the difference between control and pilot areas was different between spring 2011 and spring 2013. A significant interaction effect would support the notion that variable pricing in the pilot areas could account for the observed difference.

For weekdays, the results of the ANOVA model in Table B-28 revealed a significant difference in the number of people boarding and alighting between the baseline and post-deployment period in the pilot areas as well as in the control areas (p-value<-0.0001). The interaction effect was not significant (p-value=0.1116), indicating that the mean difference between the boardings and alightings from the baseline to post-deployment period was not significantly different between control and pilot areas. For the pilot areas, there were 4.09 more boardings and alightings per trip on average in spring 2013 than in spring 2011. In the control areas, there were 3.06 more boardings and alightings per trip on average in spring 2013 than in spring 2011.

For Saturdays, the results of the ANOVA model showed that there was a significant difference in the number of people boarding and alighting between baseline and post-deployment periods in the pilot areas (p-value<-0.0001), but not in the control areas (p-value=0.4791). The interaction effect was also significant (p-value<0.0001), which means that the mean difference between the boardings and alightings in the baseline and post-deployment periods was significantly different across control versus pilot areas. For the pilot areas, there were 8.46 more boardings and alightings per trip on average in spring 2013 than in spring 2011. In the control areas, there were 1.13 more boardings and alightings per trip on average in spring 2013 than in spring 2011.

Table B-28. Results from ANOVA Model Testing for Significant Differences in Boardings and Alightings (per trip) between Pilot and Control Areas by Wave

Day of Week	Comparison	Difference in Average Boardings and Alightings	P-Value
Weekdays	Pilot Area (Spring 2013 – Spring 2011)	**4.09**	**<0.0001***
	Control Area (Spring 2013 – Spring 2011)	**3.06**	**<0.0001***
	[Pilot Area (Spring 2013 – Spring 2011)] – [Control Area (Spring 2013 – Spring 2011)]	1.03	0.1116
Saturday	Pilot Area (Spring 2013 – Spring 2011)	**8.46**	**<0.0001***
	Control Area (Spring 2013 – Spring 2011)	1.13	0.4791
	[Pilot Area (Spring 2013 – Spring 2011)] – [Control Area (Spring 2013 – Spring 2011)]	**7.33**	**<0.0001***

*Values in bold indicate the comparison was significant at the 0.05 level

Source: Battelle based on SFMTA data, 2014.

The data on boardings and alightings showed higher ridership in the spring of 2013 compared to 2011 in both pilot and control areas. The pilot areas showed a bigger before/after difference than the control areas, with a much larger difference on Saturdays. With regard to the impact of variable pricing, the evidence (interaction effect in the ANOVA model) supports variable pricing as an explanation for Saturday increases in ridership in the pilot areas, but not the weekday increases in ridership.

Transit Speed

Analysis of the speed of buses through the pilot and control areas was presented in Appendix A – Congestion Analysis. Muni buses equipped with automatic passenger counters on routes through the pilot and control areas was the source of the data, which were edited to remove dwell time as buses loaded and unloaded passengers at stops. Comparison of transit speed data from the spring of 2011, prior to the implementation of variable pricing in the pilot areas, to the spring of 2012 and spring of 2013 revealed little impact from pricing on transit speeds in the pilot areas. The results presented in Appendix A showed that average transit speeds declined, stayed the same, or increased, depending upon the particular pilot area. However, from 2011 to 2013 all the observed changes in the pilot areas were less than 0.5 mph – except for the 0.8 mph decrease in the South Embarcadero pilot area. The two control areas in the analysis experienced declines averaging 0.1 mph. Despite tests indicating statistical significance, these modest differences over time and between pilot and control areas suggest minimal change, if any, on transit speeds due to variable pricing.

B.6 Summary of Pricing Analysis

Table B-29 presents a summary of the pricing analysis across the six hypotheses. Analysis of parking sensor data supported the first hypothesis that parking pricing increased parking availability, despite the fact that analysis of data from a survey of disabled placard parking suggested no significant change on blocks where there was heavy use of disabled placard parking. The impact of parking pricing on parking availability was primarily measured by 1) the trend in average on-street occupancy, 2) the trend of the percentage of blocks exceeding 85 percent occupancy, and 3) a regression analysis of parking price on parking occupancy. The regression analysis almost universally showed that average block occupancy had a negative and statistically significant relationship with parking price. That is, when price went up occupancy went down and vice versa.

Table B-29. Summary of Pricing Analysis across Hypotheses

Hypotheses/ Questions	Result	Evidence
Parking pricing will increase parking availability.	Mostly supported	A regression analysis of parking price on parking occupancy almost universally showed that average block occupancy had a negative and statistically significant relationship with parking price. Average occupancy and the percentage of blocks exceeding 85 percent occupancy differed depending on the pilot area. In highly congested areas (i.e., Civic Center, Downtown, Fillmore, and Marina), average occupancy stayed flat while the proportion of blocks exceeding 85 percent declined. In the Fisherman's Wharf and South Embarcadero, both metrics increased over time, likely due to increased economic activity in Fisherman's Wharf and in both South Embarcadero and Fisherman's Wharf a broad reduction in on-street parking price based meant to raise occupancy levels. Regarding the evaluation of disabled placards, a separate modeling analysis for the field data indicated that there was no significant change from 2011 to 2013 in the rate of disabled placard parking in both the pilot and the control areas. This suggests that the effectiveness of SF*park* may be hindered where and when disabled placard parking is widespread.
Parking pricing will lead to reduced search time.	Supported	The models using the parking search time field data indicate a 15% reduction in parking search time in the pilot relative to the control.
Parking pricing will reduce double parking.	Somewhat supported	Model results for field data indicate that double parking for personal vehicle may have been reduced by about 14% and for commercial vehicles by about 21% in the pilot versus the control. However, due to the variability in the double parking rate data, the sample size may not have been large enough to conclude that the differences observed in the control and pilot areas were significantly different.

Table B-29. Summary of Pricing Analysis across Hypotheses (Continued)

Hypotheses/ Questions	Result	Evidence
Parking pricing will shorten the duration of the average on-street parking session.	Not supported	Payment data was used to evaluate session length given the absence of session data from sensors. Analysis showed that payment duration for on-street parking rose or stayed flat in most every pilot area during weekdays and weekends. In Civic Center, Fisherman's Wharf, and South Embarcadero average parking session length rose from 0.8 hours to between 1.4 and 2.0 hours (depending on location and time of day). In the Downtown, Fillmore, Marina, and Mission, parking session length remained mostly flat following an initial increase. This result was not solely influenced by pricing. Installation of smart meters eliminated the need for coinage, making longer sessions easier to purchase. In addition, SFMTA reduced prices on many blocks, making longer sessions more affordable. Also, allowable time at meters went up substantially (to at least four hours), which allowed people to stay longer. These factors produced trends that were counter to the initial expectations of the evaluation.
Parking pricing will improve the reliability and speed of public transit.	Not supported	Reliability measured by schedule adherence of Muni buses improved between 2 and 3 percent, but the difference between pilot and control areas was not statistically different. Changes in transit speed were minimal and were not in a consistent direction among pilot areas, indicating no impact from variable pricing.
Parking pricing will cause a shift to other modes and parking garages.	Somewhat supported	The models using data from the visitor/shopper survey indicate no significant change between control and pilot areas in terms of mode or type of parking. However, several of the pilot areas exhibited increased utilization of SFMTA and non-SFMTA garages and off-street lots. Upward trends in off-street parking were not shared across all pilot areas. But increases of transient entrances to SFMTA garages were as high as 45% in the Civic Center, 15% in Downtown and 32% in the Marina. These increases, alongside the general upward trend in parking tax receipts in most areas, support the hypothesis that some shift to off-street parking did occur.

Source: Battelle, 2014.

The direction of trends in average occupancy and the percentage of blocks exceeding 85 percent occupancy differed depending on the pilot area. In highly congested areas such as the Civic Center, Downtown, Fillmore, and the Marina, average occupancy stayed flat while the proportion of blocks exceeding 85 percent occupancy declined. This pointed to a desirable spatial spreading of parking availability in the face of constant overall average parking occupancy. In the Fisherman's Wharf and South Embarcadero, both occupancy metrics increased over time, but with low baseline occupancies this was not a negative result. This likely resulted from increased economic activity in tourist-heavy Fisherman's Wharf and in both Fisherman's Wharf and South Embarcadero a broad reduction in on-street parking price meant to raise low occupancy levels.

The analysis supported the second hypothesis that parking pricing would reduce parking search time. Models using the parking search time survey data indicated a 15 percent reduction in parking search time in the pilot areas relative to the control areas.

The analysis somewhat supported the third hypothesis on double parking. Models using field data showed that that double parking for personal vehicles was reduced by about 14 percent and for commercial vehicles by about 21 percent in the pilot versus the control areas, but the reduction was not statistically significant, possibly indicative of the need for a larger sample size.

To assess the fourth hypothesis, parking duration was analyzed by evaluating the time duration of on-street parking sessions purchased through payment data. Sensor reported sessions turned out not to be useful for reporting discrete session times, and instead payment data was applied to evaluate parking duration. Payment duration was considered a viable proxy as it signaled "expected or intended session length" on the part of the paying user. The evidence from analysis of the payment session data broadly suggests that the average parking session length increased or did not change, but it did not go down as was hypothesized. The results showed that the duration of parking length rose or stayed flat in every pilot area during both weekdays and weekends. In the Civic Center, Fisherman's Wharf, and South Embarcadero parking areas, average parking session length rose steadily from 0.8 hours to between 1.4 and 2.0 hours. In the Downtown, Fillmore, Marina, and Mission parking areas, parking session length remained mostly flat following an initial increase at the beginning of the evaluation period. The observed increase in session length was likely in part due to the installation of smart meters that made advanced payment methods available for on-street parking during the project, which eliminated the need for coins to pay the meter. In addition, some blocks (particularly in the Fisherman's Wharf and South Embarcadero) experienced considerable price declines, making longer parking sessions more affordable. Also, allowable time at meters went up substantially (to at least four hours), which allowed people to stay longer. These factors produced trends that were counter to the initial expectations of the evaluation.

In the fifth hypothesis parking pricing was expected to improve the reliability and speed of public transit, but that was not supported by the data. Transit reliability was measured by schedule adherence for buses arriving either early or on-time. Data on Muni buses traversing the pilot and control areas showed an improvement in schedule adherence of 2.9 percent for the pilot areas and 2.3 percent for the control areas, but the difference between the pilot and control areas was not statistically significant, and thus variable parking pricing appeared not to have made a difference. Data on average transit speeds showed a decline, no change, or an increase, depending upon the particular pilot area. However, across all the pilot areas the observed changes were less than 0.5 mph – except for a 0.8 mph decrease in the South Embarcadero pilot area. The two control areas in the analysis showed a decline of an average 0.1 mph. These modest differences over time and between pilot and control areas suggest minimal change, if any, on transit speeds due to variable pricing.

The expectation in the sixth hypothesis was that pricing would cause a change in modes and use of parking garages. Statistical analyses of the visitor/shopper survey indicated no significant change in the respondents' travel modes after variable pricing went into effect and no change in use of parking garages between the pilot and control areas. In some of the pilot regions, particularly the Civic Center, Downtown, and Marina, the trend in transient (non-monthly) entrances to several SFMTA parking garages did exhibit a notable increase. From the start to end of the evaluation period, transient parking entrances ended 45 percent higher in the Civic Center, 15 percent higher in the Downtown, and 32 percent higher in the Marina. The Fillmore and Mission also had SFMTA garages, but exhibited only a 5 percent and -2 percent change in entrances respectively. Because there were no SFMTA garages in the control areas, a pilot and control comparison on public garages could not be made. A comparison of the normalized trends in parking tax receipts from private garages across all regions (pilot and control) showed that all regions exhibited an upward trend in parking tax receipts, though some regions more than others. Thus, while the visitor/shopper survey showed no significant change in garage activity, a general increase in garage utilization was observed in the data within select areas.

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Appendix C. Technology Analysis

Technology was an important element of the San Francisco Urban Partnership Agreement (UPA) projects. Intelligent transportation systems (ITS) underlie SF*park*, which uses networked parking meters, parking occupancy sensors, and, until recently, real-time parking information systems. Information dissemination technologies included the SF*park* website and mobile app, MTC's enhanced 511 phone system and website, and variable message signs. Due to the delay in implementing the variable message signs, they were not included in the national evaluation. Similarly, use of the regional Clipper® card for parking payment was removed from the evaluation when its schedule no longer aligned with the rest of the UPA. Thus, the technology analysis evaluated the technology used to manage SF*park* and the real-time parking information systems used by travelers. The technology analysis focused on the ITS technologies supporting the parking management and congestion-reducing objectives and not on determining how well the technology performed.

Table C-1 presents the two hypotheses for assessing the San Francisco UPA technology elements. The first hypothesis is that implementing advanced parking technology will improve the local agency's ability to manage parking. The second hypothesis is that improving the dissemination of parking information via the 511 phone system, websites, and text messaging will reduce parking search times.

Table C-1. San Francisco UPA Technology Analysis Hypotheses

Hypotheses
• Implementing advanced parking technology will improve the local agency's ability to manage parking
• Improving the dissemination of parking information via the 511 phone system and websites[1] will reduce parking search times.

Source: Battelle, 2014.

The remainder of this appendix is divided into six sections. The data sources used in the analysis are described in Section C.1. Section C.2 summarizes the results of interviews with representatives from the San Francisco Municipal Transportation Agency (SFMTA) on the impacts of the parking sensors and the parking meters on improving parking management. Information from the post-deployment workshop with SFMTA personnel is also presented. Section C.3 highlights aspects of the parking assessment presented in Appendix B – Parking Analysis related to the role of technology in supporting parking management. Section C.4 examines changes in the number of parking citations issued before and after deployment of the new parking meters. Section C.5 presents findings of the evaluation of the parking information dissemination to travelers. The appendix concludes with a summary of the technology analysis hypotheses in Section C.6.

[1] The hypothesis originally included SFMTA's text messaging method of parking information dissemination. However, SFMTA discontinued text messaging after a few months due to low usage, and, thus, that dissemination method was eliminated from the national evaluation.

C.1 Data Sources

The data used in the technology analysis came primarily from six sources. First, the pre- and post-deployment interviews and workshops with SFMTA personnel provided perspectives on the contribution of the advanced parking technology to improve SFMTA's ability to manage parking. The interviews and the workshop are both discussed more extensively in Appendix H – Non-Technical Success Factors Analysis. Second, information on testing, implementing, and operating the parking technology contained in the SFMTA monthly e-mail status reports were reviewed. Third, information from Appendix B – Parking Analysis on the use of data from the parking sensors and the parking meters to manage parking is summarized. Fourth, the SF*park* meter-related citation dataset was examined to assess changes in the number of citations issued during the project. Fifth, records on the usage of real-time parking information technologies were obtained from SFMTA and MTC and examined. Sixth, the visitor/shopper survey provided data on the use of parking information sources by travelers. Details about the survey methodology are presented in Appendix B.

C.2 Perceptions of San Francisco Municipal Transportation Agency Staff

As part of the national evaluation, members of the Battelle team conducted two rounds of interviews and workshops with representatives from the local partnership agencies. The first interviews and workshop were conducted in the fall of 2010, prior to deployment of SF*park*. The second set of interviews was completed in the summer of 2012 and the second workshop was held in September 2012. The purpose of the interviews and workshops was to gain additional insights into the institutional arrangements, partnerships, outreach methods, and other activities contributing to planning, deploying, and operating the San Francisco UPA projects.

The pre-deployment interviews with two SFMTA staff included information on the parking sensor technology. The post-deployment interviews and workshop with SFMTA sought to gain insights into the parking management system, including perceptions related to the parking technology. For that purpose seven SFMTA staff members were included in the post-deployment interviews and eight participated in the post-deployment workshop.

Questions in the post-deployment interviews and the workshop focused on a number of topics, including the advanced parking system technologies and the ability to better manage parking in the SF*park* pilot areas. This section summarizes responses to interview questions and comments at the post-deployment workshop related to the parking sensor and parking meter technologies and parking management.

The SFMTA personnel included in the interviews and the workshops were responsible for the various aspects of SF*park*, including executive sponsorship, project management, contract management, parking meters, parking and traffic operations, parking enforcement, and media relations. Most of the same SFMTA representatives participated in the post-deployment workshop.

SF*park* is an advanced technology-based parking management system that relies on state-of-the-art field equipment on-street and in garages connected via wireless and wired communication systems to a sophisticated business intelligence system that stores and processes parking and other data used by SFMTA staff for managing the variable parking pricing system. To obtain real-time parking occupancy data used in for pricing decisions, in-ground parking sensors (Figure C-1) were installed in the SF*park* pilot and control areas and garage hardware was upgraded at the SFMTA-owned garages. SFMTA also installed advanced meter technology in the pilot areas (Figure C-2) that provided for new payment methods for customers and enabled SFMTA to expand parking time limits.

Source: SFMTA, 2013.

Figure C-1. In-ground Parking Sensor

Source: SFMTA, 2013.

Figure C-2. Advanced Parking Meters Used in San Francisco

All of the SFMTA personnel indicated that the advanced parking technology, including the parking occupancy sensors and the parking meters, improved the agency's ability to manage parking in the SF*park* pilot project sites. The initial technology problems with the parking sensors, which caused project implementation delays, were noted as an issue. The shorter than anticipated battery life of the parking sensors was also discussed. Even with these concerns, agency personnel reported that the system worked well and provided the data needed to manage parking pricing at the pilot sites. SFMTA personnel noted that the parking sensor technology was still new and evolving. They further noted that SF*park* helped accelerate the development of parking sensor technology and the use of parking sensor data.[2]

The issues encountered with the parking sensors throughout the project were noted by SFMTA personnel in the interviews and workshops, and were documented in the monthly summaries. The initial parking sensors did not meet the SFMTA performance standards. As a result, the contractor removed them and the SFMTA never paid for the sensors. A second parking sensor vendor was used by the contractor. The second technology met the performance standards, but the battery life of the sensors was much less than anticipated, causing an unexpected problem.

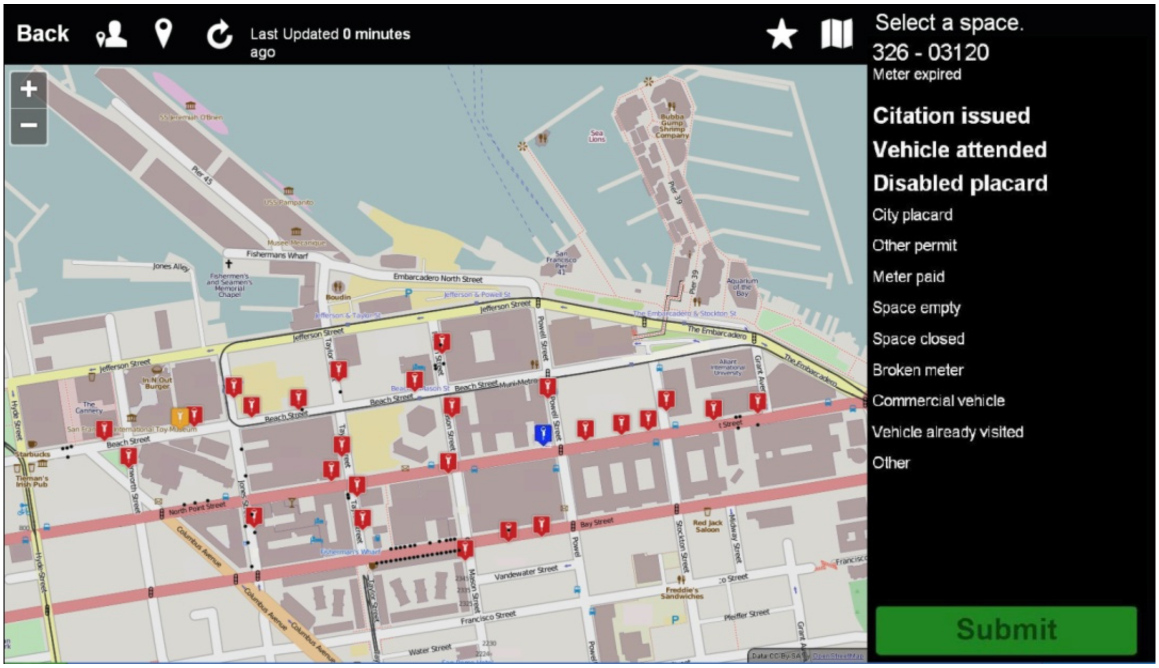
SFMTA personnel noted that the capabilities of the parking sensor technology may have been over-estimated at the beginning of the project. SFMTA staff further suggested that by serving as a test site for parking sensor technology, SF*park* helped accelerate the development of sensor technology. SFMTA personnel noted the project was successfully deployed even with the parking sensor problems. They indicated that implementing all the project components was a major accomplishment.

SFMTA personnel reported that the new parking meters were operating well. They indicated that no major problems were encountered with implementing and operating the new meters. It was noted that the new parking meters were well received by the public. The ability to pay for parking using cash, credit cards, SFMTA issued parking/debit cards, and cellphones has been viewed positively by the public. SFMTA personnel suggested that more people are paying for parking now, because is it easier, rather than risking receiving a citation.

SFMTA personnel suggested that the technology enabled the implementation of SF*park*, which moved parking rate setting away from political considerations and into the market place. It was noted that this focus on market-based demand represented a culture change. It was further suggested that the technology and the ability to deliver the innovative project established credibility for SFMTA locally and brought national attention.

The development and testing of a handheld enforcement device was identified as another technology that will contribute to the ability of SFMTA to manage parking. The initial prototype shown in Figure C-3 provided enhanced enforcement efficiency. It was noted that the ongoing development of this system will provide future benefits.

[2] At the time of the post-deployment workshop in 2012 the battery-life issue did not appear to be as big a problem as it was ultimately found to be. Over a year later in December 2013, SFMTA discontinued use of the parking sensors citing battery life as announced on their website: "As of December 30, 2013, the parking sensors in the street will be turned off and their data feed will no longer be available as parking sensor batteries have reached the end of their useful lives. This means that the real-time information on parking space occupancy will not be available for mobile apps and similar uses." (http://sfpark.org/2013/12/16/sfpark-pilot-evaluation-and-mobile-app-changes/).



Source: SFMTA, 2014.

Figure C-3. reEnforce Data Collection Tool Piloted by SFMTA Parking Control Officers

C.3 Parking Management Summary

Appendix B – Pricing Analysis contains a detailed assessment of SF*park* pricing strategies. The appendix analyzes various metrics, including parking occupancy, parking rate changes, and differences in average occupancy and average price for blocks with and without a price change. The appendix also describes the parking sensor and parking meter technology used to gather the data needed for the management system, as well as the size and complexity of the resulting SFMTA parking data set.

The analysis, based on parking occupancy data through May 31, 2013, notes the issues encountered with the parking sensors, including the less-than-anticipated battery life and the decline in working sensors over time. The analysis indicated that even with these concerns, however, the data from the sensors were sufficient to support the pricing changes and parking management at the SF*park* pilot sites through May 31, 2013, the end of the national evaluation data collection. The analysis further suggests that the wealth of sensor data can be used to calibrate data from existing and new parking meters in the future.

Overall, the analysis indicated that the parking sensor and parking meter technology provided the data needed for the SF*park* management system. As a result, the technology improved SFMTA's ability to manage parking at the pilot areas.

C.4 Changes in Parking Meter Citations

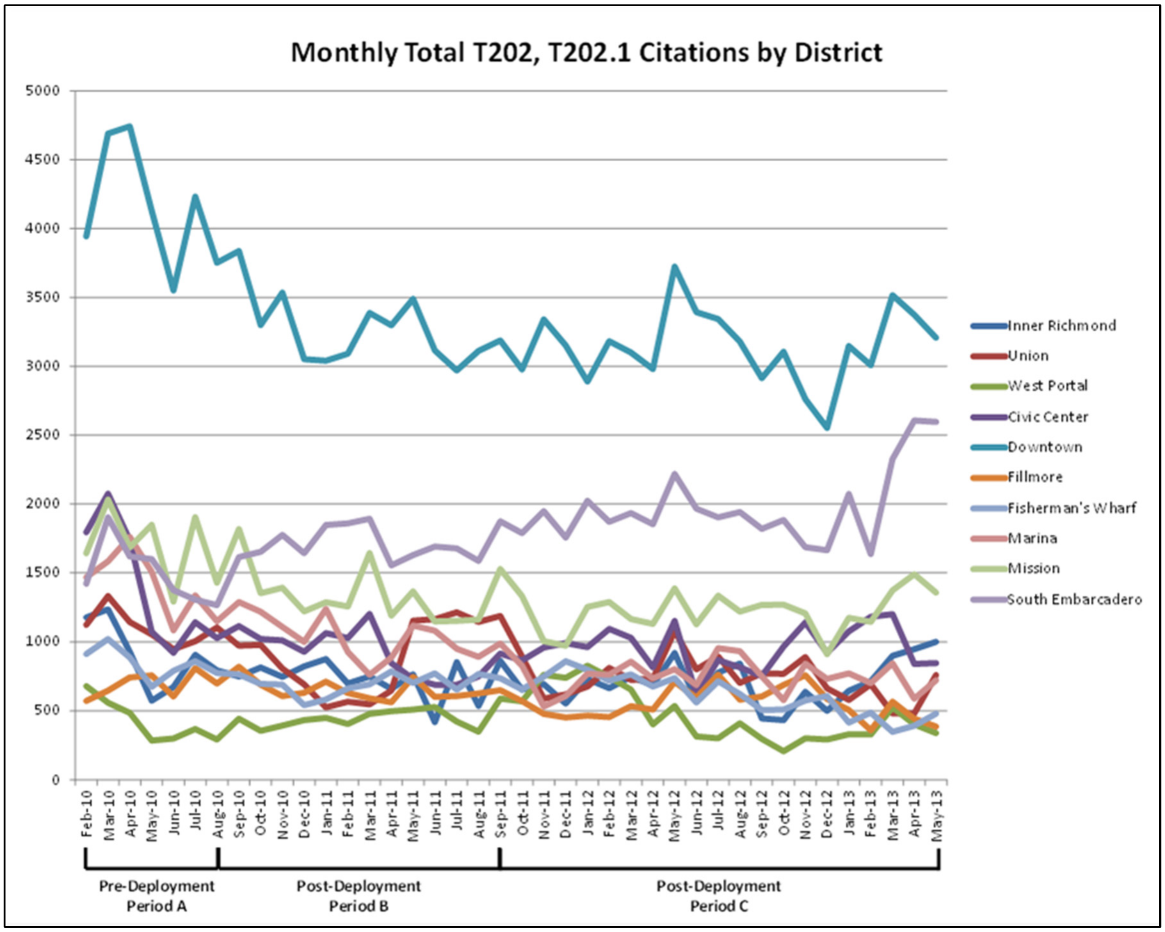
Monthly parking citation data were examined for the period from February 2010 through June 2013. The number of violations cited for meters in the pilot and control areas was obtained from the SFMTA meter-related citation dataset. Information on the contents and potential limitations of the data set is included in the SFMTA Meter-Related Citation Data Guide.[3] The dataset includes the citations issued by parking control officers (PCOs). There were approximately 270 PCOs covering parking areas throughout the city before and during the demonstration, although the exact number may have varied by year based on budget limitations. While the PCOs were deployed 24 hours a day, seven days a week, the largest meter enforcement shifts were Monday through Saturday from 6:00 a.m. to 8:00 p.m. and Sundays from 11:00 a.m. to 6:30 p.m. Shifts typically began at 6:00 a.m., 9:00 a.m., and 11:00 a.m., with PCOs traveling their beats by driving, bicycling, and by walking.

The guide noted the following limitations with use of the dataset. First, the citation data may have been influenced by the number of officers deployed, the total hours of deployment, changes in beat and citation type assignments, special events, and fixed post assignments. For example, the meter post identifications were input by PCOs by “free form” entry with no validation prior to December 2011. In addition, the guide notes that preliminary analysis indicated that approximately five percent of all citation data was not transmitted from Xerox to the SFMTA. As a result, the guide indicated that “definitive conclusions regarding trends in citations issued may be difficult to obtain.”

The number of parking meter citations issued on weekdays was examined by month from February 2010 through June 2013 for the pilot and control areas. The citations include the number of violations for individual meters each weekday. The violation codes examined for this analysis were T202-PRK METER, which included violations for a vehicle parked at an expired meter, overtime at a meter, and parked longer than two hours at a broken meter. The analysis also included T202.1, PRK METER DOWNTOWN, which uses the same definitions but for the downtown district.

Figure C-4 presents the monthly total citations for the pilot and control districts for the pre-deployment period (February 2010 – July 2010), the first post-deployment period (September 2010 – August 2011), and the second post-deployment period (September 2012 – May 2013). These three periods are designated A, B, and C, respectively, in the following discussion. The monthly totals exhibit a range of changes over the 39-month time period. While many districts experienced declines in the number of citations, especially during pre-deployment period A, no specific trends are evident.

[3] Meter-Related Citations Guide, San Francisco Municipal Transportation Agency, November 22, 2013.



Source: Texas A&M Transportation Institute, based on data from SFMTA data, 2014.

Figure C-4. Monthly Total Citations by Pilot and Control Districts

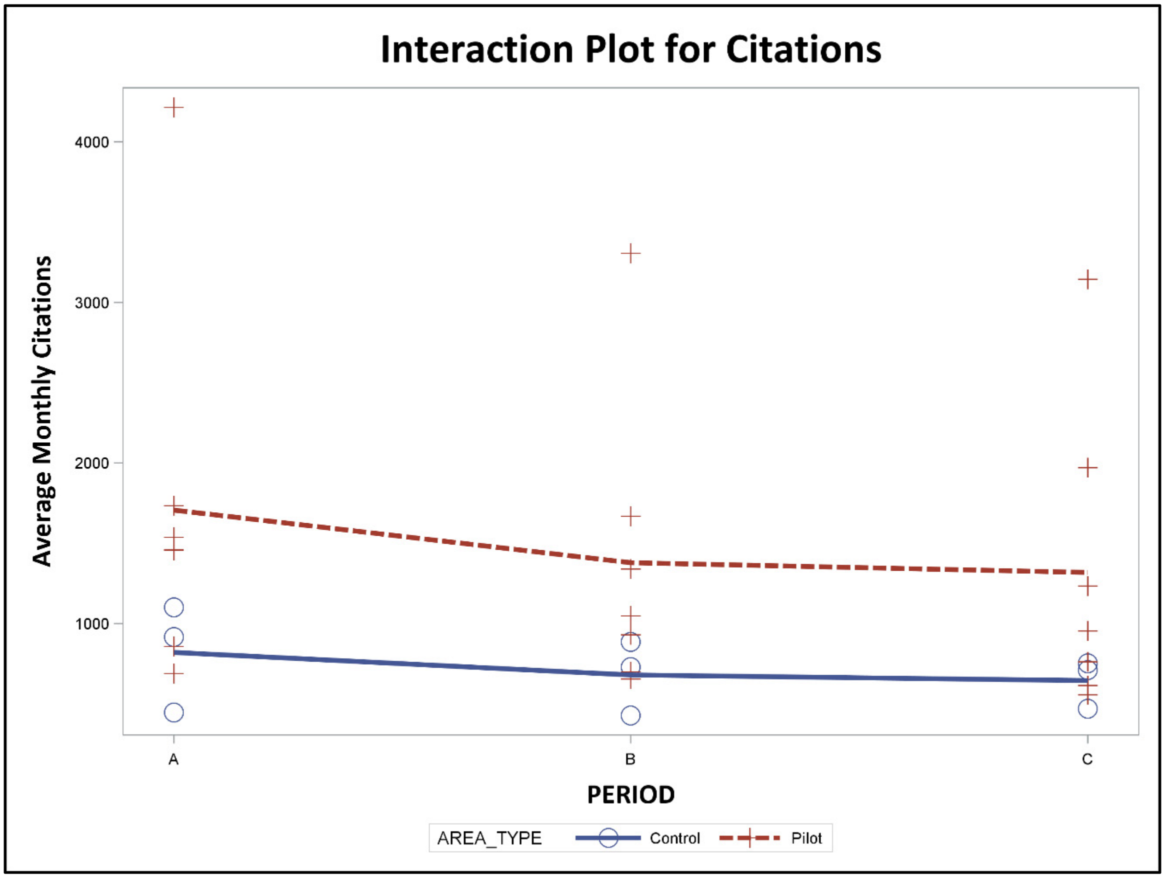
A two-way mixed analysis of variance (ANOVA) was conducted to analyze the number of citations by the three time periods (A, B, and C) and the two district types (control and pilot). The analysis used average monthly citations in each parking district. The total number of monthly citations was averaged over all months within each period to reduce the potential for correlated observations within each parking district and to mitigate the effect of different numbers of months for each period. This information, which is presented in Table C-2, was used for the ANOVA. As evident in Table C-2, the Downtown pilot parking area plays a large role in the analysis, accounting for approximately 34 percent of the total citations in the pilot areas in all three time periods.

Table C-2. Average Monthly Citations by Parking District for Parking Meter Violations (T202, T202.1)

Parking Area	Parking District	Average Monthly Citations		
		Period A February 2010 – July 2010	Period B August 2010 – August 2011	Period C September 2011 – May 2013
Control	Inner Richmond	916	730	711
	Union	1101	886	752
	West Portal	447	428	470
Pilot	Civic Center	1458	931	953
	Downtown	4215	3306	3145
	Fillmore	689	656	555
	Fisherman's Wharf	858	699	615
	Marina	1457	1048	761
	Mission	1734	1340	1235
	South Embarcadero	1538	1669	1971

Source: Texas A&M Transportation Institute, based on data from SFMTA data, 2014.

Figure C-5 illustrates the mean trends of parking meter citations (T202 and T202.1) by period and area type. The figure indicates a decline in the number of parking citations issued in the pilot districts from the pre-deployment period A to the post-deployment period B, when the new parking meters were deployed, and a leveling off during post-deployment period C. These results may indicate that the introduction of the new meters, with multiple payment methods, had more of an impact on reducing citations than the pricing changes. The control districts did not exhibit as much of a decline from the pre-deployment period to the post-deployment period B. The large outliers in the figure represent the Downtown pilot district.



Source: Texas A&M Transportation Institute, based on data from SFMTA, 2014.

Figure C-5. Interaction Plot for Citations

A two-way mixture ANOVA model was fit to the data, with period and area type (pilot and control) as fixed effects and parking district as a random effect nested within area type. Because of the dominance of Downtown in the citation data, the analysis was performed both with and without citations from Downtown. The results for tests of the fixed effects are presented in Table C-3. When Downtown is included, period is seen here to be statistically significant at the .05 significance level (p = 0.0425) whereas area type is not (p = 0.2455). When Downtown was excluded from the analysis, the effect of period became statistically insignificant at α=0.05 (although only marginally so at (p = 0.0620), indicating the important influence of Downtown on the decline in citations.

Table C-3. ANOVA Results for Monthly Average Parking Meter Citations by Area

	Type III Tests of Fixed Effects				
	Effect	**Numerator DF**	**Denominator DF**	**F Value**	**Pr > F**
Analysis with Downtown	Period	2	16	3.87	0.0425*
	Area	1	8	1.57	0.2455
	Period x Area	2	16	0.57	0.5765
Analysis without Downtown	Period	2	14	3.41	0.0620
	Area	1	7	2.35	0.1694
	Period x Area	2	14	0.18	0.8405

*Significant at P-level <.05.

Source: Texas A&M Transportation Institute, based on data from SFMTA data, 2014.

Table C-4 lists the average monthly citations by period and their associated standard deviations in parentheses, as well as the differences and percent changes across periods for control and pilot areas. Tukey-Kramer multiple comparison tests between treatment means indicated that differences in citations between the time periods presented in Table C-4 for the control and pilot sites were not statistically significant at the 5 percent significant level with one exception. The difference for C-A in the pilot area was statistically significant at the .05 significance level when Downtown was included. When Downtown was excluded from the analysis, however, the difference for C-A became statistically insignificant α=0.05. The percent changes for the pilot area were almost the same as the percent changes for the control area for all three periods whether or not Downtown was included.

Table C-4. Comparison of Monthly Average Citations in Control and Pilot Areas during Pre- and Post-Deployment Periods

(Standard Deviation in Parentheses)

Parking Area	Period A: Feb. 2010 – July 2010	Period B: Aug. 2010 – Aug. 2011	Period C: Sept. 2011 – May 2013	Change: A to B		Change: B to C		Change: A to C	
				Difference (B-A)	Percent Change (B-A)/A	Difference (C-B)	Percent Change (C-B)/B	Difference (C-A)	Percent Change (C-A)/A
Control	821.2 (337.3)	681.1 (232.9)	644.7 (152.4)	–140.1	–17.1%	–36.4	–5.3%	–176.5	–21.5%
Pilot (with Downtown	1706.9 (1169.0)	1378.5 (921.5)	1319.4 (938.9)	–328.4	–19.2%	–59.1	–4.3%	**–387.5***	–22.7%
Pilot (without Downtown)	1288.9 (415.6)	1057.2 (389.9)	1015.2 (529.4)	–231.7	–18.0%	–42	–4.0%	–273.7	–21.2%

*The difference was statistically significant at α=0.05. (The p-value was 0.0464.)

Source: Texas A&M Transportation Institute, based on data from SFMTA data, 2014.

The results of the citation analysis indicate that there was a reduction in the monthly average number of parking meter citations from the pre-deployment period through the two post-deployment periods for all of the pilot districts except the South Embarcadero District, which experienced an increase in citations. There was also a decrease in the number of parking citations at two of the three control districts, with the West Portal District experiencing a slight increase. The mixed effects ANOVA results and the percent changes between treatment measures indicated that these decreases were not significantly different between pilot and control areas, however. In pilot districts the deployment of the advanced parking technologies in period B and variable pricing in period C did not differentiate pilot from control areas in average monthly citations. Other factors than these, as well as the limitations in the parking citation dataset noted previously, may have hindered the ability of the analysis to fully detect and attribute changes in the parking citations in the pilot and control districts.

C.5 Parking Information Technology Usage

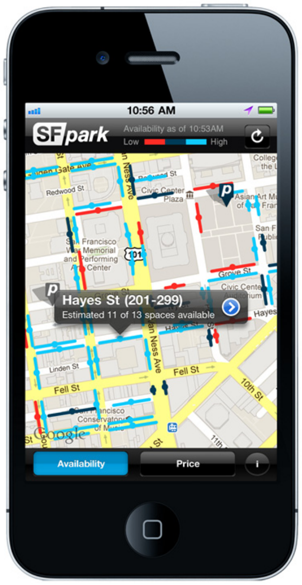
The focus of this analysis is on technologies used to access information on parking in San Francisco. Usage of the technologies and the information they provide over time serves as a gauge of their popularity. Users presumably use the information they obtain in their decisions about travel and parking. Data for the traveler information analysis was provided by SFMTA and MTC and includes SF*park*.org website utilization, SF*park* smartphone application downloads, 511 phone and web applications, and data from the visitor/shopper survey.

The information dissemination technologies deployed as part of the San Francisco UPA deployment are listed in Table C-5 below. These technologies included smartphone apps, the inclusion of parking information into the current 511 system, SFMTA website, and text messaging capabilities. Examples of the mobile app and 511 website that were used to disseminate parking information are shown in Figure C-6 and Figure C-7, respectively. Due to low usage, real-time parking information via text message was discontinued after 8.5 months. Also, the deployment of the dynamic message signs (DMS) was delayed to December 2011, placing them behind the schedule for other UPA projects at the time the evaluation was being planned. For these reasons, this analysis does not include the usage of text messaging or the DMS for disseminating parking information.

Table C-5. Parking Information Technology Projects

Parking Information Technology Project	Go Live Date
SF*park* iPhone App Launch	April 24, 2011
Real-time Parking Information on SFMTA Website	April 24, 2011
SF*park* Android App Launch	November 7, 2011
Real-time Parking Information via Text Messaging	September 15, 2011-June 1, 2012
511 Phone Real-time Parking Information	May 23, 2012
Real-time Parking Information on Dynamic Message Signs	December 2011
Real-time Parking on 511 Website and MY511	March 2012

Source: Battelle, 2014.



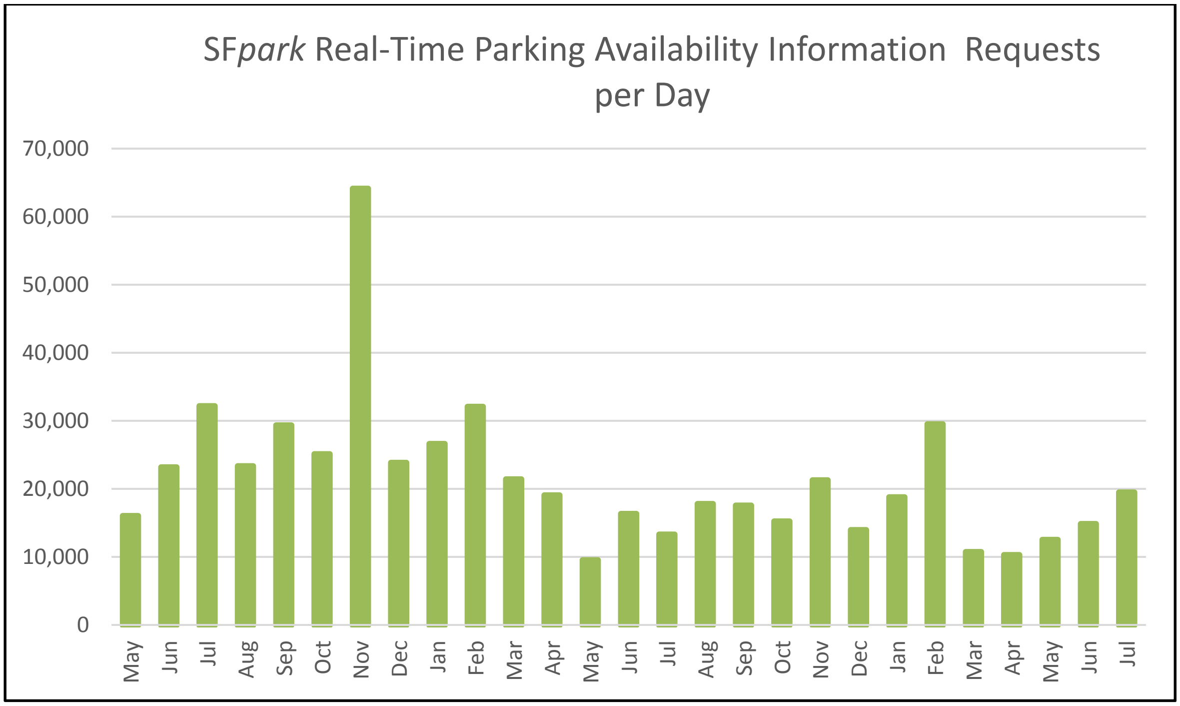
Source: SFMTA, 2013.

Figure C-6. Example of SFMTA Real-time Parking Information Mobile App

Source: MTC, 2013.

Figure C-7. Example of Real-time Parking Information on 511 Website

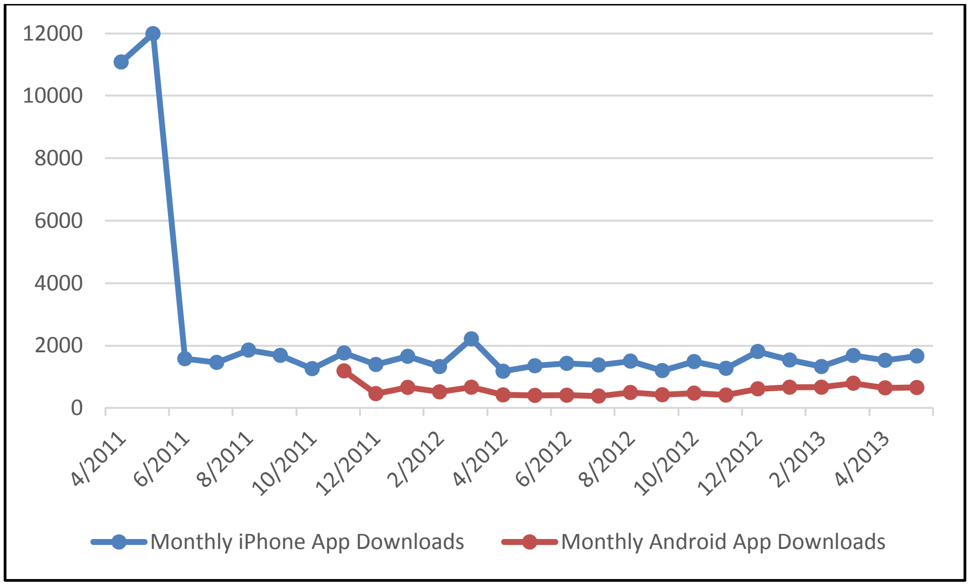
SFMTA collected data on the requests received for SF*park* real-time parking availability information. This public feed provided a single source of on- and off-street parking availability and rate information for all requests made via the SF*park* webpage, SF*park* mobile application, and third-party applications. Figure C-8 below shows the daily average number of requests in each month from May 2011 to July 2013. The highest number of website hits was in November 2011 when there were over 1.9 million hits, with an average of 64,142 hits per day. Aside from this month, the number of parking availability requests per month ranged from a high of 998,400 in July 2011, an average of 32,206 requests per day, to a low of 309,430 in April 2013, an average of 10,314 requests per day. Although the number of hits per month fluctuated throughout the evaluation period, there was an overall average of 649,057 requests per month, which is an average of 21,417 real-time parking availability information requests per day.



Source: Battelle based on SFMTA data, 2014.

Figure C-8. Average Number of Requests for SF*park* Real-time Parking Information per Day

SFMTA collected data on the number of SF*park* app downloads for iPhone and Android. These smartphone applications were developed by SFMTA, and provided users with SF*park* parking information similar to what is available on the website. Download information – but not user information nor frequency of use – was available for analysis. Figure C-9 shows the number of monthly downloads for the SF*park* application for iPhone and Android. By May 2013, the cumulative number of SF*park* application downloads for both iPhone and Android totaled 70,387.

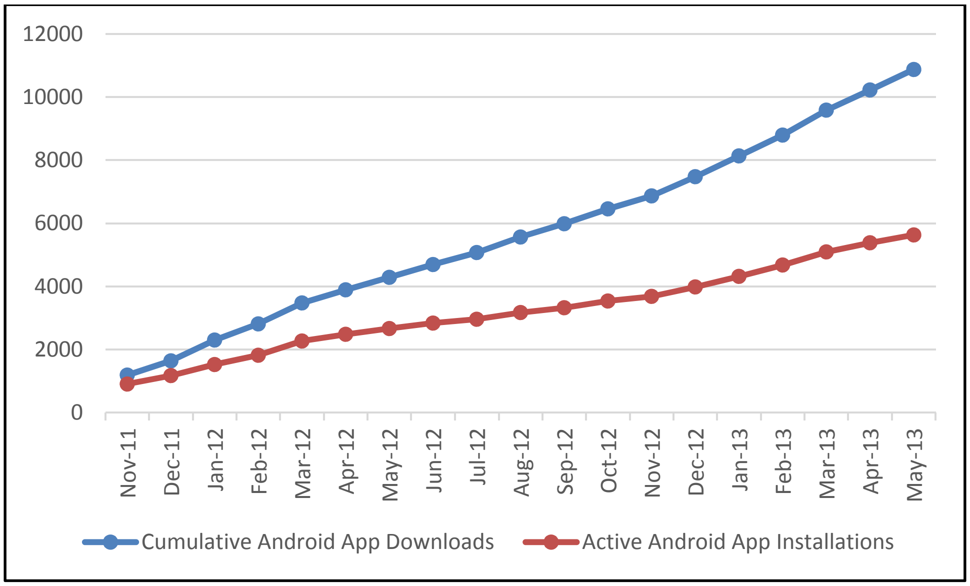


Source: Battelle based on SFMTA data, 2014.

Figure C-9. Number of SF*park* iPhone and Android Application Monthly Downloads

The iPhone app had the greatest number of downloads during the first two months of operation, April 2011 (11,206) and May 2011 (11,702), following SFMTA's major media event for the public launch of SF*park*. Monthly downloads of the iPhone app leveled off to an average of about 1500 app downloads per month for the remainder of the evaluation period, ranging between 1175 and 2212 downloads per month. The cumulative number of iPhone SF*park* app downloads through May 2013 was 59,512.

Android application downloads also peaked when the application was launched, with 2,315 downloads the first month (November 2011) followed by a rapid decrease by December 2011 (251 downloads). Monthly downloads of the Android app from December 2011 through the end of the evaluation period leveled off to an average of about 540 app downloads per month, ranging between 378 and 788 downloads per month. The cumulative number of Android SF*park* app downloads through May 2013 was 10,875. Android also reports the number of current device installations, which is the number of unique active devices that have the app installed. The number of unique active devices with the app installed increased through the evaluation period, but compared with the total number of downloads it dropped from 76 percent to 52 percent through the course of the evaluation period, with the SF*park* Android application being installed on 5632 unique active devices by May 2013 out of 10,875 total downloads. Figure C-10 shows the cumulative number of SF*park* app downloads on Android devices versus the number of unique active devices where the app was currently installed for each month.

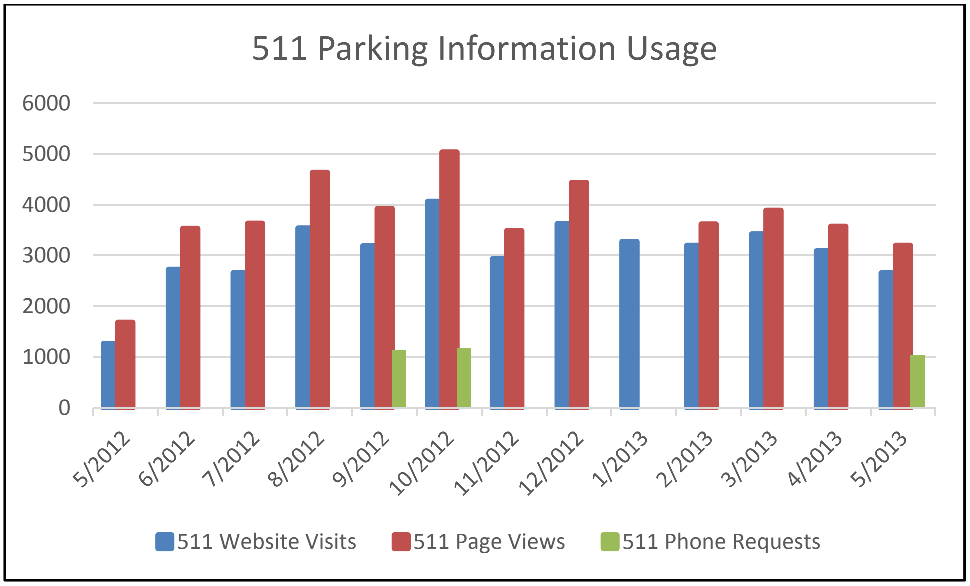


Source: Battelle based on Android and Apple data obtained by SFMTA, 2014.

Figure C-10. Cumulative Number of SF*park* Android Application Downloads and Active Installations

Various marketing and publicity activities may have contributed to some monthly peaks in app downloads, such as a New York Times article on SF*park* titled “Making the Streets of San Francisco Easier to Park On” published March 15, 2012.

Parking information usage was added about a year later to 511 by the MTC. Figure C-11 shows the average daily requests to the 511 webpage from May 2012 through May 2013 and 511 phone requests for each month from June 2012 through May 2013. Data were unavailable for the number of web page views in January 2013. After the first month, the lowest months of website visitation for parking information occurred in July 2012 and May 2013 with 2656 and 2651 visits, respectively. The highest number of website visits for parking information was 4062 in October 2012, corresponding to a high of 5032 web page views. Through the evaluation period, the number of website visits and web page views remained relatively steady, following similar trends, with respective averages of 3045 and 3716. Overall, the number of 511 phone requests for parking information held very steady at about 979 per month through the evaluation period.



*Information was unavailable for 511 page views in January 2013.

Source: Battelle based on MTC data, 2014.

Figure C-11. Usage* of Parking Information on the 511 Website and Phone

One reason for the relatively modest number of requests for parking information on 511 is that MTC did not promote the parking information enhancements during the evaluation period. MTC was performing various upgrades to their 511 services and advertising parking information was delayed until the other aspects of the site upgrades were complete. Consequently, they conducted a major media campaign in the fall of 2013 after the evaluation period had ended in May of 2013.

Data from the visitor/shopper survey conducted by SFMTA in the spring of 2013 provided an opportunity to assess travelers' awareness and usage of the real-time parking information sources. Details of the survey methodology are presented in Appendix B – Pricing Analysis. Data for 711 individuals in SF*park* pilot areas and 666 respondents in control areas provided valuable insight on the use of parking information sources by travelers.

As shown in Table C-6 a total of 215 individuals, or 15.6 percent of all respondents, were aware of parking information sources. Respondents in pilot and control areas were similar in their level of awareness. That the vast majority of respondents were unaware of real-time parking information sources was not surprising, given that SFMTA's promotional event occurred two years prior to the time of the survey and also given that MTC had not yet conducted any promotion of parking information added to their phone and website.

Table C-6. Awareness of Parking Information Sources: Summary Statistics (N and Percent) for "Are you aware of ways to get information to help you park in the area?" by Area*

Area	Are you aware of ways to get information to help you park in the area?	After Period N (Percent)
Control	1. Yes	99 (14.86%)
	2. No	567 (85.14%)
	Total	666 (100.00%)
Pilot	1. Yes	116 (16.32%)
	2. No	595 (83.68%)
	Total	711 (100.00%)

*Chi-square test had a P-value of 0.4588, indicating there was no significant between the pilot and control areas at the 0.05 level of significance.

Source: Battelle based on SFMTA data, 2014.

Of the 215 respondents who were aware of any way to get information to help park, they collectively identified 240 sources in response to the question, “How frequently do you use this source of information to go this area?” Results to the question are shown in Table C-7. Respondents could choose multiple sources, but almost none did. In both the pilot and control area, respondents were most familiar with 511.org and the SF*park* mobile application. Of the individuals who were aware of ways to get information to help park, only 36 people used any source of information sometimes or often (27 in the control area, 9 in the pilot area). Only one individual in the pilot area used any source of information often.

Table C-7. Frequency of Use of Parking Information Sources: Summary Statistics (N and Percent) for “How frequently do you use this source of information to go to this area?” by Area*

Area	Source of Information	How Frequently Do You Use This Source of Information to Go to This Area?				
		Often	Sometimes	Rarely	Never	Total
Control (n=116)	Dial 511 Phone	1 (0.86%)	0 (0.00%)	3 (2.59%)	6 (5.17%)	10 (8.62%)
	511.org Web	2 (1.72%)	5 (4.31%)	13 (11.21%)	28 (24.14%)	48 (41.38%)
	SF*park* Mobile App	3 (2.59%)	7 (6.03%)	12 (10.34%)	18 (15.52%)	40 (34.48%)
	SF*park* Website	1 (0.86%)	1 (0.86%)	7 (6.03%)	9 (7.76%)	18 (15.51%)
	Other App for Parking Info	5 (4.31%)	2 (1.72%)	7 (6.03%)	2 (1.72%)	16 (13.78%)
	Total	12 (10.34%)	15 (12.92%)	42 (30.17%)	63 (54.31%)	132
Pilot (n=99)	Dial 511 Phone	0 (0.00%)	0 (0.00%)	3 (3.03%)	1 (1.01%)	4 (4.04%)
	511.org web	0 (0.00%)	3 (3.03%)	8 (8.08%)	39 (39.39%)	50 (50.50%)
	SF*park* Mobile App	0 (0.00%)	2 (2.02%)	16 (16.16%)	13 (13.13%)	31 (31.31%)
	SF*park* Website	0 (0.00%)	0 (0.00%)	5 (5.05%)	0 (0.00%)	5 (5.05%)
	Other App for Parking Info	1 (1.01%)	3 (3.03%)	11 (11.11%)	3 (3.03%)	18 (18.18%)
	Total	1 (1.01%)	8 (8.08%)	43 (43.43%)	56 (56.56%)	108

*Based on 215 respondents who said they were aware of information sources. Overall total column and row percentages do not add to 100 because individuals could select multiple responses. Numbers in some cells were two low for statistical testing.

Source: Battelle based on SFMTA data, 2014.

In conclusion, the real-time parking information technologies held more promised than was realized during the evaluation period. They were launched with great fanfare (by SFMTA but not MTC during the evaluation period), and the smartphone parking app in particular garnered considerable media coverage, as noted in Appendix H – Non-technical Success Factors Analysis. Despite that attention, the awareness and use of those technologies did not filter down to the average person who visited the SF*park* areas. Thus, they ultimately were not effective in helping people with their decisions about parking.

C.6 Summary of Technology Impacts

This section provides a summary of the results of the technology analysis. Table C-8 summarizes the technology impacts for the two hypotheses. The first hypothesis – implementing advanced parking technology will improve SFMTA's ability to manage parking – was supported by the results from the post-deployment interviews and workshop, and, to a lesser degree, the analysis of the parking citation data. The results from the post-deployment interviews and workshop indicated that SFMTA personnel perceived improvements in the agency's ability to manage parking in the SF*park* pilot sites through the use of the parking occupancy sensor and parking meter technologies. The analysis of the parking citation data in the pilot and the control districts showed a statistically significant reduction in the number of citations from the pre-to-post deployment periods, with a slightly larger percent change in the pilot districts. The limitations within the citation dataset described in the SFMTA Meter-Related Citation Data Guide may also hinder the ability to detect and attribute changes in citations in the pilot and control districts. Real-time parking information was provided to the public via a number of sources. However, findings from the visitor/shopper survey indicate that awareness and use of these real-time parking information sources were not effective in helping the average person with decisions about parking in the SF*park* areas that might reduce parking search times. Thus, the second hypothesis is not supported.

Table C-8. Summary of Impacts Across Technology Hypotheses

Hypotheses	Result	Evidence
Implementing advanced parking technology will improve the local agency's ability to manage parking.	Supported	SFMTA personnel who were interviewed perceived improvements in the agency's ability to manage parking in the SF*park* pilot sites as a result of the technology. Parking sensors and meter technology provided accurate data and enhanced the ability of SFMTA to manage parking at the pilot sites. The analysis of the parking citation data indicated a statistically significant reduction in the number of citations in the pilot and control districts from the pre-deployment period to the initial post deployment period, with a slightly larger percent change in the pilot districts (when Downtown was included). However, the differences in percent changes between the pilot and control districts were not significant whether or not Downtown was included. The limitations in the parking citation dataset may influence the ability of the analysis to detect and attribute changes in citations to advanced parking technology and variable pricing.
Improving the dissemination of parking information via the 511 phone system, websites, and text messaging, will reduce parking search times.	Not supported	Parking information was widely disseminated. Usage of 511 remained constant and SF*park* apps continued to be downloaded through the deployment period. Text messaging was less successful and was discontinued. Among surveyed respondents awareness of information sources was low (15.6%) and regular usage even lower. Thus, parking information was not shown to be effective at helping users make decisions about parking, which might have reduced parking search times.

Source: Texas A&M Transportation Institute and Battelle, 2014.

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Appendix D. Equity Analysis

This analysis examines potential equity concerns associated with the San Francisco UPA projects. It assesses whether the positive or negative effects of SF*park* fall disproportionately on different user groups.

Table D-1 presents the four questions in the equity analysis. The first question focused on the potential impacts of the UPA projects on various users. The second question sought to understand how different parking districts where SF*park* was implemented were affected. The third question looked at the distribution of impacts by socio-economic groups. The fourth question focused on the reinvestment of revenues generated by SF*park* and how that reinvestment impacts different user groups.

Table D-1. Equity Analysis Questions

Hypotheses/Questions
• What are the direct social effects (parking fees, travel times, adaptation costs) for various transportation system user groups?
• Are there any differential impacts on certain socioeconomic groups?
• What is the spatial distribution of aggregate out-of-pocket and inconvenience costs, and travel-time and mobility benefits?
• How does reinvestment of parking pricing revenues impact various transportation system users?

Source: Battelle, 2014.

The remainder of the appendix is divided into five sections. Section D.1 describes the data sources used in the equity analysis. Section D.2 presents the analysis of potential equity impacts to the user groups. Analysis of geographic equity is presented in Section D.3. Section D.4 discusses the planned reinvestment of potential revenues from SF*park*. The appendix concludes with a summary of the potential equity impacts in Section D.5.

D.1 Data Sources

The equity analysis drew on data from several sources, which included the following:

- Two cross-sectional surveys of visitors and shoppers. The first took place in the spring of 2011 before the start of variable parking pricing that summer, and the second occurred in the spring of 2013, approximately 21 months after variable pricing started. The original post-deployment period was 12 months, but it was extended to 21 months to allow more time for variable pricing to reach an equilibrium level and for visitors and shoppers to adapt their parking behavior patterns. Each of these on-street intercept surveys included a total of approximately 1500 respondents in five SF*park* pilot areas and two SF*park* control areas. Each respondent had either driven to the area and parked on the day of the survey or had done so within the previous 12 months. Selected survey questions pertinent to the equity analysis were used. Details about the survey methodology are presented in Appendix B – Pricing Analysis.

- Data on congestion by pilot and control areas. As reported in Appendix A – Congestion Analysis, before and after measures of traffic speed and travel time were derived from roadway sensor data and from Muni buses equipped with automatic passenger counters (APC).
- Estimates of air quality impacts of variable parking pricing by pilot and control areas based on changes in vehicle miles traveled (VMT) in SF*park* pilot areas.
- Communication with SFMTA personnel about revenue reinvestment policies.

D.2 Potential Equity Impact on SF*park* User Groups

The evaluation examined the potential variation of benefits and costs experienced by different groups of users of parking in the SF*park* pilot and control areas before and after variable pricing. In that the strategy of raising the price in high-demand locations and times of day to increase parking availability, a potential effect might be that individuals with higher income would derive greater benefits in less time spent searching for parking and parking closer to their destinations than those with lower incomes. Similarly, parking pricing might have differential impact on individuals according to age. For example, might the youngest or the oldest age groups be negatively impacted by needing to park farther from their destination?

Data from the visitor/shopper survey was used to examine the impact of SF*park* on respondents by income and age. The survey recorded the respondent's household income by 10 categories starting with less than $10,000 and ending with $250,00 or more. Respondents had to be age 18 or over to participate in the survey, and their ages were recorded in eight categories starting with 18 – 24 and ending with 85 and over. Using these income and age categories, the analysis of impacts by user groups focused on the following four survey questions:

- How long did you look for parking once you got to the area? (in minutes)
- How far did you end up parking from your destination? (in blocks)
- How easy was it to find parking using a scale from 1 to 5, with 1 being very easy and 5 being very difficult?
- How much did you personally pay (or expect to pay) for parking today? (in dollars)

D.2.1 Three-Way Analysis of Variance Model

Given the complexity of the visitor/shopper survey data, it was necessary to fit a three-way analysis of variance (ANOVA) model to control for potential effects. The three factors were area (pilot/control), time period (before/after) and income (10 levels) or age (8 levels). For each of these eight analyses (four questions crossed separately with income and age), a set of two tables presented. The first table shows the summary statistics for each area, income or age level, and time period. The second table shows the results of the ANOVA model fit. For each income (or age) level, the ANOVA table shows three rows of information corresponding to the three comparisons that were performed regarding the question of interest:

- Row 1: after vs. before in the control area
- Row 2: after vs. before in the pilot area
- Row 3: pilot area time period difference (row 1) vs. control area time period difference (row 2).

Each row shows the estimated difference in the variable of interest (e.g., parking time) for the comparison as well as the p-value determining whether the difference is significantly different from zero. Negative values in either the first or second row indicate the variable of interest (e.g., parking time) decreased from before to after while positive values indicate the variable increased from before to after. The sign in the third row when taken together with the before and after changes yields the following six interpretations shown in Table D-2 to interpret the findings for the eight analyses presented below.

Table D-2. Interpretation of Tables of Summary Statistics

Control Area Effect Across Time Periods (Row 1)	Pilot Area Effect Across Time Periods (Row 2)	Difference in Pilot and Control Area Effects (Row 3)	Interpretation
Positive	Positive	Positive	After values higher compared to Before for both control and pilot but more so in pilot
Positive	Positive	Negative	After values higher compared to Before for both control and pilot but more so in control
Negative	Negative	Negative	Before values higher compared to After for both control and pilot but more so in pilot
Negative	Negative	Positive	Before values higher compared to After for both control and pilot but more so in control
Positive	Negative	Negative	After values higher compared to Before in control area but Before values higher compared to After in pilot area
Negative	Positive	Positive	After values higher compared to Before in pilot area but Before values higher compared to After in control area

Source: Battelle, 2014.

The final row of the ANOVA tables shows the p-value for a test performed to determine if income (or age) was a significant factor in the relationship in the variable of interest between time periods and areas (i.e., if the differences presented in the third row of each income level [or age] are significantly different across income [or age] levels). This is the key piece of information in determining whether income (or age) is significantly related to the relationship between time periods and areas with respect to the variable of interest. If the p-value for this test is less than 0.05, then income (or age) was a significant factor.

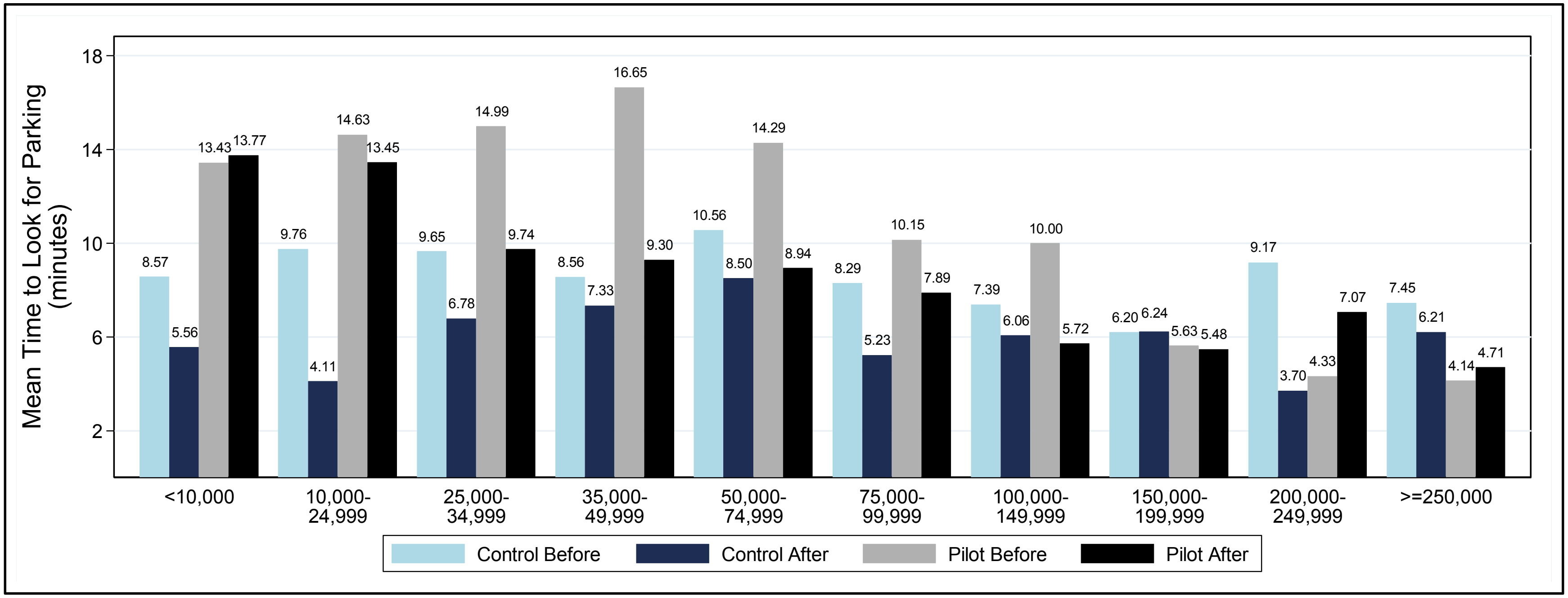
D.2.2 Income Equity Results

This section presents the analysis of the four survey questions by income categories.

Parking Search Time

Figure D-1 illustrates the relationship between household income and the time the it took respondents to look for parking before and after variable pricing and by control and pilot areas. Summary statistics are presented in Table D-3. In general, it appears respondents surveyed in the two control areas reported shorter searches for parking compared to the five pilot areas surveyed regardless of income, but both control and pilot areas appeared to enjoy a reduction in search time during the after period, with the largest reduction in the pilot areas in the $35,000 - $74,999 range. A notable exception is that the highest income categories ($150,000 or more) tended not to see reductions in parking search times in the pilot areas. However, they had the lowest search times before variable pricing, and they still did after price changes. Another exception was the lowest income category, less than $10,000, which did not show the pilot area reductions exhibited in other income categories.

To tease out the effects and the relationship to income, the results of the ANOVA are presented in Table D-4. The p-value testing for a relationship between income, area, and time period was less than 0.0001 indicating that any relationship between area and time period in terms of parking search time differs significantly by income overall. For incomes ranging from $35,000 to $49,999 and from $200,000 to $249,000, the difference in parking search time between before and after in the pilot areas was significantly different than that of the control area (as shown in Table D-4 by the statistically significant interaction term Pilot Area (After – Before) – Control Area (After – Before) for these two income categories). For incomes between $35,000 and $49,999, parking search times were shorter in both the control and pilot areas but more so in the pilot area. For incomes ranging from $200,000 to $249.999, parking search time in the after period was less than that of the before period in the control area while there was no significant difference in the pilot area, resulting in a significantly different relative increase In the pilot areas. Nevertheless, despite these differences in specific income levels, variable pricing did not result in a general pattern of improvement in parking search time according to income level.



Source: Battelle based on data provided by SFMTA, 2014.

Figure D-1. Mean Parking Search Time by Area, Total Household Income, and Time Period

Table D-3. Summary Statistics (Mean and 95 Percent Confidence Interval) for Total Household Income Crossed with Parking Search Time by Area and Time Period

Area	Household Income	Time to Look for Parking (minutes)			
		Before		After	
		N	Mean (CI)	N	Mean (CI)
Control	Less than $10,000	28	8.57 (5.39, 11.76)	18	5.56 (2.77, 8.34)
	$10,000 – 24,999	33	9.76 (6.64, 12.88)	18	4.11 (2.26, 5.96)
	$25,000 – 34,999	40	9.65 (6.86, 12.44)	32	6.78 (3.95, 9.61)
	$35,000 – 49,999	61	8.56 (6.57, 10.54)	69	7.33 (5.69, 8.98)
	$50,000 – 74,999	84	10.56 (8.35, 12.77)	96	8.50 (5.16, 11.84)
	$75,000 – 99,999	58	8.29 (6.23, 10.35)	88	5.23 (4.09, 6.36)
	$100,000 – 149,999	66	7.39 (5.36, 9.43)	94	6.06 (4.27, 7.86)
	$150,000 – 199,999	40	6.20 (3.29, 9.11)	80	6.24 (3.99, 8.49)
	$200,000 – 249,999	23	9.17 (4.13, 14.21)	37	3.70 (2.16, 5.24)
	$250,000 or more	42	7.45 (4.78, 10.12)	43	6.21 (3.54, 8.88)
Pilot	Less than $10,000	23	13.43 (8.91, 17.96)	30	13.77 (8.62, 18.91)
	$10,000 – 24,999	65	14.63 (12.09, 17.17)	29	13.45 (7.94, 18.95)
	$25,000 – 34,999	78	14.99 (12.62, 17.36)	43	9.74 (5.99, 13.50)
	$35,000 – 49,999	78	16.65 (14.13, 19.18)	50	9.30 (7.13, 11.47)
	$50,000 – 74,999	86	14.29 (11.91, 16.67)	103	8.94 (6.95, 10.93)
	$75,000 – 99,999	55	10.15 (7.38, 12.91)	90	7.89 (5.94, 9.84)
	$100,000 – 149,999	49	10.00 (6.84, 13.16)	113	5.72 (4.53, 6.91)
	$150,000 – 199,999	38	5.63 (1.73, 9.54)	87	5.48 (4.27, 6.69)
	$200,000 – 249,999	15	4.33 (0.78, 7.89)	43	7.07 (4.93, 9.21)
	$250,000 or more	36	4.14 (1.52, 6.76)	41	4.71 (2.03, 7.38)

Source: Battelle based on data provided by SFMTA, 2014.

Table D-4. Results from ANOVA Model Testing for Significant Differences in Total Household Income Crossed with Parking Search Time

Household Income	Comparison	Difference in Time (Minutes)	P-Value
Less than $10,000	Control Area (After – Before)	-3.02	0.3396
	Pilot Area (After – Before)	0.33	0.9086
	Pilot Area (After – Before) – Control Area (After – Before)	3.35	0.4343
$10,000 – 24,999	Control Area (After – Before)	-5.65	0.0665
	Pilot Area (After – Before)	-1.18	0.6122
	Pilot Area (After – Before) – Control Area (After – Before)	4.47	0.2469
$25,000 – 34,999	Control Area (After – Before)	-2.87	0.2369
	Pilot Area (After – Before)	-5.24	0.0074*
	Pilot Area (After – Before) – Control Area (After – Before)	-2.37	0.4443
$35,000 – 49,999	Control Area (After – Before)	-1.22	0.4248
	Pilot Area (After – Before)	-7.35	<0.0001*
	Pilot Area (After – Before) – Control Area (After – Before)	-6.13	0.0057*
$50,000 – 74,999	Control Area (After – Before)	-2.06	0.2640
	Pilot Area (After – Before)	-5.35	0.0032*
	Pilot Area (After – Before) – Control Area (After – Before)	-3.29	0.2022
$75,000 – 99,999	Control Area (After – Before)	-3.07	0.0283*
	Pilot Area (After – Before)	-2.26	0.1099
	Pilot Area (After – Before) – Control Area (After – Before)	0.81	0.6828
$100,000 – 149,999	Control Area (After – Before)	-1.33	0.3192
	Pilot Area (After – Before)	-4.28	0.0028*
	Pilot Area (After – Before) – Control Area (After – Before)	-2.95	0.1305
$150,000 – 199,999	Control Area (After – Before)	0.04	0.9828
	Pilot Area (After – Before)	-0.15	0.9319
	Pilot Area (After – Before) – Control Area (After – Before)	-0.19	0.9396
$200,000 – 249,999	Control Area (After – Before)	-5.47	0.0068*
	Pilot Area (After – Before)	2.74	0.2244
	Pilot Area (After – Before) – Control Area (After – Before)	8.21	0.0071*
$250,000 or more	Control Area (After – Before)	-1.24	0.4959
	Pilot Area (After – Before)	0.57	0.7673
	Pilot Area (After – Before) – Control Area (After – Before)	1.81	0.4943
3-way ANOVA interaction (Income, Area, Time Period) p-value<0.0001*			

*Comparison significant at the 0.05 level.

Source: Battelle based on data provided by SFMTA, 2014.

Distance Parked from Destination

Summary statistics for household income and the number of blocks the respondent parked from the destination is shown in Table D-5 by control and pilot areas and by time period. Table D-6 presents the three-way analysis of variance model that was fit to the data, in which the distance parked from destination was treated as a continuous variable with 0.5 blocks used for "less than 1 block away" and 6 blocks used for "more than 4 blocks away." The "other" response was not used. The last row of Table D-6 shows that the overall three-way ANOVA interaction between income, area, and time period was significant (p-value=0.0004) indicating that there are some significant differences in distances parked from destination between the variables included in the model (income, area, and time period). The final column in Table D-6 shows the results for each specific comparison between the three variables. The distance parked from destination was significantly less in the after period compared to before in the control area for incomes between $200,000 and $249,000 and in the pilot areas for incomes between $25,000 and $34,999 and between $50,000 and $74,999. In addition, the distance parked from destination was significantly less in the after period compared to before in both the control and pilot areas for incomes greater than $250,000. Despite these significant before/after differences in some income categories, none of the interaction terms (Pilot Area (After – Before) – Control Area (After – Before)) for the income categories are statistically significant. This indicates that any observed differences in parking distance from destination due to time period were not significantly different between the pilot and control areas at any income level. Thus, variable pricing did not result in a general pattern of improvement in distance parked from destination according to income level.

Table D-5. Summary Statistics (N and Percent) for Total Household Income Crossed with How Far Parked from Destination By Area and Time Period

Household Income	Area	How Far Did You End Up Parking from Your Destination?	Before N (Percent)	After N (Percent)
Less than $10,000	Control	1. Less than 1 block away	9 (32.14%)	4 (22.22%)
		2. About 1 block away	5 (17.86%)	3 (16.67%)
		3. About 2 blocks away	6 (21.43%)	9 (50.00%)
		4. About 3 blocks away	5 (17.86%)	1 (5.56%)
		5. About 4 blocks away	2 (07.14%)	1 (5.56%)
		6. More than 4 blocks away	1 (3.57%)	0 (0.00%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	2 (8.70%)	9 (30.00%)
		2. About 1 block away	2 (8.70%)	5 (16.67%)
		3. About 2 blocks away	7 (30.43%)	6 (20.00%)
		4. About 3 blocks away	5 (21.74%)	2 (6.67%)
		5. About 4 blocks away	4 (17.39%)	3 (10.00%)
		6. More than 4 blocks away	3 (13.04%)	5 (16.67%)
		7. Other	0 (0.00%)	0 (0.00%)

Table D-5. Summary Statistics (N and Percent) for Total Household Income Crossed with How Far Parked from Destination By Area and Time Period (Continued)

Household Income	Area	How Far Did You End Up Parking from Your Destination?	Before N (Percent)	After N (Percent)
$10,000 – 24,999	Control	1. Less than 1 block away	9 (29.03%)	8 (44.44%)
		2. About 1 block away	3 (9.68%)	2 (11.11%)
		3. About 2 blocks away	4 (12.90%)	5 (27.78%)
		4. About 3 blocks away	6 (19.35%)	2 (11.11%)
		5. About 4 blocks away	4 (12.90%)	0 (0.00%)
		6. More than 4 blocks away	5 (16.13%)	1 (5.56%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	17 (25.76%)	10 (34.48%)
		2. About 1 block away	4 (6.06%)	3 (10.34%)
		3. About 2 blocks away	15 (22.73%)	7 (24.14%)
		4. About 3 blocks away	16 (24.24%)	3 (10.34%)
		5. About 4 blocks away	6 (9.09%)	3 (10.34%)
		6. More than 4 blocks away	8 (12.12%)	3 (10.34%)
		7. Other	0 (0.00%)	0 (0.00%)
$25,000 – 34,999	Control	1. Less than 1 block away	12 (30.00%)	15 (46.88%)
		2. About 1 block away	3 (7.50%)	3 (9.38%)
		3. About 2 blocks away	4 (10.00%)	5 (15.63%)
		4. About 3 blocks away	11 (27.50%)	3 (9.38%)
		5. About 4 blocks away	5 (12.50%)	0 (0.00%)
		6. More than 4 blocks away	5 (12.50%)	6 (18.75%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	14 (18.18%)	13 (30.23%)
		2. About 1 block away	3 (3.90%)	6 (13.95%)
		3. About 2 blocks away	20 (25.97%)	11 (25.58%)
		4. About 3 blocks away	16 (20.78%)	5 (11.63%)
		5. About 4 blocks away	13 (16.88%)	4 (9.30%)
		6. More than 4 blocks away	11 (14.29%)	4 (9.30%)
		7. Other	0 (0.00%)	0 (0.00%)
$35,000 – 49,999	Control	1. Less than 1 block away	9 (14.75%)	15 (21.74%)
		2. About 1 block away	11 (18.03%)	13 (18.84%)
		3. About 2 blocks away	18 (29.51%)	18 (26.09%)
		4. About 3 blocks away	15 (24.59%)	15 (21.74%)
		5. About 4 blocks away	3 (4.92%)	2 (2.90%)
		6. More than 4 blocks away	5 (8.20%)	6 (8.70%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	7 (8.75%)	6 (12.00%)
		2. About 1 block away	4 (5.00%)	14 (28.00%)
		3. About 2 blocks away	31 (38.75%)	7 (14.00%)
		4. About 3 blocks away	15 (18.75%)	13 (26.00%)
		5. About 4 blocks away	12 (15.00%)	6 (12.00%)
		6. More than 4 blocks away	11 (13.75%)	4 (8.00%)
		7. Other	0 (0.00%)	0 (0.00%)

Table D-5. Summary Statistics (N and Percent) for Total Household Income Crossed with How Far Parked from Destination By Area and Time Period (Continued)

Household Income	Area	How Far Did You End Up Parking from Your Destination?	Before N (Percent)	After N (Percent)
$50,000 – 74,999	Control	1. Less than 1 block away	24 (28.24%)	31 (32.29%)
		2. About 1 block away	15 (17.65%)	21 (21.88%)
		3. About 2 blocks away	16 (18.82%)	24 (25.00%)
		4. About 3 blocks away	17 (20.00%)	13 (13.54%)
		5. About 4 blocks away	7 (8.24%)	2 (2.08%)
		6. More than 4 blocks away	6 (7.06%)	5 (5.21%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	15 (16.67%)	28 (27.18%)
		2. About 1 block away	5 (5.56%)	12 (11.65%)
		3. About 2 blocks away	18 (20.00%)	27 (26.21%)
		4. About 3 blocks away	17 (18.89%)	20 (19.42%)
		5. About 4 blocks away	10 (11.11%)	5 (4.85%)
		6. More than 4 blocks away	23 (25.56%)	11 (10.68%)
		7. Other	2 (2.22%)	0 (0.00%)
$75,000 – 99,999	Control	1. Less than 1 block away	21 (35.00%)	30 (34.09%)
		2. About 1 block away	8 (13.33%)	18 (20.45%)
		3. About 2 blocks away	11 (18.33%)	20 (22.73%)
		4. About 3 blocks away	12 (20.00%)	12 (13.64%)
		5. About 4 blocks away	3 (5.00%)	3 (3.41%)
		6. More than 4 blocks away	5 (8.33%)	5 (5.68%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	8 (14.29%)	21 (23.33%)
		2. About 1 block away	8 (14.29%)	15 (16.67%)
		3. About 2 blocks away	25 (44.64%)	19 (21.11%)
		4. About 3 blocks away	6 (10.71%)	22 (24.44%)
		5. About 4 blocks away	2 (3.57%)	7 (7.78%)
		6. More than 4 blocks away	7 (12.50%)	6 (6.67%)
		7. Other	0 (0.00%)	0 (0.00%)
$100,000 – 149,999	Control	1. Less than 1 block away	20 (30.30%)	48 (51.06%)
		2. About 1 block away	10 (15.15%)	9 (9.57%)
		3. About 2 blocks away	19 (28.79%)	17 (18.09%)
		4. About 3 blocks away	9 (13.64%)	14 (14.89%)
		5. About 4 blocks away	3 (4.55%)	4 (4.26%)
		6. More than 4 blocks away	5 (7.58%)	2 (2.13%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	13 (26.53%)	31 (27.43%)
		2. About 1 block away	4 (8.16%)	17 (15.04%)
		3. About 2 blocks away	11 (22.45%)	30 (26.55%)
		4. About 3 blocks away	8 (16.33%)	21 (18.58%)
		5. About 4 blocks away	7 (14.29%)	7 (6.19%)
		6. More than 4 blocks away	6 (12.24%)	7 (6.19%)
		7. Other	0 (0.00%)	0 (0.00%)

Table D-5. Summary Statistics (N and Percent) for Total Household Income Crossed with How Far Parked from Destination By Area and Time Period (Continued)

Household Income	Area	How Far Did You End Up Parking from Your Destination?	Before N (Percent)	After N (Percent)
$150,000 – 199,999	Control	1. Less than 1 block away	14 (35.00%)	31 (38.27%)
		2. About 1 block away	6 (15.00%)	19 (23.46%)
		3. About 2 blocks away	9 (22.50%)	18 (22.22%)
		4. About 3 blocks away	4 (10.00%)	5 (6.17%)
		5. About 4 blocks away	3 (7.50%)	2 (2.47%)
		6. More than 4 blocks away	4 (10.00%)	6 (7.41%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	13 (34.21%)	28 (32.18%)
		2. About 1 block away	10 (26.32%)	14 (16.09%)
		3. About 2 blocks away	5 (13.16%)	23 (26.44%)
		4. About 3 blocks away	4 (10.53%)	14 (16.09%)
		5. About 4 blocks away	3 (7.89%)	4 (4.60%)
		6. More than 4 blocks away	3 (7.89%)	4 (4.60%)
		7. Other	0 (0.00%)	0 (0.00%)
$200,000 – 249,999	Control	1. Less than 1 block away	4 (16.67%)	21 (56.76%)
		2. About 1 block away	4 (16.67%)	5 (13.51%)
		3. About 2 blocks away	8 (33.33%)	6 (16.22%)
		4. About 3 blocks away	4 (16.67%)	3 (8.11%)
		5. About 4 blocks away	1 (4.17%)	2 (5.41%)
		6. More than 4 blocks away	3 (12.50%)	0 (0.00%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	3 (20.00%)	13 (30.23%)
		2. About 1 block away	4 (26.67%)	7 (16.28%)
		3. About 2 blocks away	1 (6.67%)	6 (13.95%)
		4. About 3 blocks away	3 (20.00%)	11 (25.58%)
		5. About 4 blocks away	1 (6.67%)	5 (11.63%)
		6. More than 4 blocks away	3 (20.00%)	1 (2.33%)
		7. Other	0 (0.00%)	0 (0.00%)
$250,000 or more	Control	1. Less than 1 block away	8 (19.05%)	21 (48.84%)
		2. About 1 block away	9 (21.43%)	5 (11.63%)
		3. About 2 blocks away	9 (21.43%)	10 (23.26%)
		4. About 3 blocks away	10 (23.81%)	3 (6.98%)
		5. About 4 blocks away	0 (0.00%)	0 (0.00%)
		6. More than 4 blocks away	6 (14.29%)	4 (9.30%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	8 (22.86%)	19 (46.34%)
		2. About 1 block away	7 (20.00%)	10 (24.39%)
		3. About 2 blocks away	7 (20.00%)	9 (21.95%)
		4. About 3 blocks away	8 (22.86%)	0 (0.00%)
		5. About 4 blocks away	1 (2.86%)	1 (2.44%)
		6. More than 4 blocks away	4 (11.43%)	2 (4.88%)
		7. Other	0 (0.00%)	0 (0.00%)

Source: Battelle based on data provided by SFMTA, 2014.

Table D-6. Results from ANOVA Model Testing for Significant Differences in Total Household Income Crossed with How Far Parked from Destination

Household Income	Comparison	Difference in Blocks	P-Value
Less than $10,000	Control Area (After – Before)	-0.14	0.7773
	Pilot Area (After – Before)	-0.55	0.2149
	Pilot Area (After – Before) – Control Area (After – Before)	-0.41	0.5269
$10,000 – 24,999	Control Area (After – Before)	-1.01	0.0552
	Pilot Area (After – Before)	-0.36	0.3622
	Pilot Area (After – Before) – Control Area (After – Before)	0.65	0.3210
$25,000 – 34,999	Control Area (After – Before)	-0.45	0.2923
	Pilot Area (After – Before)	-0.72	0.0369*
	Pilot Area (After – Before) – Control Area (After – Before)	-0.27	0.6233
$35,000 – 49,999	Control Area (After – Before)	-0.16	0.5549
	Pilot Area (After – Before)	-0.50	0.0783
	Pilot Area (After – Before) – Control Area (After – Before)	-0.34	0.3944
$50,000 – 74,999	Control Area (After – Before)	-0.36	0.1432
	Pilot Area (After – Before)	-0.96	0.0001*
	Pilot Area (After – Before) – Control Area (After – Before)	-0.60	0.0877
$75,000 – 99,999	Control Area (After – Before)	-0.26	0.3180
	Pilot Area (After – Before)	-0.17	0.5155
	Pilot Area (After – Before) – Control Area (After – Before)	0.09	0.8126
$100,000 – 149,999	Control Area (After – Before)	-0.47	0.0526
	Pilot Area (After – Before)	-0.46	0.0706
	Pilot Area (After – Before) – Control Area (After – Before)	0.01	0.9928
$150,000 – 199,999	Control Area (After – Before)	-0.38	0.2063
	Pilot Area (After – Before)	-0.01	0.9746
	Pilot Area (After – Before) – Control Area (After – Before)	0.37	0.3848
$200,000 – 249,999	Control Area (After – Before)	-1.13	0.0042*
	Pilot Area (After – Before)	-0.60	0.1765
	Pilot Area (After – Before) – Control Area (After – Before)	0.53	0.3697
$250,000 or more	Control Area (After – Before)	-0.72	0.0426*
	Pilot Area (After – Before)	-0.90	0.0172*
	Pilot Area (After – Before) – Control Area (After – Before)	-0.18	0.7271
3-way ANOVA interaction (Income, Area, Time Period) p-value=0.0004*			

*Comparison significant at the 0.05 level.

Source: Battelle based on data provided by SFMTA, 2014.

Ease of Finding Parking

Table D-7 presents the summary statistics on the ease of finding parking by respondents' income and by control and pilot areas and time period. Table D-8 shows the results of the ANOVA model, in which the p-value testing for a relationship between income, area, and time period was less than 0.0001, indicating that any relationship between area and time period in terms of ease of parking differed significantly by income overall. Specifically in the control area, respondents perceived parking to be significantly easier to find in the after period compared to before for incomes of less than $10,000 and between $50,000 and $149,999. For the pilot area, parking was perceived to be significantly easier to find in the after period compared to before for incomes ranging from $35,000 to $74,999. Any observed differences in ease of parking due to time period were not significantly different between the pilot and control areas at any income level. Overall, the data indicate that differences were more likely to be greater and statistically significant in the control areas, which means that variable pricing was not the cause of any improvements in perception among income groups.

Table D-7. Summary Statistics (N and Percent) for Total Household Income Crossed with How Easy to Find Parking By Area and Time Period

Household Income	Area	How Easy Was It to Find Parking? (1=very easy, 5=very difficult)	Before N (Percent)	After N (Percent)
Less than $10,000	Control	1	8 (28.57%)	8 (44.44%)
		2	4 (14.29%)	3 (16.67%)
		3	4 (14.29%)	5 (27.78%)
		4	6 (21.43%)	2 (11.11%)
		5	6 (21.43%)	0 (0.00%)
	Pilot	1	5 (21.74%)	5 (16.67%)
		2	3 (13.04%)	5 (16.67%)
		3	3 (13.04%)	6 (20.00%)
		4	5 (21.74%)	9 (30.00%)
		5	7 (30.43%)	5 (16.67%)
$10,000 – 24,999	Control	1	9 (27.27%)	8 (47.06%)
		2	4 (12.12%)	2 (11.76%)
		3	11 (33.33%)	5 (29.41%)
		4	5 (15.15%)	2 (11.76%)
		5	4 (12.12%)	0 (0.00%)
	Pilot	1	4 (6.06%)	6 (20.69%)
		2	13 (19.70%)	4 (13.79%)
		3	23 (34.85%)	8 (27.59%)
		4	12 (18.18%)	2 (6.90%)
		5	14 (21.21%)	9 (31.03%)

Table D-7. Summary Statistics (N and Percent) for Total Household Income Crossed with How Easy to Find Parking By Area and Time Period (Continued)

Household Income	Area	How Easy Was It to Find Parking? (1=very easy, 5=very difficult)	Before N (Percent)	After N (Percent)
$25,000 – 34,999	Control	1	7 (17.50%)	12 (37.50%)
		2	10 (25.00%)	6 (18.75%)
		3	12 (30.00%)	5 (15.63%)
		4	4 (10.00%)	3 (9.38%)
		5	7 (17.50%)	6 (18.75%)
	Pilot	1	10 (13.16%)	14 (32.56%)
		2	12 (15.79%)	3 (6.98%)
		3	23 (30.26%)	12 (27.91%)
		4	15 (19.74%)	6 (13.95%)
		5	16 (21.05%)	8 (18.60%)
$35,000 – 49,999	Control	1	13 (21.31%)	21 (30.43%)
		2	12 (19.67%)	14 (20.29%)
		3	19 (31.15%)	17 (24.64%)
		4	11 (18.03%)	12 (17.39%)
		5	6 (9.84%)	5 (7.25%)
	Pilot	1	10 (12.82%)	12 (24.00%)
		2	10 (12.82%)	8 (16.00%)
		3	22 (28.21%)	16 (32.00%)
		4	20 (25.64%)	9 (18.00%)
		5	16 (20.51%)	5 (10.00%)
$50,000 – 74,999	Control	1	22 (26.19%)	35 (36.46%)
		2	10 (11.90%)	16 (16.67%)
		3	13 (15.48%)	22 (22.92%)
		4	24 (28.57%)	18 (18.75%)
		5	15 (17.86%)	5 (5.21%)
	Pilot	1	13 (15.29%)	31 (30.39%)
		2	11 (12.94%)	14 (13.73%)
		3	23 (27.06%)	27 (26.47%)
		4	18 (21.18%)	19 (18.63%)
		5	20 (23.53%)	11 (10.78%)

Table D-7. Summary Statistics (N and Percent) for Total Household Income Crossed with How Easy to Find Parking By Area and Time Period (Continued)

Household Income	Area	How Easy Was It to Find Parking? (1=very easy, 5=very difficult)	Before N (Percent)	After N (Percent)
$75,000 – 99,999	Control	1	19 (31.67%)	31 (35.23%)
		2	4 (6.67%)	21 (23.86%)
		3	14 (23.33%)	23 (26.14%)
		4	14 (23.33%)	8 (9.09%)
		5	9 (15.00%)	5 (5.68%)
	Pilot	1	13 (24.53%)	29 (32.22%)
		2	10 (18.87%)	12 (13.33%)
		3	17 (32.08%)	26 (28.89%)
		4	9 (16.98%)	11 (12.22%)
		5	4 (7.55%)	12 (13.33%)
$100,000 – 149,999	Control	1	18 (27.69%)	44 (46.81%)
		2	13 (20.00%)	13 (13.83%)
		3	10 (15.38%)	17 (18.09%)
		4	15 (23.08%)	13 (13.83%)
		5	9 (13.85%)	7 (7.45%)
	Pilot	1	17 (36.17%)	51 (45.13%)
		2	9 (19.15%)	18 (15.93%)
		3	6 (12.77%)	21 (18.58%)
		4	9 (19.15%)	16 (14.16%)
		5	6 (12.77%)	7 (6.19%)
$150,000 – 199,999	Control	1	17 (42.50%)	32 (39.51%)
		2	8 (20.00%)	24 (29.63%)
		3	5 (12.50%)	13 (16.05%)
		4	6 (15.00%)	6 (7.41%)
		5	4 (10.00%)	6 (7.41%)
	Pilot	1	20 (54.05%)	37 (42.53%)
		2	5 (13.51%)	16 (18.39%)
		3	6 (16.22%)	14 (16.09%)
		4	4 (10.81%)	13 (14.94%)
		5	2 (5.41%)	7 (8.05%)

Table D-7. Summary Statistics (N and Percent) for Total Household Income Crossed with How Easy to Find Parking By Area and Time Period (Continued)

Household Income	Area	How Easy Was It to Find Parking? (1=very easy, 5=very difficult)	Before N (Percent)	After N (Percent)
$200,000 – 249,999	Control	1	6 (25.00%)	17 (45.95%)
		2	6 (25.00%)	9 (24.32%)
		3	5 (20.83%)	7 (18.92%)
		4	5 (20.83%)	2 (5.41%)
		5	2 (8.33%)	2 (5.41%)
	Pilot	1	3 (21.43%)	15 (35.71%)
		2	5 (35.71%)	8 (19.05%)
		3	1 (7.14%)	10 (23.81%)
		4	2 (14.29%)	6 (14.29%)
		5	3 (21.43%)	3 (7.14%)
$250,000 or more	Control	1	18 (42.86%)	17 (39.53%)
		2	5 (11.90%)	9 (20.93%)
		3	6 (14.29%)	5 (11.63%)
		4	7 (16.67%)	8 (18.60%)
		5	6 (14.29%)	4 (9.30%)
	Pilot	1	22 (61.11%)	25 (60.98%)
		2	2 (5.56%)	6 (14.63%)
		3	5 (13.89%)	4 (9.76%)
		4	3 (8.33%)	5 (12.20%)
		5	4 (11.11%)	1 (2.44%)

Source: Battelle based on data provided by SFMTA, 2014.

Table D-8. Results from ANOVA Model Testing for Significant Differences in Total Household Income Crossed with How Easy to Find Parking

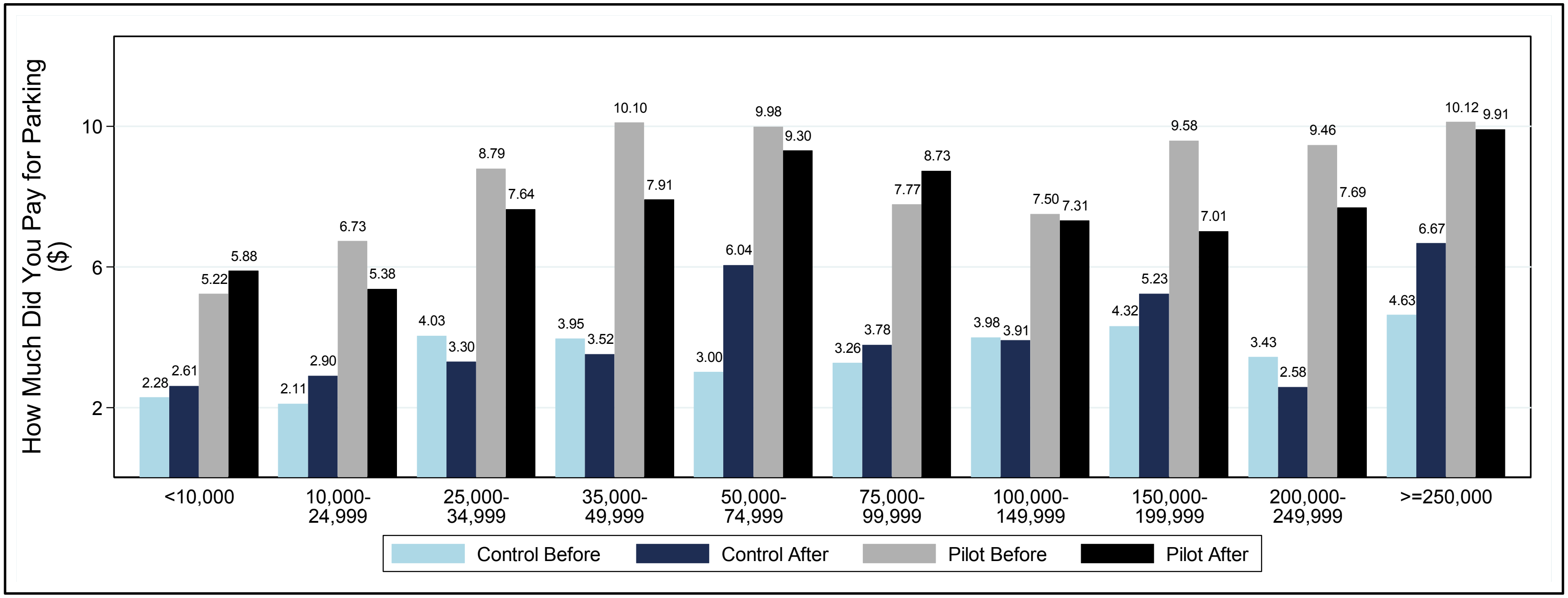
Household Income	Comparison	Difference in Easy to Park Scale	P-Value
Less than $10,000	Control Area (After – Before)	-0.87	0.0464*
	Pilot Area (After – Before)	-0.13	0.7486
	Pilot Area (After – Before) – Control Area (After – Before)	0.74	0.2071
$10,000 – 24,999	Control Area (After – Before)	-0.67	0.0860
	Pilot Area (After – Before)	-0.15	0.6041
	Pilot Area (After – Before) – Control Area (After – Before)	0.52	0.2843
$25,000 – 34,999	Control Area (After – Before)	-0.32	0.3381
	Pilot Area (After – Before)	-0.41	0.1295
	Pilot Area (After – Before) – Control Area (After – Before)	-0.09	0.8367
$35,000 – 49,999	Control Area (After – Before)	-0.25	0.2746
	Pilot Area (After – Before)	-0.54	0.0205*
	Pilot Area (After – Before) – Control Area (After – Before)	-0.29	0.3628
$50,000 – 74,999	Control Area (After – Before)	-0.60	0.0035*
	Pilot Area (After – Before)	-0.59	0.0037*
	Pilot Area (After – Before) – Control Area (After – Before)	0.01	0.9613
$75,000 – 99,999	Control Area (After – Before)	-0.57	0.0107
	Pilot Area (After – Before)	-0.03	0.8950
	Pilot Area (After – Before) – Control Area (After – Before)	0.54	0.0917
$100,000 – 149,999	Control Area (After – Before)	-0.54	0.0155*
	Pilot Area (After – Before)	-0.33	0.1706
	Pilot Area (After – Before) – Control Area (After – Before)	0.21	0.5151
$150,000 – 199,999	Control Area (After – Before)	-0.16	0.5201
	Pilot Area (After – Before)	0.28	0.2877
	Pilot Area (After – Before) – Control Area (After – Before)	0.44	0.2270
$200,000 – 249,999	Control Area (After – Before)	-0.63	0.0685
	Pilot Area (After – Before)	-0.40	0.3138
	Pilot Area (After – Before) – Control Area (After – Before)	0.23	0.6756
$250,000 or more	Control Area (After – Before)	-0.10	0.7332
	Pilot Area (After – Before)	-0.22	0.4884
	Pilot Area (After – Before) – Control Area (After – Before)	-0.12	0.7887
3-way ANOVA interaction (Income, Area, Time Period) p-value<0.0001*			

*Comparison significant at the 0.05 level.

Source: Battelle based on data provided by SFMTA, 2014.

How Much Paid for Parking

Figure D-2 shows the relationship between household income and the amount paid the respondents on the day of the survey. Table D-9 presents the summary statistics for how much respondents paid for parking by household income and by control and pilot areas and time period. Respondents who did not pay for parking were not included in the analysis. In general, more was paid for parking in pilot areas than control areas. However, in the pilot areas the average price paid was less after variable pricing than before in all income categories but one, whereas the average went up in 6 of the 10 categories in the control areas. Table D-10 shows the ANOVA results, with the p-value testing for a relationship between income, area, and time period being 0.8579, indicating that any relationship between area and time period in terms of price paid for parking does not differ significantly by income overall. There were no income levels in which the price paid for parking was significantly different in the after period compared to the before period for both the control and pilot areas. Any observed differences in price paid for parking due to wave were not significantly different between the pilot and control areas at any income level.



Source: Battelle based on data provided by SFMTA, 2014.

Figure D-2. How Much Did You Pay for Parking (Average) by Area, Total Household Income, and Time Period

Table D-9. Summary Statistics (N and Percent) for Total Household Income Crossed with How Much Paid for Parking

Area	Household Income	Price Paid for Parking (dollars)			
		Before (Before)		After (After)	
		N	Mean (CI)	N	Mean (CI)
Control	Less than $10,000	12	2.28 (1.12, 3.44)	9	2.61 (0.37, 4.85)
	$10,000 – 24,999	14	2.11 (0.97, 3.25)	5	2.90 (0.11, 5.69)
	$25,000 – 34,999	22	4.03 (2.91, 5.16)	14	3.30 (1.16, 5.45)
	$35,000 – 49,999	32	3.95 (2.71, 5.20)	27	3.52 (2.69, 4.35)
	$50,000 – 74,999	41	3.00 (1.83, 4.17)	52	6.04 (2.57, 9.51)
	$75,000 – 99,999	30	3.26 (1.67, 4.86)	50	3.78 (2.73, 4.83)
	$100,000 – 149,999	33	3.98 (2.72, 5.25)	59	3.91 (2.98, 4.84)
	$150,000 – 199,999	20	4.32 (1.53, 7.10)	53	5.23 (1.92, 8.55)
	$200,000 – 249,999	14	3.43 (1.52, 5.34)	22	2.58 (1.99, 3.17)
	$250,000 or more	24	4.63 (2.97, 6.28)	30	6.66 (3.40, 9.93)
Pilot	Less than $10,000	9	5.22 (0.52, 9.92)	17	5.88 (2.74, 9.02)
	$10,000 – 24,999	33	6.73 (4.33, 9.12)	10	5.38 (1.83, 8.92)
	$25,000 – 34,999	53	8.79 (6.74, 10.85)	26	7.64 (1.85, 13.43)
	$35,000 – 49,999	51	10.10 (7.92, 12.28)	29	7.91 (5.17, 10.64)
	$50,000 – 74,999	59	9.98 (7.85, 12.12)	60	9.30 (5.40, 13.21)
	$75,000 – 99,999	40	7.77 (5.33, 10.20)	54	8.73 (5.29, 12.17)
	$100,000 – 149,999	28	7.50 (4.96, 10.04)	83	7.31 (5.77, 8.85)
	$150,000 – 199,999	23	9.58 (5.55, 13.61)	65	7.01 (4.70, 9.32)
	$200,000 – 249,999	12	9.46 (2.12, 16.80)	33	7.69 (5.09, 10.29)
	$250,000 or more	21	10.12 (3.90, 16.33)	27	9.91 (6.26, 13.55)

Source: Battelle based on data provided by SFMTA, 2014.

Table D-10. Results from ANOVA Model Testing for Significant Differences in Total Household Income Crossed with How Much Paid for Parking

Household Income	Comparison	Difference in Amount (dollars)	P-Value
Less than $10,000	Control Area (After – Before)	0.33	0.8767
	Pilot Area (After – Before)	0.66	0.7415
	Pilot Area (After – Before) – Control Area (After – Before)	0.33	0.9108
$10,000 – 24,999	Control Area (After – Before)	0.79	0.7827
	Pilot Area (After – Before)	-1.35	0.4978
	Pilot Area (After – Before) – Control Area (After – Before)	-2.14	0.5401
$25,000 – 34,999	Control Area (After – Before)	-0.73	0.8058
	Pilot Area (After – Before)	-1.16	0.5787
	Pilot Area (After – Before) – Control Area (After – Before)	0.43	0.9066
$35,000 – 49,999	Control Area (After – Before)	-0.43	0.7835
	Pilot Area (After – Before)	-2.19	0.1206
	Pilot Area (After – Before) – Control Area (After – Before)	-1.76	0.4064
$50,000 – 74,999	Control Area (After – Before)	3.04	0.1932
	Pilot Area (After – Before)	-0.68	0.7401
	Pilot Area (After – Before) – Control Area (After – Before)	-3.72	0.2315
$75,000 – 99,999	Control Area (After – Before)	0.52	0.7888
	Pilot Area (After – Before)	0.96	0.5819
	Pilot Area (After – Before) – Control Area (After – Before)	0.44	0.8647
$100,000 – 149,999	Control Area (After – Before)	-0.07	0.9539
	Pilot Area (After – Before)	-0.19	0.8782
	Pilot Area (After – Before) – Control Area (After – Before)	-0.12	0.9459
$150,000 – 199,999	Control Area (After – Before)	0.92	0.7271
	Pilot Area (After – Before)	-2.57	0.2896
	Pilot Area (After – Before) – Control Area (After – Before)	-3.49	0.3296
$200,000 – 249,999	Control Area (After – Before)	-0.85	0.7085
	Pilot Area (After – Before)	-1.77	0.4303
	Pilot Area (After – Before) – Control Area (After – Before)	-0.92	0.7730
$250,000 or more	Control Area (After – Before)	2.04	0.4259
	Pilot Area (After – Before)	-0.21	0.9386
	Pilot Area (After – Before) – Control Area (After – Before)	-2.25	0.5471
	3-way ANOVA interaction (Income, Area, Time period) p-value=0.8579		

*Comparison significant at the 0.05 level.

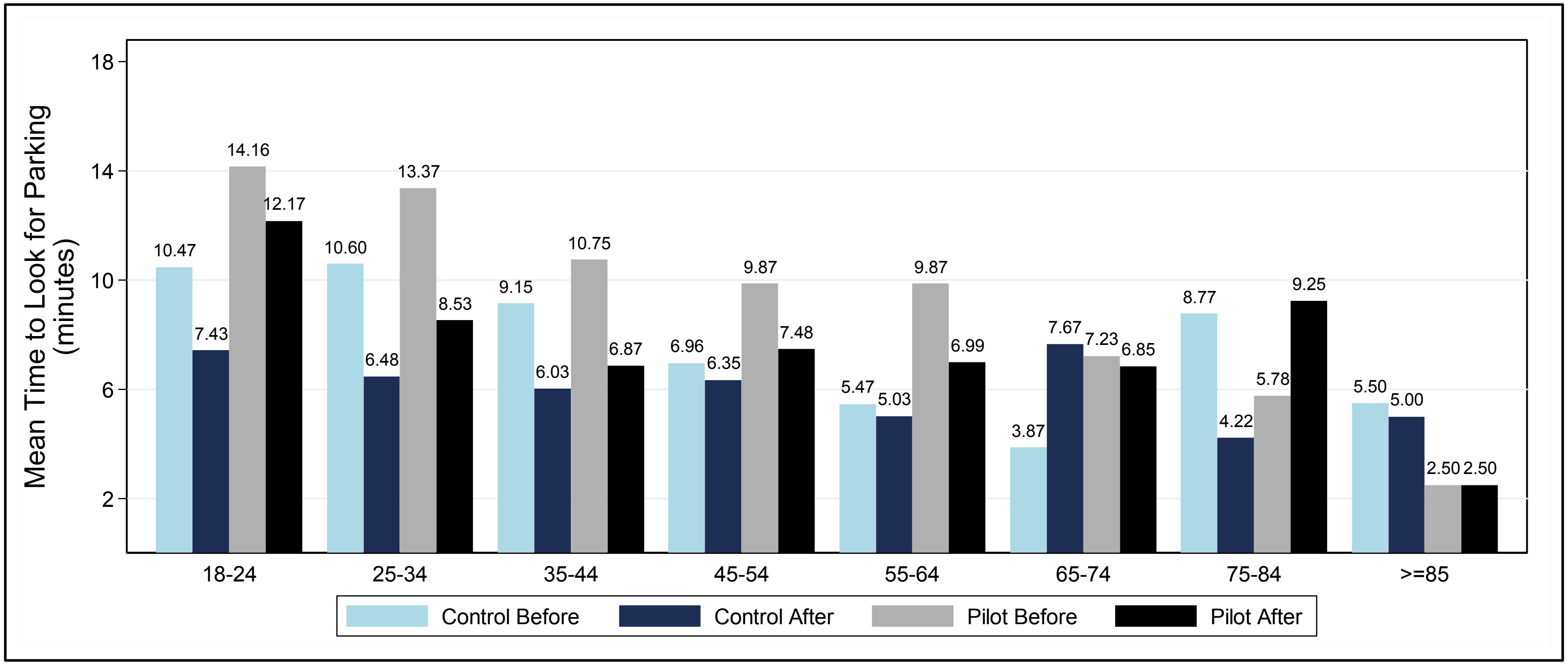
Source: Battelle based on data provided by SFMTA, 2014.

D.2.3 Age Equity Results

This section presents the analysis of the four questions by age categories.

Parking Search Time

Figure D-3 shows the average time to look for parking by age category, area and time period. Before/after reductions in time to look for parking in both the pilot and control areas are apparent in all but the 65-74 and 75-84 categories. Table D-11 presents the summary statistics for the data, and Table D-12 presents the ANOVA results. The p-value testing for a relationship between age, area, and time period in Table D-12 was less than 0.0001 indicating that any relationship between area and time period in terms of parking search time differed significantly by age overall. Some of the largest and statistically significant reductions of 3 minutes or more were for ages 25 to 44, which comprise about half of all the respondents. However, there was no significant difference between pilot and control areas in these age groups, indicating that there was no impact from pricing. On the other hand, parking search time in the after period was less than that in the before in the pilot areas, and statistically significant, for respondents between 55 and 64 years of age. It should also be noted that the apparently large increase in search time in the pilot areas in the 75 - 84 age category was not statistically significant owing to the small number of respondents and large variation in their reported search time. Similarly, for the 65-74 age category in the control area during the after period, the apparent increase in average search time is associated with a wide confidence interval. In both cases the true difference could have been no change or a reduction. The general inference, nonetheless, is that variable pricing did not have a general impact on certain age groups more than others.



Source: Battelle based on data provided by SFMTA, 2014.

Figure D-3. Mean Parking Search Time by Area, Age, and Time Period

Table D-11. Summary Statistics (Mean and 95 Percent Confidence Interval) for Age Crossed with Parking Search Time by Area and Time Period

Area	Age	Time to Look for Parking (minutes)			
		Before (Before)		After (After)	
		N	Mean (CI)	N	Mean (CI)
Control	18-24	55	10.47 (7.82, 13.13)	83	7.43 (5.98, 8.89)
	25-34	141	10.60 (8.90, 12.30)	181	6.48 (5.24, 7.71)
	35-44	137	9.15 (7.71, 10.58)	153	6.03 (4.14, 7.91)
	45-54	132	6.96 (5.58, 8.35)	127	6.35 (4.64, 8.05)
	55-64	94	5.47 (4.24, 6.69)	76	5.03 (3.48, 6.58)
	65-74	46	3.87 (2.09, 5.65)	39	7.67 (2.12, 13.21)
	75-84	13	8.77 (4.29, 13.25)	9	4.22 (0.20, 8.25)
	85 and older	2	5.50 (0.00, 62.68)	1	5.00 (--)
Pilot	18-24	75	14.16 (11.96, 16.36)	54	12.17 (9.06, 15.28)
	25-34	198	13.37 (11.77, 14.97)	217	8.53 (7.31, 9.75)
	35-44	149	10.75 (9.09, 12.41)	183	6.87 (5.70, 8.04)
	45-54	110	9.87 (7.81, 11.94)	135	7.48 (5.87, 9.09)
	55-64	77	9.87 (6.99, 12.75)	88	6.99 (4.82, 9.15)
	65-74	31	7.23 (3.10, 11.35)	33	6.85 (2.95, 10.75)
	75-84	9	5.78 (0.00, 13.24)	8	9.25 (2.73, 15.77)
	85 and older	2	2.50 (0.00, 34.27)	2	2.50 (0.00, 34.27)

Source: Battelle based on data provided by SFMTA, 2014.

Table D-12. Results from ANOVA Model Testing for Significant Differences in Age Crossed with Parking Search Time

Age	Comparison	Difference in Time (Minutes)	P-Value
18-24	Control Area (After – Before)	-3.04	0.0601
	Pilot Area (After – Before)	-1.99	0.2287
	Pilot Area (After – Before) – Control Area (After – Before)	1.05	0.6506
25-34	Control Area (After – Before)	-4.12	0.0002*
	Pilot Area (After – Before)	-4.84	<0.0001*
	Pilot Area (After – Before) – Control Area (After – Before)	-0.72	0.6249
35-44	Control Area (After – Before)	-3.12	0.0065*
	Pilot Area (After – Before)	-3.88	0.0003*
	Pilot Area (After – Before) – Control Area (After – Before)	-0.76	0.6262
45-54	Control Area (After – Before)	-0.62	0.6032
	Pilot Area (After – Before)	-2.39	0.0511
	Pilot Area (After – Before) – Control Area (After – Before)	-1.77	0.2973
55-64	Control Area (After – Before)	-0.44	0.7562
	Pilot Area (After – Before)	-2.88	0.0459*
	Pilot Area (After – Before) – Control Area (After – Before)	-2.44	0.2285
65-74	Control Area (After – Before)	3.80	0.1436
	Pilot Area (After – Before)	-0.38	0.8990
	Pilot Area (After – Before) – Control Area (After – Before)	-4.18	0.2904
75-84	Control Area (After – Before)	-4.55	0.1803
	Pilot Area (After – Before)	3.47	0.3579
	Pilot Area (After – Before) – Control Area (After – Before)	8.02	0.1174
85 and older	Control Area (After – Before)	-0.50	0.9359
	Pilot Area (After – Before)	0.00	1.0000
	Pilot Area (After – Before) – Control Area (After – Before)	0.50	0.9503
3-way ANOVA interaction (Age, Area, Time Period) p-value<0.0001*			

*Comparison significant at the 0.05 level.

Source: Battelle based on data provided by SFMTA, 2014.

Distance Parked from Destination

Table D-13 presents the summary statistics for the responses to the question “How far did you end up parking from your destination?” Results are shown for the eight age categories for control and pilot areas and before and after time periods. Table D-14 presents the ANOVA results. For the ANOVA, the distance parked from destination was treated as a continuous variable with 0.5 blocks used for “less than 1 block away” and 6 blocks used for “more than 4 blocks away.” The “other” response was not used in the ANOVA. The before/after difference in both the control and pilot areas was generally less than a block. The p-value testing for a relationship between age, area, and time period was less than 0.0001 indicating that any relationship between area and time period in terms of distance parked from destination differed significantly by age overall. The distance parked from destination was significantly less in the after time period compared to before for both the control and pilot areas for respondents between 25 and 54 years of age, ages that comprise about two-thirds of all respondents. However the reduction in parking distance from destination was not significantly different between the two areas in any age category, indicating that there was no effect of pricing on distance according to the age of respondent.

Table D-13. Summary Statistics (N and Percent) for Age Crossed with How Far Parked from Destination By Area and Time Period

Age	Area	How Far Did You End Up Parking from Your Destination?	Before N (Percent)	After N (Percent)
18-24	Control	1. Less than 1 block away	15 (27.27%)	19 (22.89%)
		2. About 1 block away	8 (14.55%)	14 (16.87%)
		3. About 2 blocks away	9 (16.36%)	27 (32.53%)
		4. About 3 blocks away	14 (25.45%)	14 (16.87%)
		5. About 4 blocks away	6 (10.91%)	3 (3.61%)
		6. More than 4 blocks away	3 (5.45%)	6 (7.23%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	13 (17.33%)	11 (20.37%)
		2. About 1 block away	3 (4.00%)	8 (14.81%)
		3. About 2 blocks away	20 (26.67%)	8 (14.81%)
		4. About 3 blocks away	15 (20.00%)	15 (27.78%)
		5. About 4 blocks away	13 (17.33%)	5 (9.26%)
		6. More than 4 blocks away	11 (14.67%)	7 (12.96%)
		7. Other	0 (0.00%)	0 (0.00%)

Table D-13. Summary Statistics (N and Percent) for Age Crossed with How Far Parked from Destination By Area and Time Period (Continued)

Age	Area	How Far Did You End Up Parking from Your Destination?	Before N (Percent)	After N (Percent)
25-34	Control	1. Less than 1 block away	29 (20.57%)	64 (35.36%)
		2. About 1 block away	19 (13.48%)	36 (19.89%)
		3. About 2 blocks away	34 (24.11%)	42 (23.20%)
		4. About 3 blocks away	26 (18.44%)	21 (11.60%)
		5. About 4 blocks away	17 (12.06%)	6 (3.31%)
		6. More than 4 blocks away	16 (11.35%)	12 (6.63%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	44 (22.00%)	55 (25.35%)
		2. About 1 block away	11 (5.50%)	36 (16.59%)
		3. About 2 blocks away	55 (27.50%)	47 (21.66%)
		4. About 3 blocks away	40 (20.00%)	38 (17.51%)
		5. About 4 blocks away	21 (10.50%)	17 (7.83%)
		6. More than 4 blocks away	27 (13.50%)	24 (11.06%)
		7. Other	2 (1.00%)	0 (0.00%)
35-44	Control	1. Less than 1 block away	34 (24.82%)	67 (43.51%)
		2. About 1 block away	23 (16.79%)	27 (17.53%)
		3. About 2 blocks away	28 (20.44%)	33 (21.43%)
		4. About 3 blocks away	28 (20.44%)	19 (12.34%)
		5. About 4 blocks away	12 (8.76%)	3 (1.95%)
		6. More than 4 blocks away	12 (8.76%)	5 (3.25%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	23 (15.33%)	58 (31.69%)
		2. About 1 block away	17 (11.33%)	25 (13.66%)
		3. About 2 blocks away	46 (30.67%)	51 (27.87%)
		4. About 3 blocks away	27 (18.00%)	30 (16.39%)
		5. About 4 blocks away	13 (8.67%)	10 (5.46%)
		6. More than 4 blocks away	24 (16.00%)	8 (4.37%)
		7. Other	0 (0.00%)	1 (0.55%)

Table D-13. Summary Statistics (N and Percent) for Age Crossed with How Far Parked from Destination By Area and Time Period (Continued)

Age	Area	How Far Did You End Up Parking from Your Destination?	Before N (Percent)	After N (Percent)
45-54	Control	1. Less than 1 block away	40 (30.08%)	51 (40.16%)
		2. About 1 block away	23 (17.29%)	26 (20.47%)
		3. About 2 blocks away	30 (22.56%)	26 (20.47%)
		4. About 3 blocks away	24 (18.05%)	16 (12.60%)
		5. About 4 blocks away	5 (3.76%)	3 (2.36%)
		6. More than 4 blocks away	11 (8.27%)	5 (3.94%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	22 (19.64%)	32 (23.70%)
		2. About 1 block away	15 (13.39%)	32 (23.70%)
		3. About 2 blocks away	24 (21.43%)	30 (22.22%)
		4. About 3 blocks away	23 (20.54%)	21 (15.56%)
		5. About 4 blocks away	11 (9.82%)	9 (6.67%)
		6. More than 4 blocks away	17 (15.18%)	11 (8.15%)
		7. Other	0 (0.00%)	0 (0.00%)
55-64	Control	1. Less than 1 block away	33 (34.74%)	42 (55.26%)
		2. About 1 block away	17 (17.89%)	9 (11.84%)
		3. About 2 blocks away	19 (20.00%)	7 (9.21%)
		4. About 3 blocks away	14 (14.74%)	12 (15.79%)
		5. About 4 blocks away	4 (4.21%)	0 (0.00%)
		6. More than 4 blocks away	8 (8.42%)	6 (7.89%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	16 (20.78%)	36 (40.91%)
		2. About 1 block away	17 (22.08%)	10 (11.36%)
		3. About 2 blocks away	20 (25.97%)	20 (22.73%)
		4. About 3 blocks away	12 (15.58%)	10 (11.36%)
		5. About 4 blocks away	5 (6.49%)	8 (9.09%)
		6. More than 4 blocks away	7 (9.09%)	4 (4.55%)
		7. Other	0 (0.00%)	0 (0.00%)

Table D-13. Summary Statistics (N and Percent) for Age Crossed with How Far Parked from Destination By Area and Time Period (Continued)

Age	Area	How Far Did You End Up Parking from Your Destination?	Before N (Percent)	After N (Percent)
65-74	Control	1. Less than 1 block away	28 (59.57%)	20 (51.28%)
		2. About 1 block away	5 (10.64%)	2 (5.13%)
		3. About 2 blocks away	5 (10.64%)	12 (30.77%)
		4. About 3 blocks away	4 (8.51%)	2 (5.13%)
		5. About 4 blocks away	1 (2.13%)	1 (2.56%)
		6. More than 4 blocks away	3 (6.38%)	2 (5.13%)
		7. Other	1 (2.13%)	0 (0.00%)
	Pilot	1. Less than 1 block away	7 (22.58%)	12 (36.36%)
		2. About 1 block away	7 (22.58%)	6 (18.18%)
		3. About 2 blocks away	7 (22.58%)	5 (15.15%)
		4. About 3 blocks away	7 (22.58%)	4 (12.12%)
		5. About 4 blocks away	3 (9.68%)	1 (3.03%)
		6. More than 4 blocks away	0 (0.00%)	5 (15.15%)
		7. Other	0 (0.00%)	0 (0.00%)
75-84	Control	1. Less than 1 block away	3 (21.43%)	4 (44.44%)
		2. About 1 block away	2 (14.29%)	1 (11.11%)
		3. About 2 blocks away	5 (35.71%)	2 (22.22%)
		4. About 3 blocks away	3 (21.43%)	0 (0.00%)
		5. About 4 blocks away	0 (0.00%)	1 (11.11%)
		6. More than 4 blocks away	1 (7.14%)	1 (11.11%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	4 (44.44%)	3 (37.50%)
		2. About 1 block away	1 (11.11%)	3 (37.50%)
		3. About 2 blocks away	1 (11.11%)	0 (0.00%)
		4. About 3 blocks away	0 (0.00%)	0 (0.00%)
		5. About 4 blocks away	0 (0.00%)	1 (12.50%)
		6. More than 4 blocks away	3 (33.33%)	1 (12.50%)
		7. Other	0 (0.00%)	0 (0.00%)

Table D-13. Summary Statistics (N and Percent) for Age Crossed with How Far Parked from Destination By Area and Time Period (Continued)

Age	Area	How Far Did You End Up Parking from Your Destination?	Before N (Percent)	After N (Percent)
85 and older	Control	1. Less than 1 block away	0 (0.00%)	0 (0.00%)
		2. About 1 block away	0 (0.00%)	0 (0.00%)
		3. About 2 blocks away	1 (50.00%)	0 (0.00%)
		4. About 3 blocks away	0 (0.00%)	0 (0.00%)
		5. About 4 blocks away	0 (0.00%)	0 (0.00%)
		6. More than 4 blocks away	1 (50.00%)	1 (100.00%)
		7. Other	0 (0.00%)	0 (0.00%)
	Pilot	1. Less than 1 block away	0 (0.00%)	1 (50.00%)
		2. About 1 block away	1 (50.00%)	0 (0.00%)
		3. About 2 blocks away	1 (50.00%)	1 (50.00%)
		4. About 3 blocks away	0 (0.00%)	0 (0.00%)
		5. About 4 blocks away	0 (0.00%)	0 (0.00%)
		6. More than 4 blocks away	0 (0.00%)	0 (0.00%)
		7. Other	0 (0.00%)	0 (0.00%)

Source: Battelle based on data provided by SFMTA, 2014.

Table D-14. Results from ANOVA Model Testing for Significant Differences in Age Crossed with How Far Parked from Destination By Area and Time Period

Age	Comparison	Difference in Blocks	P-Value
18-24	Control Area (After – Before)	-0.12	0.6755
	Pilot Area (After – Before)	-0.31	0.2926
	Pilot Area (After – Before) – Control Area (After – Before)	-0.19	0.6438
25-34	Control Area (After – Before)	-0.72	0.0001*
	Pilot Area (After – Before)	-0.34	0.0375*
	Pilot Area (After – Before) – Control Area (After – Before)	0.38	0.1331
35-44	Control Area (After – Before)	-0.73	0.0001*
	Pilot Area (After – Before)	-0.81	<0.0001*
	Pilot Area (After – Before) – Control Area (After – Before)	-0.08	0.7148
45-54	Control Area (After – Before)	-0.44	0.0256*
	Pilot Area (After – Before)	-0.56	0.0059*
	Pilot Area (After – Before) – Control Area (After – Before)	-0.12	0.6717
55-64	Control Area (After – Before)	-0.34	0.1606
	Pilot Area (After – Before)	-0.37	0.1379
	Pilot Area (After – Before) – Control Area (After – Before)	-0.03	0.9430
65-74	Control Area (After – Before)	0.12	0.7256
	Pilot Area (After – Before)	0.21	0.5932
	Pilot Area (After – Before) – Control Area (After – Before)	0.09	0.8629
75-84	Control Area (After – Before)	-0.15	0.8637
	Pilot Area (After – Before)	-0.74	0.4468
	Pilot Area (After – Before) – Control Area (After – Before)	-0.59	0.6458
85 and older	Control Area (After – Before)	2.00	0.4292
	Pilot Area (After – Before)	-0.25	0.8978
	Pilot Area (After – Before) – Control Area (After – Before)	-2.25	0.4850
3-way ANOVA interaction (Age, Area, Time period) p-value=0.0001*			

*Comparison significant at the 0.05 level.

Source: Battelle based on data provided by SFMTA, 2014.

Ease in Finding Parking

Summary statistics on the ease with which respondents found parking are shown in Table D-15 by age category, control and pilot areas, and before and after time periods. Table D-16 presents the ANOVA results. The p-value testing for a relationship between age, area, and time period was less than 0.0001 indicating that any relationship between area and time period in terms of ease of parking differs significantly by age overall. The perceived parking experience was significantly easier in the after period compared to before for both the control and pilot areas for respondents between the ages of 25 and 44, the largest age categories among the respondents. However, the improved ease of parking was not significantly different between the two areas in this age range. In addition, respondents between the ages of 18 and 24 years and between 75 and 84 years found it significantly easier to park in the after than before for the control area only (no significant difference in the pilot area). Thus, there was no disproportionate benefit in ease of parking for certain age groups due to pricing in the pilot areas.

Table D-15. Summary Statistics (N and Percent) for Age Crossed with Ease to Park By Area and Time Period

Age	Area	How Easy was it to Find Parking? (1=very easy, 5=very difficult)	Before N (Percent)	After N (Percent)
18-24	Control	1	13 (23.64%)	22 (26.83%)
		2	8 (14.55%)	17 (20.73%)
		3	10 (18.18%)	23 (28.05%)
		4	11 (20.00%)	14 (17.07%)
		5	13 (23.64%)	6 (7.32%)
	Pilot	1	10 (13.51%)	9 (16.67%)
		2	15 (20.27%)	9 (16.67%)
		3	21 (28.38%)	17 (31.48%)
		4	14 (18.92%)	9 (16.67%)
		5	14 (18.92%)	10 (18.52%)
25-34	Control	1	25 (17.73%)	58 (32.04%)
		2	19 (13.48%)	47 (25.97%)
		3	39 (27.66%)	40 (22.10%)
		4	39 (27.66%)	22 (12.15%)
		5	19 (13.48%)	14 (7.73%)
	Pilot	1	40 (20.62%)	68 (31.34%)
		2	28 (14.43%)	33 (15.21%)
		3	53 (27.32%)	59 (27.19%)
		4	32 (16.49%)	34 (15.67%)
		5	41 (21.13%)	23 (10.60%)

Table D-15. Summary Statistics (N and Percent) for Age Crossed with Ease to Park By Area and Time Period (Continued)

Age	Area	How Easy was it to Find Parking? (1=very easy, 5=very difficult)	Before N (Percent)	After N (Percent)
35-44	Control	1	26 (19.12%)	66 (42.86%)
		2	21 (15.44%)	30 (19.48%)
		3	34 (25.00%)	34 (22.08%)
		4	35 (25.74%)	19 (12.34%)
		5	20 (14.71%)	5 (3.25%)
	Pilot	1	39 (26.35%)	73 (40.33%)
		2	20 (13.51%)	33 (18.23%)
		3	33 (22.30%)	30 (16.57%)
		4	33 (22.30%)	33 (18.23%)
		5	23 (15.54%)	12 (6.63%)
45-54	Control	1	48 (36.09%)	51 (40.16%)
		2	26 (19.55%)	22 (17.32%)
		3	23 (17.29%)	29 (22.83%)
		4	18 (13.53%)	12 (9.45%)
		5	18 (13.53%)	13 (10.24%)
	Pilot	1	29 (26.61%)	52 (38.52%)
		2	17 (15.60%)	21 (15.56%)
		3	25 (22.94%)	27 (20.00%)
		4	21 (19.27%)	15 (11.11%)
		5	17 (15.60%)	20 (14.81%)
55-64	Control	1	41 (43.62%)	39 (51.32%)
		2	14 (14.89%)	9 (11.84%)
		3	15 (15.96%)	10 (13.16%)
		4	17 (18.09%)	13 (17.11%)
		5	7 (7.45%)	5 (6.58%)
	Pilot	1	31 (41.89%)	36 (41.38%)
		2	8 (10.81%)	14 (16.09%)
		3	21 (28.38%)	17 (19.54%)
		4	8 (10.81%)	12 (13.79%)
		5	6 (8.11%)	8 (9.20%)

Table D-15. Summary Statistics (N and Percent) for Age Crossed with Ease to Park By Area and Time Period (Continued)

Age	Area	How Easy was it to Find Parking? (1=very easy, 5=very difficult)	Before N (Percent)	After N (Percent)
65-74	Control	1	23 (48.94%)	19 (48.72%)
		2	5 (10.64%)	9 (23.08%)
		3	11 (23.40%)	6 (15.38%)
		4	4 (8.51%)	3 (7.69%)
		5	4 (8.51%)	2 (5.13%)
	Pilot	1	11 (37.93%)	16 (48.48%)
		2	2 (6.90%)	3 (9.09%)
		3	5 (17.24%)	7 (21.21%)
		4	4 (13.79%)	1 (3.03%)
		5	7 (24.14%)	6 (18.18%)
75-84	Control	1	1 (7.14%)	6 (66.67%)
		2	4 (28.57%)	2 (22.22%)
		3	3 (21.43%)	0 (0.00%)
		4	1 (7.14%)	1 (11.11%)
		5	5 (35.71%)	0 (0.00%)
	Pilot	1	4 (44.44%)	3 (37.50%)
		2	0 (0.00%)	0 (0.00%)
		3	2 (22.22%)	2 (25.00%)
		4	1 (11.11%)	0 (0.00%)
		5	2 (22.22%)	3 (37.50%)
85 and older	Control	1	1 (50.00%)	0 (0.00%)
		2	0 (0.00%)	0 (0.00%)
		3	0 (0.00%)	0 (0.00%)
		4	1 (50.00%)	0 (0.00%)
		5	0 (0.00%)	1 (100.00%)
	Pilot	1	1 (50.00%)	1 (50.00%)
		2	0 (0.00%)	0 (0.00%)
		3	0 (0.00%)	1 (50.00%)
		4	1 (50.00%)	0 (0.00%)
		5	0 (0.00%)	0 (0.00%)

Source: Battelle based on data provided by SFMTA, 2014.

Table D-16. Results from ANOVA Model Testing for Significant Differences in Age Crossed with Ease to Park By Area and Time Period

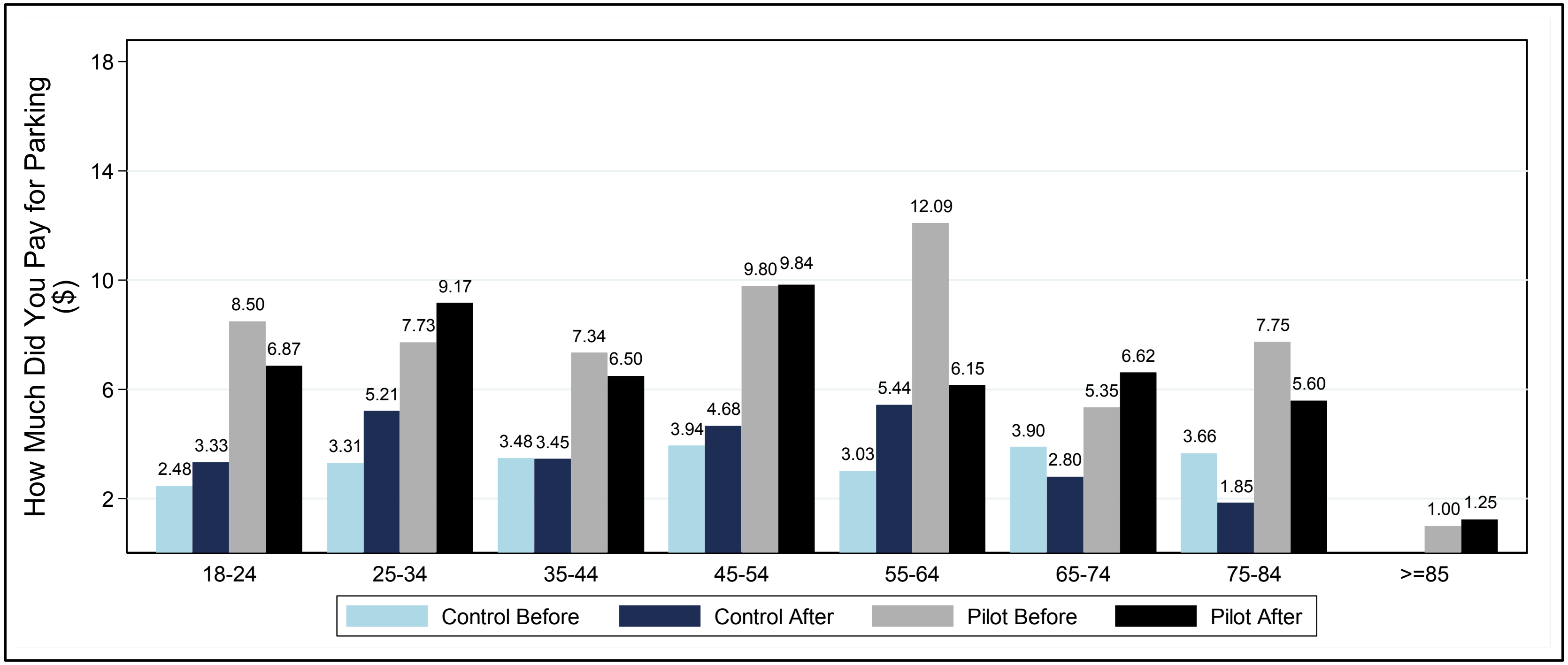
Age	Comparison	Difference in Easy to Park Scale	P-Value
18-24	Control Area (After – Before)	-0.48	0.0404*
	Pilot Area (After – Before)	-0.06	0.8106
	Pilot Area (After – Before) – Control Area (After – Before)	0.42	0.2069
25-34	Control Area (After – Before)	-0.68	<0.0001*
	Pilot Area (After – Before)	-0.44	0.0009*
	Pilot Area (After – Before) – Control Area (After – Before)	0.24	0.2297
35-44	Control Area (After – Before)	-0.88	<0.0001*
	Pilot Area (After – Before)	-0.55	0.0002*
	Pilot Area (After – Before) – Control Area (After – Before)	0.33	0.1210
45-54	Control Area (After – Before)	-0.17	0.3475
	Pilot Area (After – Before)	-0.34	0.0679
	Pilot Area (After – Before) – Control Area (After – Before)	-0.17	0.5062
55-64	Control Area (After – Before)	-0.15	0.4773
	Pilot Area (After – Before)	0.01	0.9669
	Pilot Area (After – Before) – Control Area (After – Before)	0.16	0.5988
65-74	Control Area (After – Before)	-0.20	0.5277
	Pilot Area (After – Before)	-0.46	0.2080
	Pilot Area (After – Before) – Control Area (After – Before)	-0.26	0.5812
75-84	Control Area (After – Before)	-1.80	0.0088*
	Pilot Area (After – Before)	0.33	0.6550
	Pilot Area (After – Before) – Control Area (After – Before)	2.13	0.0369*
85 and older	Control Area (After – Before)	2.50	0.3646
	Pilot Area (After – Before)	-0.50	0.8109
	Pilot Area (After – Before) – Control Area (After – Before)	-3.00	0.3948
3-way ANOVA interaction (Age, Area, Time period) p-value<0.0001*			

*Comparison significant at the 0.05 level.

Source: Battelle based on data provided by SFMTA, 2014.

Amount Paid for Parking

Figure D-4 shows the relationship between age of respondent and the amount paid the respondents on the day of the survey. Table D-17 presents the summary statistics for how much respondents paid for parking by age and by control and pilot areas and time period. Respondents who did not pay for parking were not included in the analysis. On average, respondents in every age group paid more for parking in pilot areas than control areas both before and after variable pricing in the pilot areas, although the average amount dropped in the pilot areas in the after period for most age groups. Table D-18 shows the ANOVA results, with a p-value testing for a relationship between age, area, and time period of 0.0275, indicating that any relationship between area and time period in terms of amount paid differed significantly by age overall. Respondents in the pilot area between the ages of 55 and 64 years paid less for parking in the after time period compared to before. This differed significantly from the control area where respondents paid more for parking in the after period (although not a significant increase) for the same age group. There were no significant differences in any other age group. Given these results, one can conclude that variable pricing had no impact on how much was paid for parking among different age groups.



Source: Battelle based on data provided by SFMTA, 2014.

Figure D-4. Average Amount Paid for Parking by Area, Age, and Time Period

Table D-17. Summary Statistics (Mean and 95 Percent Confidence Interval) for Age Crossed with Amount Paid for Parking by Area and Time Period

Area	Age	Price Paid for Parking (dollars)			
		Before (Before)		After (After)	
		N	Mean (CI)	N	Mean (CI)
Control	18-24	32	2.48 (1.81, 3.14)	36	3.33 (2.31, 4.36)
	25-34	63	3.31 (2.41, 4.22)	103	5.21 (3.12, 7.31)
	35-44	75	3.48 (2.65, 4.32)	99	3.45 (2.74, 4.17)
	45-54	74	3.94 (2.93, 4.94)	68	4.68 (2.57, 6.79)
	55-64	46	3.03 (1.92, 4.14)	49	5.44 (3.55, 7.33)
	65-74	23	3.90 (2.17, 5.62)	19	2.80 (1.51, 4.09)
	75-84	6	3.66 (0.00, 9.27)	5	1.85 (0.62, 3.08)
	85 and older	0	NA	0	NA
Pilot	18-24	43	8.50 (6.13, 10.87)	32	6.87 (4.65, 9.09)
	25-34	126	7.73 (6.39, 9.07)	129	9.17 (6.86, 11.48)
	35-44	93	7.34 (6.08, 8.61)	131	6.50 (5.40, 7.60)
	45-54	79	9.80 (7.87, 11.73)	90	9.84 (7.18, 12.50)
	55-64	37	12.09 (8.16, 16.02)	57	6.15 (4.31, 8.00)
	65-74	18	5.35 (2.32, 8.38)	20	6.62 (3.47, 9.77)
	75-84	3	7.75 (0.00, 36.27)	5	5.60 (0.00, 15.71)
	85 and older	1	1.00 (--)	2	1.25 (-8.28, 10.78)

-- Confidence Interval cannot be calculated because of only one respondent.

NA No data for respondents in this age range.

Source: Battelle based on data provided by SFMTA, 2014.

Table D-18. Results from ANOVA Model Testing for Significant Differences in Age Crossed with Amount Paid for Parking By Area and Time Period

Age	Comparison	Difference in Amount (Dollars)	P-Value
18-24	Control Area (After – Before)	0.86	0.5171
	Pilot Area (After – Before)	-1.63	0.1999
	Pilot Area (After – Before) – Control Area (After – Before)	-2.49	0.1758
25-34	Control Area (After – Before)	1.90	0.2387
	Pilot Area (After – Before)	1.44	0.2532
	Pilot Area (After – Before) – Control Area (After – Before)	-0.46	0.8232
35-44	Control Area (After – Before)	-0.03	0.9696
	Pilot Area (After – Before)	-0.85	0.2375
	Pilot Area (After – Before) – Control Area (After – Before)	-0.82	0.4501
45-54	Control Area (After – Before)	0.74	0.6357
	Pilot Area (After – Before)	0.04	0.9800
	Pilot Area (After – Before) – Control Area (After – Before)	-0.70	0.7399
55-64	Control Area (After – Before)	2.41	0.1194
	Pilot Area (After – Before)	-5.93	0.0002*
	Pilot Area (After – Before) – Control Area (After – Before)	-8.34	0.0002*
65-74	Control Area (After – Before)	-1.09	0.4906
	Pilot Area (After – Before)	1.27	0.4444
	Pilot Area (After – Before) – Control Area (After – Before)	2.36	0.3042
75-84	Control Area (After – Before)	-1.81	0.6627
	Pilot Area (After – Before)	-2.15	0.6672
	Pilot Area (After – Before) – Control Area (After – Before)	-0.34	0.9579
85 and older	Control Area (After – Before)	NA	NA
	Pilot Area (After – Before)	NA	NA
	Pilot Area (After – Before) – Control Area (After – Before)	NA	NA
3-way ANOVA interaction (Age, Area, Time Period) p-value=0.0275*			

NA Too few observations to make a statistical comparison.

*Comparison significant at the 0.05 level.

Source: Battelle based on data provided by SFMTA, 2014.

D.2.4 Summary of Income and Age Equity Results

The analysis by income in Section D.2.2 and by age in Section D.2.3 was based on four questions used to identify potential differential impacts by income or age. The questions dealt with how many minutes it took the respondent to find parking, how many blocks away from the destination the respondent parked, the respondent's perception of how easy it was to find parking, and how much the respondent thought he or she had paid for parking. Numerous statistically significant differences between age groups or income levels were found using a 3-way ANOVA model for each question. Most of the differences occurred between time periods within either the control or pilot areas (or sometimes both). Moreover, there were few cases where the differences observed between time periods in the pilot area, where variable pricing occurred, were significantly different from those in the control areas, where there were no price changes. The conclusion from these findings is that the response to variable pricing was not significantly influenced by the income or age of the respondent in a systematic way. Thus, no income or age equity impact was discernible in the data.

D.3 Potential Equity Impacts by SF*park* Areas

Analysis of geographic equity sought to understand whether the impacts of variable pricing varied among the pilot areas. That is, were some parking districts affected more than others, positively or negatively, which in turn impacted the people living and working in those locations? Data examined for geographic equity were based on SF*park* neighborhoods, which included travel time and speed presented in Appendix A – Congestion Analysis, parking availability in Appendix B – Pricing Analysis, and environmental impacts presented in Appendix E – Environmental and Energy Analysis.

D.3.1 Changes in Traffic Congestion by Neighborhood

Variable pricing was expected to improve traffic congestion in the pilot areas in which it was implemented. Appendix A – Congestion Analysis examined a variety of congestion measures to assess the impact of pricing, including speed based on roadway sensors, speed and travel time based on Muni buses traveling through the SF*park* areas. Presented here are the findings of that analysis by SF*park* pilot areas.

Table D-19 shows changes weekday average daily link speed based on available roadway sensor data in spring of 2012 and 2013 compared to spring 2011. By 2012, mid-way through the evaluation period, average daily travel speeds had increased in only three pilot districts: the Fillmore pilot district and on one street each in both the Downtown and the Mission pilot districts. By the end of the evaluation period in 2013 average daily travel speed had increased only in the Fillmore pilot district on Geary Street by an additional 1.5 mph. Link speed on other roadways had changed little or actually declined, notably on 3rd Street in the South Embarcadero and Downtown.

Table D-19. Change in Measured Average Daily Link Speeds (mph) from Available Sensors in SF*park* Pilot Parking Management Districts*

Pilot Management District	Roadway	Weekdays	
		2011 to 2012	2011 to 2013
Downtown	Embarcadero	-0.4	-1.7
	Main	+0.4	-1.4
Fillmore	Geary St.	+1.6	+1.5
Fisherman's Wharf	Beach St.	-0.3	-1.6
Marina	Pierce St.	-0.2	-0.6
	Chestnut St.	-0.5	-0.4
Mission	22nd St.	-0.4	0.0
	23rd St.	+0.3	-0.5
South Embarcadero	Townsend St.	-0.6	-0.3
	3rd St.	-2.2	-1.3

*The Civic Center pilot area is not included due to insufficient roadway sensor data.

Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Additional analysis of available roadway sensor data by time of day in Appendix A – Congestion Analysis indicated that average link speeds for most of the pilot area remained relatively constant across all time-of-day intervals, which suggests that the roadways where data were available did not exhibit severe congestion in the peak period and operated in a similar fashion throughout the day. The findings suggest that, with the exception of the Fillmore pilot parking management district, deploying variable pricing did not result in a significant increase in travel speeds in the pilot parking management districts. On the roadways in the pilot districts where data were available, average travel speed remained constant or even declined slightly after variable pricing was implemented. The only corridor which experienced a sustained increase in average travel speeds was Geary Street in the Fillmore area. It was not possible to perform statistical tests for the significance of the before/after observed differences in the pilot areas, and roadway sensor data from the control areas were not available for comparison to determine to what extent the changes observed in the pilot areas could be attributable to parking pricing or other causes.

Another source of data on travel speeds by SF*park* neighborhood came from Muni buses equipped with APCs with routes through the pilot and control areas. The data were edited to remove dwell time as buses loaded and unloaded passengers at stops, and as a result they serve as a useful proxy for travel time and speeds for all vehicles.

Table D-20 shows the results of the statistical analyses of average travel speed of transit vehicles by SF*park* pilot and control areas. Data were not available for the Downtown pilot area and the West Portal control area. Cells in the table shaded green indicate statistically significant increases in speed relative to 2011 before variable pricing in the pilot areas began and cells shaded red indicate statistically significant reductions in speed. On average, transit travel speeds declined by 0.1 mph in the control area in both 2012 and 2013 compared to 2011, indicating average transit travel speeds were declining slightly over time. Average transit speed varied among the pilot areas, with a significant increase in the Civic Center and Fisherman's Wharf areas, but with a significant decrease in the Mission and South Embarcadero areas. However, by the spring of 2013 the earlier improvements had been erased and only Mission recorded a slight but statistically significant increase in average transit speed. However, with the exception of South Embarcadero from 2011 to 2013, all the observed changes by neighborhood were less than 0.5 mph. These modest differences suggest minimal change, if any, on transit speeds due to variable pricing, and, therefore, speeds in individual neighborhoods were not impacted by variable pricing.

Table D-20. Statistical Comparison* of the Change in Average Transit Speeds by Parking Management District*

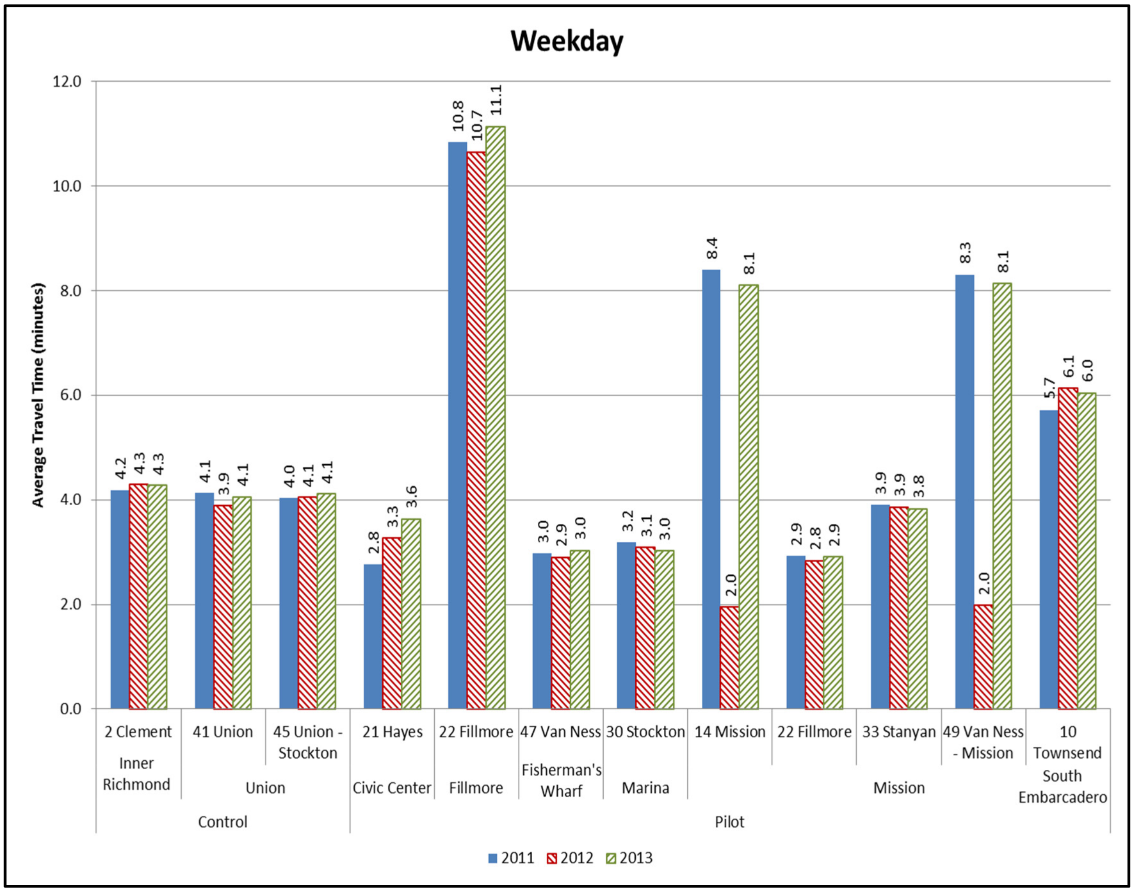
Parking Management Districts		Change in Average Transit Speed (mph)					
		Spring 2011 to Spring 2012			Spring 2011 to Spring 2013		
		ΔSpeed	Std. Error	t-value	ΔSpeed	Std. Error	t-value
Control	Inner Richmond	-0.15	0.064	-2.30	-0.07	0.066	-1.06
	Union	-0.08	0.042	-1.81	-0.15	0.042	-3.60
	Total	-0.10	0.035	-2.73	-0.13	0.035	-3.66
Pilot	Civic Center	0.37	0.060	6.19	-0.29	0.063	-4.61
	Fillmore	0.00	0.044	0.03	-0.18	0.040	-4.37
	Fisherman's Wharf	0.16	0.055	2.98	0.06	0.056	1.18
	Marina	-0.06	0.053	-1.22	0.10	0.052	1.83
	Mission**	-0.23	0.033	-7.11	0.13	0.024	5.30
	South Embarcadero	-0.34	0.074	-4.65	-0.82	0.074	-11.12
	Total	-0.01	0.019	-0.52	-0.02	0.017	-0.95

*T-test for significant before/after difference in average speeds was performed. Shaded cells indicate t-values that are statistically significant at 95 percent level of confidence, with red indicating a negative difference and green a positive difference.

**Data for Mission routes 14 and 49 for 2012 not included due to impact of construction.

Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

The travel time of buses on these same routes through pilot and control areas is shown in Figure D-5. The average travel times in the control areas changed little, suggesting that the background level of congestion (at least that affecting transit travel times) remained the same over the duration of the evaluation period. However, little change was also observed in most of the pilot areas, where variable pricing was in effect. The exception was a dramatic drop in travel time in 2012 on bus routes 14 and 49 in the Mission area caused by rerouting due to construction and an increase in travel time on bus route 21 through the Civic Center pilot area. It is possible that the Civic Center area was experiencing more traffic congestion due to an improving economy thereby causing the higher travel time in that area. In the final analysis, it does not appear that travel time in any pilot area benefited from variable pricing. All changes from the period before variable pricing began were less than a minute (with the exception of construction-caused changes in two routes in the Embarcadero), an amount of similar magnitude in the control areas.



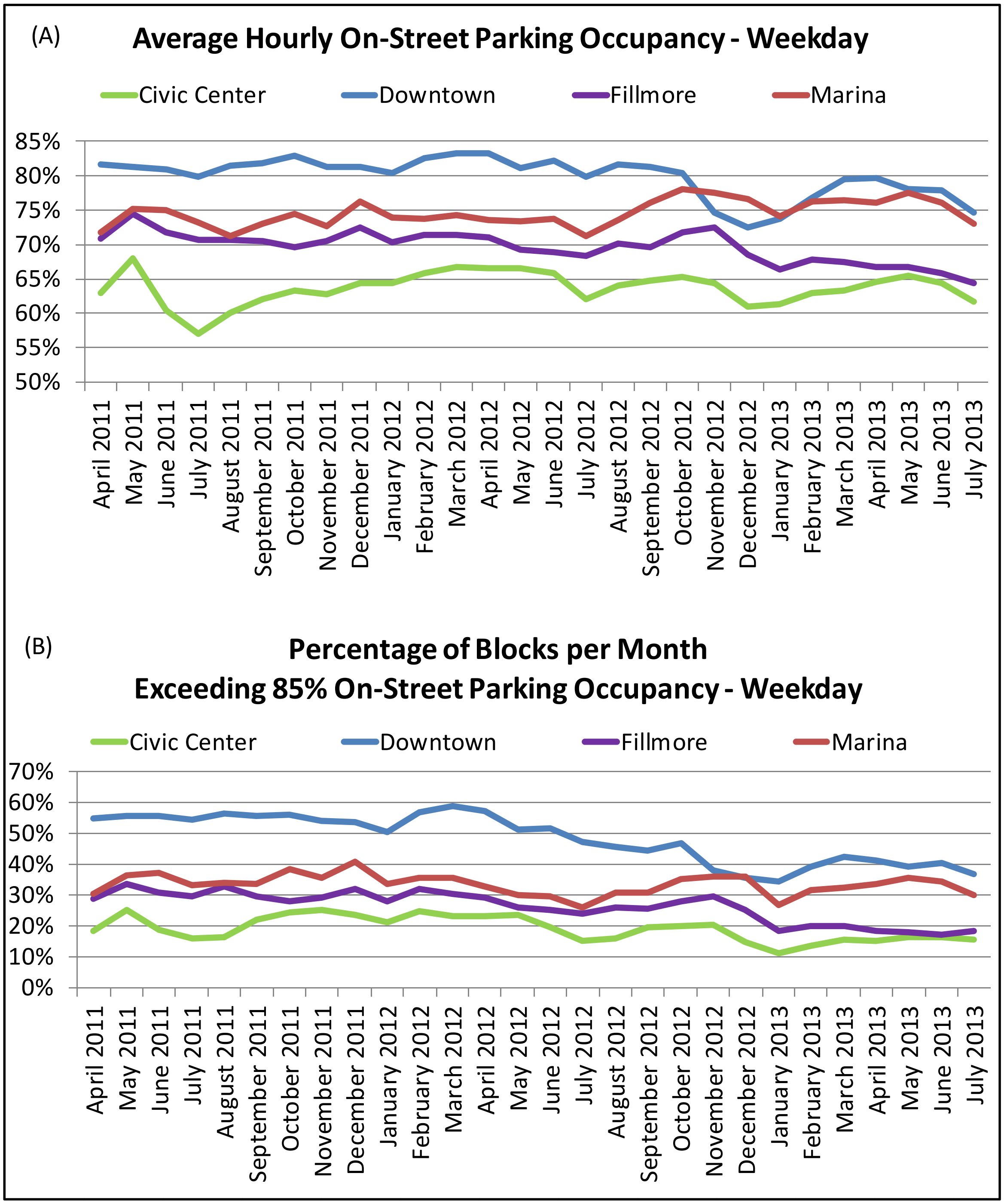
Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure D-5. Weekday Average Transit Travel Times by Routes in Pilot and Control Parking Management Districts

D.3.2 Changes in Parking Availability by Neighborhood

Appendix B – Pricing Analysis provided another source of data on the impact of variable pricing by SF*park* neighborhoods. Trends in parking occupancy based on parking sensor and meter data showed that pilot areas with higher initial parking occupancies experienced reductions in occupancy over time, whereas the pilot areas with lower initial occupancies experienced increases over time. Thus, the neighborhoods where parking was the least available realized the greatest benefit. At the same time, in neighborhoods where parking availability was more abundant, variable pricing helped raise parking occupancies through price reductions. While SF*park* pricing actions were implemented on a block-by-block basis, their impacts could be discerned by neighborhoods that initially differed on overall parking availability.

Figure D-6 shows four pilot areas which began with high average occupancies above at least 60 percent, as shown in the upper of the two graphs in the figure. As demonstrated in the lower graph, repeated demand-based price changes from the beginning of 2012 onward began to affect parking availability by lowering parking occupancy as the percent of highly congested blocks (85 percent occupancy or more) declined in these areas.



Source: Elliot Martin, 2014.

Figure D-6. Average Hourly Parking Occupancy (A) and Percentage of Blocks Exceeding 85 Percent Occupancy (B) for Weekdays in Four Pilot Areas

In two of the other three pilot areas – Fisherman's Wharf and South Embarcadero – an opposite impact was observed (and demonstrated in Appendix A). They began with lower parking occupancies of about 55 percent but experienced a gradual and steady increase in parking occupancy during the second year of the evaluation.

Mission, the remaining pilot area proved to be an anomaly. Whereas parking occupancies in the Mission started at 70 percent, similar to pilot areas shown in Figure D-6, a large-scale construction effort starting in 2012 removed the sensors for 9 of the 28 blocks taking them out of the variable pricing process during the evaluation period and causing SFMTA to focus its pricing actions on other pilot areas with less disruption. Consequently, pricing in the Mission did not change occupancy, which in fact increased slightly, perhaps a consequence of the construction affecting on-street parking more than pricing.

The analysis of parking occupancy indicates that the impact of SF*park* pricing varied by neighborhood. Some neighborhoods benefited by having more parking available on their most congested blocks, albeit at a higher price. Other neighborhoods benefited by lower parking prices that in turn helped fill unused parking spaces but led to slightly more congestion on some blocks.

D.3.3 Emissions and Energy Use by Neighborhood

The environmental analysis reported in Appendix E – Environmental and Energy Analysis estimated an overall 27 percent reduction in emissions from reduced cruising for parking on weekdays and a 23 percent weekend reduction in the SF*park* pilot areas over what it would have been without variable pricing. (The terms "with and without" variable pricing is used rather than "before and after", because the miles are estimated using a statistical model rather than observed.) The reductions in energy were the same, as both emissions and energy use were based on a linear function of changes in vehicle miles traveled (VMT) in the pilot areas. Changes in speed were not significant enough to warrant non-linear estimation models of emissions and energy usage.

The change in VMT associated with cruising to look for parking varied by neighborhood as shown in Table D-21 and Table D-22 for weekday and weekend periods for SFMTA's general metered parking. (During the evaluation period, SFMTA did not charge for parking at on-street meters on Sundays, and, thus, the weekend change in VMT is represented by data for Saturday only.)

Table D-21. Parking Cruise VMT by SF*park* Neighborhood and Time Period on Weekdays*

SF*park* Neighborhood	Variable Pricing	Average Hourly Miles 9 a.m. – 6 p.m.	Total Miles 9 a.m. – 6 p.m.	Percent Change in Total Miles
Civic Center	Without	255	2,295	-28.84
	With	181	1,633	
Downtown	Without	174	1,570	-38.55
	With	107	965	
Fillmore	Without	198	1,784	-30.01
	With	139	1,249	
Marina	Without	125	1,125	-7.17
	With	116	1,044	
Mission	Without	264	2,373	-9.72
	With	238	2,142	
South Embarcadero	Without	365	3,283	-36.37
	With	232	2,089	
Total	Without	1,381	12,431	-26.61
	With	1,014	9,123	

*The Fisherman's Wharf pilot area is not included due to insufficient data needed to estimate VMT.

Source: Earth Matters, Inc., 2014.

Table D-22. Parking Cruise VMT by SF*park* Neighborhood and Time Period on Weekends*

SF*park* Neighborhood	Variable Pricing	Average Hourly Miles 12 p.m. – 6 p.m.	Total Miles 12 p.m. – 6 p.m.	Percent Change in Total Miles
Civic Center	Without	286	2,576	-25.68%
	With	213	1,915	
Downtown	Without	187	1,683	-31.34%
	With	128	1,155	
Fillmore	Without	218	1,960	-24.43%
	With	165	1,482	
Marina	Without	128	1,152	+0.28%
	With	128	1,155	
Mission	Without	304	2,735	-5.07%
	With	289	2,597	
South Embarcadero	Without	400	3,601	-35.07%
	With	260	2,338	
Total	Without	1523	13,707	-22.37%
	With	1,182	10,641	

*Saturdays only, as SFMTA did not have general metered pricing on Sundays during the evaluation period.

Source: Earth Matters, Inc., 2014.

Since emissions and energy usage are a function of VMT, the percentage change in total miles associated with cruising for parking by neighborhood corresponds to emission and energy changes for the neighborhood. While a reduction in both emissions and energy usage was estimated for every pilot area, some neighborhoods benefited much more than others. Downtown and South Embarcadero declined the most – by more than 30 percent on weekdays and weekends. At the other extreme were Marina and Mission. Mission showed about a 10 percent drop in emissions and energy use on weekdays and half that on weekends. Marina had a 7 percent reduction on weekdays, but no improvement (+0.28 percent) on weekends. In between were Civic Center and Fillmore with between 20 and 30 percent reductions in emissions and energy usage.

D.3.4 Conclusions about Geographic Equity

Analysis of congestion measures of travel speed and travel time showed little to no impact from variable pricing in the SF*park* pilot areas. Roadway sensor data measuring average daily speeds on a very limited number of links showed increased speed only in the Fillmore area (and only 1.5 mph), whereas link speeds in other pilot areas were either unchanged or less than before the start of pricing. Speed based on Muni buses traveling through the pilot areas likewise showed minimal changes, either increases or decreases in speed, after the start of variable pricing.

Similarly, travel time of buses in the pilot areas did not appear to benefit from variable pricing, with travel times essentially the same as before pricing.

Variable pricing had the most direct impact by neighborhoods in terms of parking availability. Analysis of parking occupancy over the evaluation period revealed that pilot areas that began with high average parking occupancies saw the percentage of highly congested blocks decline and pilot areas starting with lower occupancies saw an increase. These opposite trends reflected the action of higher prices to lower occupancy and lower prices to raise occupancy in the different pilot areas.

All SF*park* pilot areas benefited from air quality improvements and reductions of energy use as vehicles cruised fewer miles looking for parking. Some neighborhoods benefited more, with Downtown and South Embarcadero seeing the greatest reductions in emissions and energy use and Marina and Mission seeing the least. Thus, the people living or coming to these areas would be impacted in terms of air quality or, for those who drove, less fuel consumed in the search for parking.

D.4 Impact of Planned Re-investment of Potential SF*park* Revenues

One measure of equity is how parking revenues collected by SFMTA are used. For example, were revenues collected as parking fees and citations applied to other transportation modes or facilities?

By City Charter all meter and citation revenues are returned to the SFMTA to fund its operational budget of about $850 million per year, which pays for transit operations (the largest cost) and other operations including parking.[1] The following is the section of the City Charter that states this requirement:

> "Section SEC. 8A.105. MUNICIPAL TRANSPORTATION FUND.
>
> (e) It is the policy of the City and County of San Francisco to use parking-related revenues to support public transit. To that end, the following parking-related revenues deposited in the Transportation Fund shall be used to support the capital and operating expenses arising from the Agency's transit functions:
>
> 1. Revenues from parking meters, except those amounts collected from parking meters operated by the Recreation and Park Department and the Port Commission and except to the extent that they are required by law to be dedicated to other traffic regulation and control functions;
>
> 2. Revenues from off-street parking facilities under the jurisdiction of the Agency (excluding facilities owned by the Parking Authority), including facilities leased to private owners and non-profit corporations, except those amounts generated from any parking on or below any land or facilities under the jurisdiction of the Recreation and Park Department and except those amounts obligated by contract executed before 1993 to pay debt service;

[1] Personal communication with SFMTA staff February 26, 2014.

3. Revenues from fines, forfeited bail, or penalties for parking violations, except those amounts to be credited to the courthouse construction fund as provided in Administrative Code Section 10.117-35."

Thus, revenues generated through SFMTA's parking operations, including SF*park*, are separated by statute from how SFMTA funding is handled. From the equity standpoint, parking revenues are used to benefit a broader set of travelers than those who drive and park in SFMTA facilities. By serving a wide range of travelers, parking revenue re-investment has a positive equity effect.

D.5 Summary of Equity Analysis

Table D-23 presents a summary of the equity analysis across the four questions. Based on available data, analyses presented in this appendix provide evidence for addressing the four questions.

For the first question the visitor/shopper survey provided data to examine direct costs in terms of parking fees and parking convenience as reported by user groups defined by income and age categories. Survey respondents reported how much they paid for parking, how long they looked for parking, how far away they parked from their destination, and their overall perception of how easy it was to find parking. Based on summary statistics, such as averages and percentages by income or age category, and on ANOVA models, the findings revealed no systematic differences by income or age that indicate an equity impact from variable pricing in the pilot areas.

The second question examined geographic equity using data on traffic congestion measures, parking availability, and environmental and energy impacts. Congestion measures of travel speed and travel time based on data from roadway sensors and Muni buses showed little to no change, and thus, no discernible impact of variable pricing. Changes in parking availability varied among the pilot areas. Those pilot areas with the highest parking congestion, such as Downtown, saw the percentage of highly congested blocks decline as higher parking prices began to enhance availability of spaces. Pilot areas starting with lower occupancies saw an increase resulting from price reductions, but parking availability was still within an acceptable range. Thus, SF*park* pricing resulted in different outcomes for different neighborhoods depending upon their original levels of parking availability and the direction of price changes. The effect on people living in or coming to congested areas was that they would realize a benefit of greater parking availability during high-demand periods, but at a greater price. People in other neighborhoods would benefit from lower parking prices but they might experience less parking availability than before. Environmental and energy usage due to less cruising for parking after variable pricing benefited all the pilot areas, but some more than others. Downtown and South Embarcadero saw the greatest reductions, while Marina and Mission saw the least. Thus, people living in or driving to those areas would have been similarly impacted.

The third question addressed whether any user groups were positively or negatively impacted by the UPA projects. The data available to address this question were the same as used for the first question. No additional data on race or ethnicity was available in the visitor/shopper survey to further explore impacts on minority groups, and therefore the focus is on impact on user groups defined by income and age. Based on income and age no systematic impacts of variable pricing, positive or negative, were identified among the respondents in the visitor/shopper survey.

In the fourth question, the impact of reinvestment of parking revenues was examined. San Francisco's City Charter requires parking-related revenues be used to support capital and operating expenses of SFMTA's transit services. Thus, from an equity standpoint, parking revenues are used to benefit a broader set of travelers than those who drive and park in SFMTA facilities, and, therefore the equity effect is positive.

Table D-23. Summary of Equity Impacts Across Evaluation Questions

Questions	Result	Evidence
What are the direct social effects (parking fees, travel times, adaptation costs) for various transportation system user groups?	No equity impact.	Respondents to the 2011 and 2013 visitor/shopper survey reported parking cost; parking search time and distance from destination; and perception of ease of parking. Differences by age and income categories in pilot and control areas in the pre- and post-pricing periods revealed no systematic impact by age or income that could be characterized as an equity issue.
Are there any differential impacts on certain socioeconomic groups?	No equity impact	Available data on socioeconomic groups was restricted to income and age categories from the visitor/shopper survey. No systematic equity impacts by income or age were discerned in the survey findings.
What is the spatial distribution of aggregate out-of-pocket and inconvenience costs, and travel-time and mobility benefits?	Mixed effect	Geographic equity of variable pricing was examined with three types of data. Congestion measures of speed and travel time using data from roadway sensors and buses showed no before/after differences in pilot areas. Parking occupancy data showed before/after differences among pilot areas. Residents and visitors to neighborhoods with high parking congestion would have seen availability improve but higher prices. In neighborhoods with lower starting occupancies, people benefited from lower parking prices but had slightly higher parking occupancies. Reduced emissions and energy usage from less cruising for parking benefited all the pilot areas, but Downtown and South Embarcadero saw the greatest reductions and Marina and Mission the least.
How does reinvestment of parking pricing revenues impact various transportation system users?	Positive impact	By statute, SFMTA parking-related revenues are to be used to support transit, thereby serving a wider range of travelers than those who use parking facilities.

Source: Battelle, 2014.

Appendix E. Environmental and Energy Analysis

The environmental and energy analysis of SF*park* focused on the potential impacts of the projects on air quality and energy consumption. Table E-1 lists the hypotheses included in the environmental analysis. The first hypothesis addressed the air quality impacts of SF*park*. The second hypothesis sought to measure the public's perception of air quality changes due to SF*park*, but no data were available for this hypothesis and, thus, it was not tested. The third hypothesis addressed the energy impacts of SF*park*.

Table E-1. Environmental and Energy Analysis Hypotheses

Hypotheses
• SF*park* will improve air quality by reducing parking search times and shifting trips from car to transit.
• The public will perceive an improvement in air quality resulting from SF*park*
• SF*park* will reduce fuel consumption by reducing parking search times and shifting trips from car to transit.

Source: Battelle.

The remainder of this appendix is divided into four sections. Section E.1 discusses the methodology applied to the analysis. The data sources used in the analysis are presented in Section E.2. The data analysis and results for the air quality and energy assessment are discussed in Section E.3. In Section E.4 the appendix concludes with a summary of the findings of the environmental and energy analysis relative to the evaluation hypotheses.

E.1 Methodology

The environmental and energy effects of the SF*park* program were assessed based on changes in the miles of travel in searching for parking spots, and the speed of that travel. Surveys of parking behavior were conducted for the pilot and control areas before and after demand-based pricing was implemented in SF*park* pilot areas. A statistical model presented in Appendix B – Pricing Analysis was developed using the data from these surveys. The model estimated the average search time and distance that would have occurred had SF*park* not been in place and the search time and distance reported from the surveys after the program was implemented. Therefore, the model output provided an estimate of average distances and minutes spent searching for parking spots with and without SF*park*. Because of this, results presented later in this Appendix utilize the terminology "with and without pricing" as opposed to before and after.

While the environmental effects based on changes in cruising for parking are the most significant impact, other potential contributions to environmental effects are recognized but not directly estimated. It is likely there are additional effects on travelers not looking for parking spots from improvements in congestion, and from increased use of shared or non-motorized modes such as transit and bicycling to avoid the higher parking prices. Some data on changes in transit ridership and on survey respondents' stated mode shift to transit were available but the changes could not be attributed to SF*park*. Therefore these changes are not quantified in the environmental analysis, although they are qualitatively discussed in Section E.3.

Appendix A – Congestion Analysis analyzed the impact of SF*park* on congestion using data from roadway sensors and from buses equipped with automatic passenger counters. The findings were that speed and travel times had changed very little and what changes that did occur could not be attributed directly to variable pricing. In addition, changes in traffic volumes were not available from the roadway sensor data. Thus, no attempt was made to incorporate air quality and fuel impact from these general changes in congestion.

The original plan for the environmental analysis[1] called for measuring changes in vehicle idling, but field data surveys performed by SFMTA did not collect any data on idling. Changes in the amount of idling were implicit in the average speed with which parking spots were found, but explicit data on idling would have yielded more precise environmental effects. However, collection of idling data would have required a different survey methodology.

This environmental analysis was, therefore, solely based on the changes in VMT for parking cruising, with consideration for the average speed of travel while cruising for spots.

E.2 Data Sources

The evaluation of the effect of SF*park* on air pollution and energy consumption required data on the parking search distances, search speeds, parking meter occupancy, parking turnover rates, and modeled predictions of motor vehicle emission rates. This section first describes the emission factors and then the parking data.

E.2.1 Emission Factors

The environmental analysis examined changes in emissions of air pollutants such as ozone precursors, fine particulate matter, carbon monoxide, and greenhouse gases. The calculation multiplied motor vehicle emission factors in grams per mile by the number of miles travelled searching for parking spots. The speed of travel while cruising was used to select the appropriate emission factor for that speed.

The motor vehicle emission factors used for this analysis are for light duty vehicles only, i.e. passenger cars and trucks that use metered spaces. Typically, passenger vehicles have lower emission rates than larger vehicles such as haul trucks or buses. Using factors for the entire vehicle fleet that "rolled in" emission rates for large trucks would be inappropriate.[2]

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[1] Zimmerman, C. et al. "San Francisco Urban Partnership Agreement, National Evaluation Plan," Publication No. FHWA-JPO-10-022, December 22, 2009.

[2] Larger commercial vehicles do sometimes use the parking meters, but for conservatism in evaluating the benefits the environmental analysis relied on emission rates of passenger vehicles only.

The motor vehicle emission factors were modeled using the EMFAC2011 model[3], which is the latest installment of the EMFAC series of models. EMFAC is the California Air Resources Board's (ARB) tool for estimating emissions from on-road vehicles and is the EPA-approved method for doing so in California.[4] The model was used to estimate emission factors for San Francisco County for 2012. That year represented the mid-point between pre-deployment 2011 and post-deployment 2013, and allowed comparison of pre- and post-deployment emissions from parking searches using the same emission rates. Consequently any difference in emissions would be due to changes in parking search cruising and the speed of the searches.

EMFAC estimates emission factors for the fleet of motor vehicles operating on roads in San Francisco County, based on the age and type of vehicle, weight class and fuel type (i.e. gas, diesel, or electric). The number of vehicles in each class is based on an analysis of California Department of Motor Vehicles (DMV) registration data. These vary by calendar year and geographic area, so the make-up of the vehicle fleet was dependent on the calendar year and geographic area.

EMFAC models emission factors and vehicle activity data for every model year from 1965 through 2035 and then weighs the factors by the proportion of the fleet represented by each year. Within each vehicle class, the model year is represented by a combination of technology groups (TGs). For example, the earliest model year for passenger cars (1965) consisted of a non-catalyst gasoline-fueled technology group (TG-1) and a diesel-fueled technology group (TG-170).

EMFAC output for emission rates is expressed as rates (grams per mile and grams per hour) for numerous vehicle classes. Passenger vehicles rates are modeled for four classes of light duty cars (catalytic and non-catalytic, gas and diesel) and four classes of light trucks (same divisions as for cars).

The national evaluation team developed a weighted average of light duty emission factors based on the amount of the fleet represented by each vehicle type and fuel type, and the fraction of travel for each. The predominant vehicle was a gas fueled passenger car, but diesel fueled trucks, hybrid, full electric, alternatively fueled cars, and the rest were also represented.

Table E-2 presents the passenger vehicle emission rates used in the analysis. ROG represents reactive organic compounds; CO is carbon monoxide; NOx is nitrogen oxides; CO_2 is carbon dioxide, a principal greenhouse gas, and $PM_{2.5}$ is fine particle matter less than 25 microns in width. $PM_{2.5}$ emission rates are for running exhaust emissions. Additional $PM_{2.5}$ is created by aerosols of other compounds that come out of tailpipes but this "secondary" formation is not expressed as a rate; it's a much more complex process requiring complex photochemical air quality models in order to predict it. This analysis focused on the direct $PM_{2.5}$ emissions.

ROG and NOx are the primary precursors to ozone, the compound which, at breathing zone level, can damage the lungs and respiratory system. CO can be dangerous or even fatal when inhaled in large concentrations, and $PM_{2.5}$ also has significant health consequences. CO_2, as a principal component of greenhouse gases, does not cause direct health effects, but is the most commonly used metric for the concept of a carbon footprint.

[3] Model runs were made by the national evaluation team using the online version of the model.

[4] In other areas of the U.S. the EPA requires use of the MOVES model.

Table E-2. Emission Factors (grams per mile travel) from EMFAC2011 for San Francisco County, 2012 Passenger Vehicles

Speed	ROG	CO	NOx	CO_2	$PM_{2.5}$
5	0.34	4.35	0.34	1194.70	0.048
10	0.22	3.62	0.29	886.39	0.011
15	0.16	3.09	0.26	683.33	0.008
20	0.12	2.72	0.23	546.24	0.006
25	0.09	2.43	0.22	453.17	0.004
30	0.07	2.20	0.20	390.22	0.003
35	0.06	2.03	0.20	348.48	0.003
40	0.05	1.89	0.19	323.40	0.003
45	0.05	1.80	0.19	311.33	0.002
50	0.05	1.73	0.19	310.83	0.002
55	0.05	1.70	0.19	322.62	0.002
60	0.06	1.73	0.20	347.08	0.002
65	0.06	1.85	0.22	386.76	0.004

Source: Earth Matters, Inc., 2014.

Although the table displays emission rates for speeds of up to 65 mph the actual speeds of the parking searches shown in Section E.2.2 were all observed to be between 0 and 10 mph. Therefore, the speed-based factors used in the analysis consist of the factors for 5 and 10 mph depending on the average distances and search times valid for each combination of time and day type.

Fuel consumption in EMFAC2011 was calculated based on the emissions of CO, CO_2 and THC (total hydrocarbons) and a standard carbon balance equation[5]. The estimated fuel economy was averaged in the same manner as described above for emission rates from passenger vehicles (a combination of cars and light trucks). The average fuel economy across all passenger vehicle types for San Francisco in 2012 was 21.46 miles per gallon.

E.2.2 Parking Search Time and Search Distance Data

Two sources of data on cruising for parking spots were collected for this study. One was a manual survey mostly utilizing bicycles to measure the time and distance it took to find a parking spot. The other was an intercept survey of visitors and shoppers to a subset of the SF*park* pilot and control areas who were asked if they'd parked, and, if so, how long it had taken them to find a parking spot.

[5] The carbon balance method uses coefficients of emissions of carbon dioxide (CO_2) and other carbon related emissions (total hydrocarbons – THC, carbon monoxide – CO) to estimate fuel consumption. For gasoline vehicles, is the estimate is calculated as follows: FC= 100 * D / {(0.1154)*[(0.866*THC) + (0.429*CO) + (0.273*CO_2)]}. D stands for density of fuel at an assumed temperature. Specifics for EMFAC are contained in the EMFAC2011 technical appendices.

The original environmental analysis design was based on the expectation that the manual survey data would be the principal source of data on average parking search distances and times. However, analysis of the data showed that the methodology, combined with the emphasis on collecting data for specific two-hour time bands caused a bias toward shorter searches. The bias was evident in findings that showed average search times ranging from a low of 30 seconds to a high of two minutes no matter what time of day or in what neighborhood. This finding conflicted with the results of the visitor shopper survey and with the typical experience of SFMTA personnel.

The primary source of the bias was the way in which the survey methodology was used in the measurement of parking cruising in specific two-hour time bands. A detailed statistical methodology that utilized both the manual survey and the visitor shopper survey was then developed. This methodology is described in Section B.3.5 of Appendix B – Pricing Analysis. The environmental analysis is based on the combined data set, so as to be consistent with other elements of the overall evaluation. The combined data set suggests that the average search times were between 3 and 13 minutes. The intercept survey alone suggested search times of <1 to 43 minutes.

Manual Survey Data

Data on parking search time and distance were provided by SFMTA and were based on manual surveys conducted by trained staff using bicycles and occasionally autos on predetermined routes. The bicycles and autos were used to emulate parking search behavior. Details on the methodology for the parking searches and for averaging them is described in Appendix B – Pricing Analysis. Data were collected for weekdays, Saturdays and Sundays for 4 different time periods: 8 – 10 a.m.; 12 – 2 p.m.; 4 – 6 p.m.; and 8 – 10 p.m. The variable pricing was not in effect during the 8 – 10 p.m. time period. Therefore, that time period was not included in the environmental analysis of the impact of variable pricing.

Visitor and Shopper Survey Data

The visitor and shopper survey (also referred to as the intercept survey) was a cross-sectional pre- and post intervention design, incorporating a survey prior to the implementation of variable parking pricing changes and another cross-sectional survey after the implementation. The methodological approach included an intercept survey with adults in three SF*park* pilot areas and two control areas within the city of San Francisco. Further details about the surveys are presented in Appendix B – Pricing Analysis. A key survey question for the environmental analysis was the amount of time it took the respondent to find a parking space.

Combining Two Survey Datasets

The parking search time and distance data for both surveys (manual and intercept) were processed and averaged as described in Appendix B. The observed changes between 2011 and 2013 in the pilot and control areas were used to develop a model that predicted the parking search times and distances in 2013 without SF*park*. These modeled results were compared with the observed 2013 results to determine the changes in parking cruising, parking search time, and the associated environmental and energy effects.

It is important to note that the intercept surveys were not conducted for as many of the time periods and day types as the manual search surveys were. The intercept survey was not conducted on Sunday, nor did it include the 8 – 10 a.m. and the 8 – 10 p.m. time bands as did the manual survey.

Table E-3 and Table E-4 present the average amount of cruising (in miles) for parking spots with and without SF*park* and the average amount of time it took to find a parking spot with and without SF*park* for weekdays and weekends.[6] The tables show an overall reduction of about 10 to 20 percent for cruising distances and about 5 – 10 percent for time spent cruising. The larger change in the cruising distances is due to an improvement in travel speeds while searching. The improvement was small in absolute terms (speeds changed from about 5 to about 6 mph) but large proportionately. Because of the statistical approach and model employed in developing the "without SF*park*" case, these reported changes can reasonably be attributed to the SF*park* program.

Table E-3. Average Parking Search Distance in Miles with and without SF*park* by Time Band for Weekdays and Weekends

Time Band	Without SF*park* (miles)	With SF*park* (miles)	Percent Change (Without to With SF*park*)
Weekday			
8 – 10 a.m.	0.32	0.28	-11.01%
12 – 2 p.m.	0.94	0.76	-19.83%
4 – 6 p.m.	1.20	1.02	-14.43%
Weekend			
12 – 2 p.m.	1.16	1.02	-11.94%
4 – 6 p.m.	0.83	0.75	-9.75%

Source: Earth Matters Inc., 2014.

Table E-4. Average Parking Search Time in Minutes with and without SF*park* by Time Band for Weekdays and Weekends

Time Band	Without SF*park* (minutes)	With SF*park* (minutes)	Percent Change (Without to With SF*park*)
Weekday			
8 – 10 a.m.	3.07	2.88	-6.41%
12 – 2 p.m.	8.60	7.74	-9.98%
4 – 6 p.m.	11.95	10.88	-8.97%
Weekend			
12 – 2 p.m.	12.96	12.27	-5.37%
4 – 6 p.m.	9.38	8.92	-4.88%

Source: Earth Matters, Inc., 2014.

[6] The manual parking search survey was conducted on both Saturday and Sunday, and average parking search time and distance for weekends is based on data for both days.

Without SF*park* drivers cruised between 0.32 to 1.2 miles to find a parking spot on a weekday and 0.83 to 1.16 miles on weekends. With SF*park* distances decreased to between 0.28 mile to a mile on weekdays and 0.75 of a mile to a 1.02 on weekends.

On average, the combined data show it takes between three and thirteen minutes to find a parking spot in the study area. Table E-4 shows reduction in the amount of time it took to locate a parking spot of between just under five percent (4.9 percent) to about 10 percent (9.98 percent). Because of the way in which the "without parking program" data were developed, the improvement can be attributed directly to the SF*park* program.[7]

Occupancy and Turnover Data

Occupancy data were based on parking sensor data as described in Section B.4 in Appendix B – Pricing Analysis. Turnover data were derived from SFMTA's on-street parking payment data. Both types of data were available for each pilot and control area and parking pricing time of day. Only Saturday data were available for the weekend.

Occupancy, payment compliance, and turnover data were collected for each pilot and control area and parking pricing time of day. The pre-implementation period for occupancy represented by 2011 covered April through August. The post-implementation period of 2013 covered January through July.

The raw turnover rates were adjusted based on payment compliance rates. Payment compliance was as low as 30 percent, meaning that 70 percent of occupied time was not paid for. Adjustment factors were applied to the hourly turnover rates to account for low payment compliance.

Table E-5 presents the adjusted turnover rates utilized in this analysis along with the number of metered spaces in each neighborhood. The turnover rates were those valid for the mid-point of each time band evaluated. Each represents the number of times per hour a new parking session started at meters in the area during a given time period. Smaller values can mean longer parking durations, but also lower occupancy. In general, turnover was less after noon and after variable pricing.

[7] SFMTA's report on the program (SF*park Pilot Project Evaluation: the SFMTA's evaluation of the benefits of the SFpark pilot project", June, 2014")* shows larger changes. It should be noted that SFMTA compared 2011 and 2013 while the national evaluation used a statistical model that showed what 2013 would have been after controlling for area (pilot and control) and time period (before and after pricing). Therefore, the two reports are not directly comparable. For simplicity this report is referred to later in this Appendix as "the SFMTA report."

Table E-5. Turnover Rates and Meters by Time Period, Neighborhood[8] for Weekday and Saturday with and without SF*park*

		Weekday			Saturday		Number of Metered Spaces*
Neighborhood		8-10 a.m.	12-2 p.m.	4-6 p.m.	12-2 p.m.	4-6 p.m.	
Civic Center	Without	0.990	0.600	0.600	0.600	0.600	478
	With	0.820	0.480	0.530	0.540	0.530	
Downtown	Without	1.210	0.590	0.570	0.590	0.570	322
	With	0.750	0.470	0.420	0.470	0.420	
Fillmore	Without	1.100	0.610	0.700	0.610	0.700	337
	With	0.900	0.550	0.650	0.550	0.650	
Marina	Without	1.330	0.540	0.570	0.540	0.570	232
	With	1.350	0.610	0.640	0.610	0.640	
Mission	Without	1.220	0.810	0.800	0.810	0.800	412
	With	1.140	0.780	0.800	0.780	0.800	
South Embarcadero	Without	0.970	0.520	0.470	0.520	0.470	803
	With	0.760	0.360	0.370	0.760	0.370	

*The number of metered spaces represents all types of parking meters: legacy, smart, multi, and single.

Source: Earth Matters, Inc. based on SFMTA data. June, 2014.

E.3 Data Analysis and Results

The environmental and energy analyses were based on the amount of cruising for parking spots. This section presents the amount of cruising and then discusses the environmental and energy effects caused by cruising and the change in cruising (i.e., VMT) that can be attributed to SF*park.* As discussed in Section E.1, it had originally been expected that changes in mode shift that could be attributed to SF*park* would be included in the emission and energy estimates, but limitations in the data led a qualitative discussion instead.

[8] Fisherman's Wharf is another neighborhood in which pilot pricing was in effect; however no parking search data were collected for that neighborhood.

E.3.1 Evaluation of Search Distances and VMT from Cruising For Parking Spots

The surveyed search distances that were shown in Table E-3 represented the average search distance in miles, for each time band (e.g., 2 – 4 p.m.) and day type (weekday, weekend). Saturdays were used to represent the weekend, because the intercept survey was not performed on Sunday. In addition, the intercept surveys on Saturdays were not performed between 8 – 10 a.m., and, therefore, that time period is not shown.

The search distances were averaged across neighborhoods, as there were too few observations for each neighborhood to be reliable at the neighborhood level. The neighborhood level amount of cruising was calculated by applying the average search distance for all pilot areas combined and neighborhood level data on parking activity and the number of metered spaces. Specifically, the average search distance was multiplied by the number of metered spaces in a neighborhood, the hourly turnover rate, and the number of hours in the time period. This calculation provided an estimate of the total search VMT for that neighborhood during a specific time period and day type. The 9 a.m. to 6 p.m. totals are calculated based on the hourly averages from the observed 4 hours (Saturday) or 6 hours (weekday) multiplied by nine (the number of hours each day that metering was in effect) to provide a more common basis to compare weekdays and Saturdays.

Based on the described approach, Table E-6 and Table E-7 present parking cruise VMT in tabular form by neighborhood and time band for weekdays and Saturdays as well as average hourly and total VMT for cruising between 9 a.m. and 6 p.m. These values were averaged to estimate the hourly average cruising VMT for each of the 9 hours in the time period. Since 6 out of 9 of these hours were observed, it appeared reasonable to extrapolate the hourly average to the entire period in order to compare cruise VMT for both weekdays and Saturdays over the period in which SF*park* operates. Figure E-1 and Figure E-2 display the same data in graphical form for the three time bands that were surveyed.

Table E-6. Parking Cruise VMT with and without SF*park* by Neighborhood and Time Period on Weekdays[9]

Neighborhood	Program Status	8 – 10 a.m. (miles)	12 – 2 p.m. (miles)	4 – 6 p.m. (miles)	Average By Hour 9 a.m. – 6 p.m.	Est. Total 9 a.m. – 6 p.m.	Percent Change (Without to With SF*park*)
Civic Center	Without	303	541	686	255	2,295	-28.84
	With	223	347	519	181	1,633	
Downtown	Without	249	359	439	174	1,570	-38.55
	With	137	229	277	107	965	
Fillmore	Without	237	388	564	198	1,784	-30.01
	With	173	281	379	139	1,249	
Marina	Without	197	237	316	125	1,125	-7.17
	With	178	214	304	116	1,044	
Mission	Without	321	630	631	264	2,373	-9.72
	With	267	486	675	238	2,142	
S. Embarcadero	Without	498	788	903	365	3,283	-36.37
	With	347	438	608	232	2,089	
Total	Without	1,805	2,943	3,539	1,381	12,431	-26.61
	With	1,326	1,995	2,761	1,014	9,123	

Source: Earth Matters, Inc., 2014.

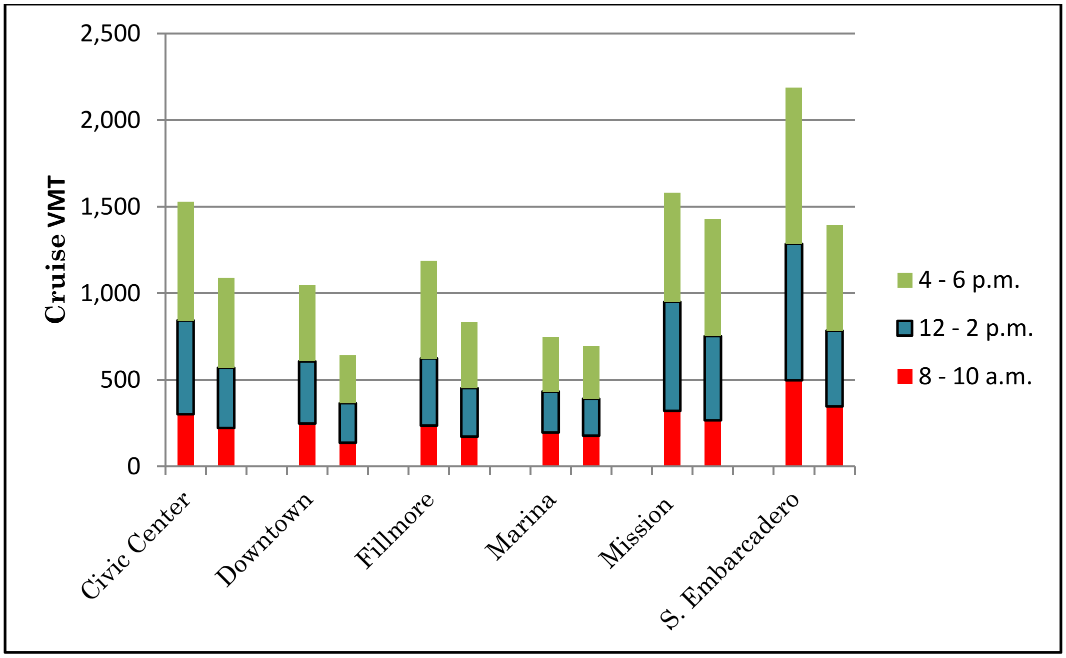
[9] The SFMTA report lists similar but slightly smaller values for weekdays because their methodology is different and they use a smaller set of 4 core neighborhoods than the national evaluation as described earlier in this appendix.

Table E-7. Parking Cruise VMT with and without SF*park* by Neighborhood and Time Period on Saturdays[10]

Neighborhood	Program Status	12 – 2 p.m. (miles)	4 – 6 p.m. (miles)	Hourly Average 9 a.m. – 6 p.m.	Est. Total 9 a.m. – 6 p.m.	Percent Change (Without to with SF*park*)
Civic Center	Without	667	478	286	2,576	-25.68%
	With	470	381	213	1,915	
Downtown	Without	442	306	187	1,683	-31.34%
	With	310	203	128	1,155	
Fillmore	Without	478	393	218	1,960	-24.43%
	With	380	279	165	1,482	
Marina	Without	291	220	128	1,152	+0.28%
	With	290	223	128	1,155	
Mission	Without	776	439	304	2,735	-5.07%
	With	658	496	289	2,597	
S. Embarcadero	Without	971	629	400	3,601	-35.07%
	With	592	447	260	2,338	
Total	Without	3,626	2,466	1523	13,707	-22.37%
	With	2,700	2,029	1,182	10,641	

Source: Earth Matters, Inc., 2014.

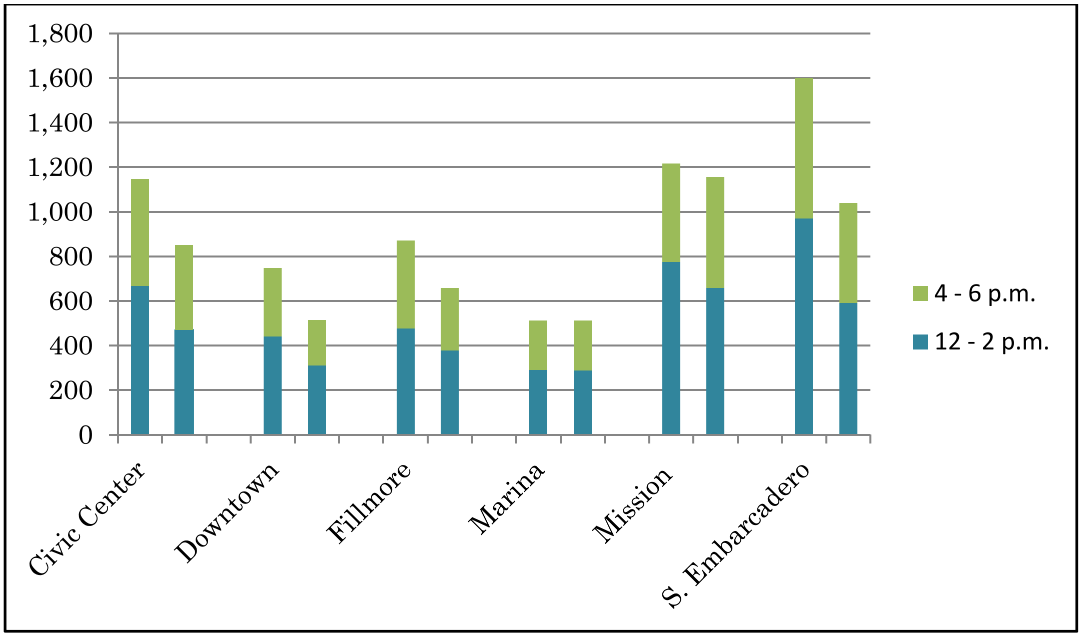
[10] Weekend parking cruise VMT are larger than weekday.



*In the pair of columns for each neighborhood, VMT in the absence of SF*park* is on the left and VMT with SF*park* is on the right.

Source: Earth Matters, Inc., 2014.

Figure E-1. VMT from Parking Searches: With and Without SF*park, Weekdays by Time Period and Neighborhood**



*In the pair of columns for each neighborhood, VMT in the absence of SF*park* is on the left and VMT with SF*park* is on the right.

Source: Earth Matters, Inc. 2014.

Figure E-2. VMT from Parking Searches: With and Without SF*park, Saturdays by Time Period and Neighborhood**

On weekdays, as shown in Figure E-1, parking cruise VMT without price changes varied considerably by neighborhood and time period ranging from 197 to 903 without SF*park* and 137 – 608 with. On Saturdays without SF*park* VMT per time period was 220 – 971 and with was 223 – 658. The figures and tables show that VMT from cruising for parking spots decreased with price changes for all neighborhoods and across time bands except for a small increase in the Mission between 4 – 6 p.m. on weekdays (rose from 631 to 675 miles) and a small one in the Marina between 4 – 6 p.m. on Saturdays (rose from 220 to 223 miles).

Overall the SF*park* program results in a 26.7 percent decrease in VMT for finding parking spots on weekdays for the 9-hour period over which the program operates. Cruise VMT is substantial. Summing across the neighborhoods, and extrapolating to the entire period as described above, without SF*park*, estimated "9 a.m. – 6 p.m." daily cruise VMT is 12,431 miles and with the program it is 9,123 miles. This represents 0.18 – 0.25 percent of all VMT in San Francisco County, which is substantial given the relatively small geographic area represented by the parking pilot zones.[11]

The averages in Table E-7 showed the impact of SF*park* on VMT for Saturdays. On Saturdays, cruising for parking in the six pilot neighborhoods represents 0.27 percent of total travel in San Francisco. Without SF*park* an estimated 13,707 miles of travel occurred between 9 a.m. and 6 p.m. on Saturdays in the pilot neighborhoods. With the program, this value decreases by 22.37 percent to 10,641 miles. This mileage, while representing only part of a day and only 6

[11] The EMFAC2011 run for San Francisco County shows 13,311,000 miles of travel daily (passenger vehicles only). Taken as an average this is 554,625 miles of travel per hour, or approximately 4,991,625 miles per 9 hour period. EMFAC reports VMT on freeways, arterials, and some surface streets.

neighborhoods, represented as much as 0.27 percent of total passenger auto and truck travel in San Francisco County, including all travel on Highways 1, 101 and 280, and all the streets in the area. With the pricing program, the amount decreased to 0.21 percent of total travel on Saturdays.

The travel time savings associated with cruising was calculated here for use in Appendix I – Benefit Cost Analysis, but they are not used directly for emission calculations. Table E-8 below shows the number of hours spent cruising by neighborhood and overall for weekdays and Saturdays and indicates substantial reduction in travel by those searching for parking.

Table E-8. Hours Spent Cruising for Parking Spots with and without Pricing

Neighborhood	Status of Pricing Program	Weekdays	Percent Change Without to With Pricing	Saturdays	Percent Change Without to With SF*park*)
Civic Center	Without	367.2	22.6%	482.5	-20.6%
	With	284.0		383.0	
Downtown	Without	251.2	33.2%	315.1	-26.7%
	With	167.8		231.0	
Fillmore	Without	285.4	23.9%	367.1	-19.3%
	With	217.2		296.3	
Marina	Without	180.0	-0.9%	215.6	-7.1%
	With	181.6		231.0	
Mission	Without	379.7	1.9%	512.2	-1.4%
	With	372.6		519.3	
S. Embarcadero	Without	525.4	30.8%	674.3	-30.7%
	With	363.4		467.6	
Total	Without	1,988.9	20.2%	2,566.8	-17.1%
	With	1,586.6		2,128.2	

Source: Earth Matters, Inc., 2014.

The values above were estimated by using the average time and distance it took to find parking spots at different times and days of the week. First speeds were estimated using the average distance it took to find a parking spot on a weekday and a Saturday, divided by the average amount of time it took. These speeds, which varied between 5.01 to 6.25 mile per hour, were used together with the VMT by neighborhood, day type, and program status (with or without variable pricing) to estimate the number of hours spent searching for spots.

On a typical day people spend hundreds of hours looking for parking spots. SF*park* appears to have reduced these unproductive hours substantially: overall there was a 20.2 percent reduction on weekdays and a 17.1 percent reduction on Saturdays, representing 402 fewer hours on weekdays and 439 fewer hours on Saturdays.

E.3.2 Mode Shift Results

Shifts between driving and other modes as a result of parking pricing and availability is another potential source of change in emissions. Data on mode shift from the visitor/shopper survey and trends in transit performance and ridership were examined. These data were not included in a quantitative assessment of emissions, because it wasn't possible to attribute changes to the parking pricing program as opposed to other factors.

The visitor/shopper survey included questions on mode shift and the reasons a shift was made. Details about the questions are reported in Appendix G – Business Impact. The results show that about one in four (or N=179) respondents to the "after" survey said they had changed their mode of travel to the pilot area as compared to a year before. Of the 166 mode "changers" who reported using a mode more about half (53 percent) said they used public transit more, 32 percent used a car more, and a smaller proportion said that they bicycled (7 percent) or walked (15 percent) more. Of the 79 respondents in pilot areas who said they used a mode less, 67 percent used a car less and 26 percent used less public transit, with other modes yielding responses of 5 percent or smaller. Thus, on balance the pilot areas had a few more transit riders after variable pricing was in effect but not many.

At the same time, when respondents in the pilot areas were asked about the reason for their mode change, parking availability or cost did not figure as prominently as a new school or work location (19 percent) or other reason (27 percent). Fifteen percent cited more difficulty in finding parking as their reason for a mode change, and 10 percent said more expensive parking was the reason. These data suggest that variable pricing was not strongly linked to mode shift in the post-pricing period.

Transit data were also examined to determine whether improved transit service in the pilot areas after variable pricing might have attracted additional riders. An evaluation of transit travel time was presented in the congestion analysis in Appendix A. The rationale was that the reduction in congestion caused by reduced parking search times and improved parking turnover would translate into improved travel times, running speeds, and travel time reliability for transit vehicles traveling through the pilot parking areas. However, average weekday transit travel times on the transit routes traversing the parking pilot areas showed that transit travel times remained relatively constant (never changing more than 0.3 minutes) – except for two routes in the Mission where significant construction caused re-routing of bus routes and in the area around the Civic Center. Thus, transit travel time did not improve in the pilot areas to serve as a stimulus to mode change.

Data on ridership on SFMTA's Muni buses, as measured by average boarding and alightings per trip, were obtained for April 1-June 1 for 2011 and 2013 for several transit routes covering the SF*park* pilot and control areas. For pilot areas, this weekday transit ridership showed an overall increase of 16.2 percent and an increase of 38.6 percent on Saturdays. Comparison of the pilot and control areas showed a bigger before/after difference in the pilot areas than the control areas, with a much larger difference on Saturdays. Statistical tests support variable pricing as an explanation for Saturday increases in ridership in the pilot areas, but not the weekday increases in ridership.

E.3.3 Emission Results

Table E-9 summarizes the impact of SF*park* on emissions across all six pilot neighborhoods reviewed here, time bands and days of the week. Overall there was a significant reduction in emissions both on weekdays and Saturdays. The "without" columns represent emissions in the absence of SF*park* and the "with" represents emissions with the program.

Table E-9. Summary of Emission Impacts of SF*park* by Weekday and Saturday

Pollutant	Weekday (lbs)		Percent Change Without to With Pricing	Saturday (lbs)		Percent Change (Without to With SF*park*)
	Without	With		Without	With	
ROG	9.25	6.79	-26.61%	10.20	7.92	-22.37%
NOx	9.39	6.89		10.36	8.04	
CO	119.15	87.44		131.38	101.99	
$PM_{2.5}$	1.31	0.96		1.44	1.12	
CO_2	32,746.16	24,032.16		36,107.91	28,031.21	

Source: Earth Matters, Inc., 2014.

The percentage change is the same for all pollutants because the estimated speed of parking cruise travel with and without SF*park* did not vary enough to require the use of different emission factors for different speeds. Therefore, the emissions change linearly with respect to the change in VMT. Had speeds been available at a finer scale, the emission changes would likely not have been linear and would have generally decreased with increased speeds.

For this reason also, emissions on a per neighborhood level are not presented. The changes on the neighborhood level are identical, in percentage terms, to the VMT changes presented earlier.

E.3.4 Energy Use Results

Energy use also declined as a result of SF*park*. Table E-10 presents energy use in gallons of gas for weekdays and Table E-11 presents energy use on Saturdays. Energy use declined overall by 26.61 percent on weekdays and by 22.37 percent on Saturdays, consistent with the relative impact on emissions, since both effects are based on changes in VMT.

Table E-10. Energy Use with and without SF*park* by Neighborhood and Time Period on Weekdays (gallons of gas)

Neighborhood	Program Status	8 – 10 a.m.	12 – 2 p.m.	4 – 6 p.m.	Estimated 9-Hour Total[12]	Percent Change (Without to With *SFpark*)
Civic Center	Without	14.01	25.07	31.76	106	-28.84%
	With	10.32	16.08	24.01	75.61	
Downtown	Without	11.53	16.60	20.32	72.69	-38.55%
	With	6.36	10.60	12.81	44.67	
Fillmore	Without	10.97	17.97	26.12	82.59	-30.01%
	With	7.99	12.99	17.56	57.81	
Marina	Without	9.13	10.95	14.64	52.09	-7.17%
	With	8.25	9.92	14.07	48.35	
Mission	Without	14.88	29.17	29.20	109.86	-9.72%
	With	12.37	22.52	31.23	99.18	
S. Embarcadero	Without	23.06	36.50	41.79	152.01	-36.37%
	With	16.08	20.26	28.15	96.73	
Total for all 6 neighborhoods	Without	83.58	136.25	163.83	575.49	-26.61%
	With	61.37	92.36	127.83	422.35	

Source: Earth Matters, Inc., 2014.

[12] Based on average of 9 a.m. to 6 p.m. data extrapolated to entire 9 hour period.

Table E-11. Energy Use with and without SF*park* by Neighborhood and Time Period on Saturdays (gallons of gas)

Neighborhood	Program Status	12 – 2 p.m.	4 – 6 p.m.	Estimated Total 9 a.m. to 6 p.m.[13]	Percent Change (Without to With SF*park*)
Civic Center	Without	30.88	22.13	119.28	-25.68%
	With	21.76	17.64	88.65	
Downtown	Without	20.46	14.16	77.89	-31.34%
	With	14.35	9.42	53.48	
Fillmore	Without	22.14	18.20	90.76	-24.43%
	With	17.58	12.91	68.59	
Marina	Without	13.49	10.20	53.31	+0.28%
	With	13.42	10.34	53.46	
Mission	Without	35.94	20.35	126.63	-5.07%
	With	30.48	22.95	120.21	
S. Embarcadero	Without	44.96	29.12	166.69	-35.07%
	With	27.41	20.69	108.23	
Total for all 6 neighborhoods	Without	167.87	114.16	634.57	-22.37%
	With	125.00	93.95	492.63	

Source: Earth Matters, Inc., 2014.

[13] Based on average of 9 a.m. to 6 p.m. data extrapolated to 9 hour period.

E.4 Conclusions

SF*park* resulted in significant reductions in emissions of air pollutants and greenhouse gases, as well as in fuel use. The data support a conclusion that parking pricing is an effective way to reduce the amount of time and distance individuals must search to find parking, and that this benefit translates to quantifiable emission and energy effects. More specifically, the SF*park* program resulted in greater than 22 percent reduction in mileage from cruising for parking spots, and associated emissions and energy use on Saturdays and greater than 26 percent on weekdays.

Table E-12. Summary of Impacts Across Hypotheses

Hypotheses	Result	Evidence
SF*park* will improve air quality by reducing parking search times and shifting trips from car to transit.	Supported for parking search time reduction	Reductions of 26.61% in weekday and 22.37% in Saturday emissions of ozone precursors, particulate matter, carbon monoxide and greenhouse gases. Shift to transit was modest and not clearly linked to the impact of variable pricing, and thus not included in emission estimates.
The public will perceive an improvement in air quality resulting from SF*park*.	Not evaluated	Data were not available.
SF*park* will reduce fuel consumption by reducing parking search times and shifting trips from car to transit.	Supported for parking search time reduction	Reduction in fuel use of 26.61% on weekdays and 22.37% on Saturdays. Shift to transit was modest and not clearly linked to the impact of variable pricing, and thus not included in energy estimates.

Source: Earth Matters, Inc., 2014.

Summing across the pilot neighborhoods, without SF*park*, the estimated 9 a.m. – 6 p.m. VMT from cruising for parking spots on an average weekday was 12,431 miles and with the program it decreased to 9,123 miles. This represents 0.18 – 0.2 percent of all VMT in San Francisco County, which is substantial given the relatively small geographic area represented by the parking pilot zones.

On Saturdays, the amounts were somewhat greater, as was the demand for parking spots.
On Saturdays, cruising for parking in the six pilot neighborhoods represented nearly 0.3 percent of total travel in San Francisco without SF*park* and 0.21 percent with. Without SF*park* 13,707 miles of travel by cruising for parking spots occurred between 9 a.m. and 6 p.m. in the pilot neighborhoods. With the program, this value decreased by 22.37 percent to 10,641 miles of cruising.

Emissions of the ozone precursors NOx and ROG declined from 9.25 (without pricing) to 6.74 (weekdays) and 9.4 to 6.9 (Saturdays) pounds per day. Emissions of fine particulate matter declined from 1.3 to .96 pounds per day on weekdays and 1.44 to 1.12 on Saturdays. Emissions of greenhouse gases decreased from 16.0 (without pricing) to 12 (with pricing) tons on weekdays and from 18.0 to 10 tons on Saturdays.

Energy use in gallons of gas declined by 26.61 percent on weekdays and 22.37 percent on Saturdays. On both weekdays and Saturdays, the largest increases were in the Downtown and South Embarcadero neighborhoods with reductions of 31 percent to 38 percent. For example, on Saturdays South Embarcadero energy use without SF*park* was 167 gallons of gas and 108 with the program. The smallest changes were in the Marina with a reduction of just over 7 percent on weekdays and a small increase of 0.15 gallons on Saturdays, from 53.31 to 53.46 gallons.

It was expected that increased use of transit attributable to the pricing program would be quantified but it was not possible to attribute changes in transit utilization to the pricing program. A small percent of survey respondents used more transit in the pilot areas, but parking issues were not the predominant reason for the shift. Transit travel time in the pilot areas did not improve after variable pricing, although transit ridership as measured by boardings and alightings increased substantially in the pilot areas – 16.2 percent on weekdays and 38.6 percent on Saturdays.

Appendix F. Goods Movement Analysis

This analysis examined potential effects of the San Francisco UPA projects on the movement of goods in San Francisco. The many businesses and offices within the areas of the city that comprised the SF*park* parking districts rely on the efficient movement of goods to and from their establishments. Commercial vehicle operators (CVOs) often depend upon the availability of on-street loading spaces or risk fines if they use other types of parking spaces or double-park. In addition, double parking by CVOs can reduce street capacity and, thereby, contribute significantly to congestion.

SF*park* is expected to improve travel and parking conditions for CVOs as indicated in the four hypotheses presented in Table F-1. In the first hypothesis, it was expected that the pricing and other improvements of SF*park* would lead to less double parking by vehicles loading and unloading their goods. As a result, fines associated with CVO double parking should have gone down, as noted in the second hypothesis, assuming similar levels of enforcement across time periods. The third hypothesis posited an increase in parking availability for vehicles using loading and freight zones as a result of SF*park*. The fourth hypothesis posited a general decrease in the time to travel in the SF*park* pilot areas which would benefit CVO and other types of vehicles traveling in those areas.

Table F-1. Goods Movement Analysis Questions

Hypotheses
• CVOs double parking will decrease in the SF*park* pilot areas.
• CVO double parking fines will decrease in the SF*park* pilot areas.
• Parking availability, including within loading and freight zones, will increase in the SF*park* pilot areas.
• Travel times will decrease in the SF*park* pilot areas for CVOs and other vehicles.

Source: Battelle, 2014.

The remainder of this appendix is divided into three sections. The data sources used in the analysis are described next in Section F.1. Section F.2 presents the analysis of the findings on the impact of the UPA projects on goods movement. The appendix concludes with a summary of the potential business impacts in Section F.1.

F.1 Data Sources

Several types of data for the goods movement analysis were obtained from SFMTA, including the following:

- The surveys of double parking conducted by SFMTA before and after the variable pricing began in SF*park* pilot areas. The survey methodology is described in Appendix B – Pricing Analysis.
- Records on citations issued for parking violations in spaces designated as loading zones. Citations were used as a proxy for fines for CVO parking violations. SFMTA's parking control officers issue citations for various types of parking violations they observe. Further details about the citation data are presented in Appendix C – Technology Analysis.
- Data on parking availability based on the analysis of parking sensor data presented in Appendix B – Pricing Analysis.
- Travel time data from SFMTA's Muni buses equipped with automatic passenger counters (APC), with bus travel time serving as a proxy for traffic in general on streets in the SF*park* pilot and control areas. Details on the data and the travel time analysis are presented in Appendix A – Congestion Analysis.

F.2 Analysis of the Impact of Variable Parking Pricing on Goods Movement

This section presents the findings of the analysis of all the sources of data pertaining to the impact of variable pricing on goods movement in the SF*park* areas.

F.2.1 Double Parking by Commercial Vehicles

SFMTA conducted manual surveys of double parking in the spring of 2011 and 2013 before and after the implementation of variable pricing, respectively. On a sample of blocks in the pilot and control areas, surveyors identified the number and types of vehicles that were double parked, including commercial vehicles. Using these data, modeling techniques described in Appendix B – Parking Analysis were applied to assess the impact of variable pricing on changes in double parking by commercial vehicles. The results indicate that double parking by commercial vehicles was reduced by about 21 percent in the pilot areas where demand-based variable pricing was implemented, along with smart meters and longer parking time allowances, compared to the control areas where such changes were not made. The impact on commercial vehicle double parking was even greater than the 14 percent reduction in double parking by personal vehicles. However the Wald test of the difference between pilot and control areas indicated that the reductions were not statistically significant at the 0.05 probability level. This result could be due to the high variability in the double parking rate variables, which might require a larger sample size to detect significance.

F.2.2 Citations in Truck Loading Zones

SFMTA uses colors on meter heads and on curbs to designate parking spaces exclusively for commercial vehicles during specified hours.[1] Yellow meter caps are for all commercial vehicles and red meter caps are for vehicles with six or more wheels. In addition, SFMTA uses painted curbs to highlight commercial loading zones. Yellow zones are for active freight loading and unloading only by commercial vehicles and are in effect during specified hours. A commercial license plate is required for vehicles parked in yellow zones, which are typically near large businesses or properties that receive or deliver a lot of shipments. Signs designate spaces for vehicles with six wheels or more, and such loading zones also have red-capped meters in metered areas.

Table F-2 shows the number of commercial vehicle meters that were in operation in the SF*park* pilot and control areas during the evaluation period. There were no commercial meters in the pilot areas of Fillmore and the Port of San Francisco and in the West Portal control area. In most areas the number of meters did not change much. The exceptions were Downtown, which saw a 4 percent drop and total reduction of 68 meters, and South Embarcadero, where 35 meters were added, an 18 percent increase.

Table F-2. Commercial Meters in Use During May of 2011 and 2013

SF*park* Area	Parking Management District	Before (May 2011)	After (May 2013)
Pilot	Civic Center	122	125
	Downtown	1689	1631
	Fillmore	69	79
	Fisherman's Wharf	61	59
	Marina	49	48
	Mission	207	209
	South Embarcadero	192	227
Control	Inner Richmond	51	53
	Union	25	25
	West Portal	5	5
Total		**2396**	**2377**

Source: SFMTA, 2014.

[1] Rules on meters and zones are shown on SFMTA's website at http://www.sfmta.com/getting-around/parking.

The analysis was based on the following categories of citations pertaining to commercial vehicle zones using the SFMTA citation numbering scheme:

- T33.3 truck loading zone citations
- T38B yellow zone citations in the Downtown area
- T38B.1 yellow zone citations outside of the Downtown area.

The citations were divided into three periods:

- Before Period A: February 2010 – July 2010, the baseline period with no pricing or other changes.
- Before Period B: August 2010 – August 2011, credit and debit payment was available with installation of smart meters and the maximum hours parking allowed was extended.
- After Period C: September 2011 – May 2013, variable pricing was in effect, pay-by-phone had begun, and handheld enforcement device was in use by some parking control officers.

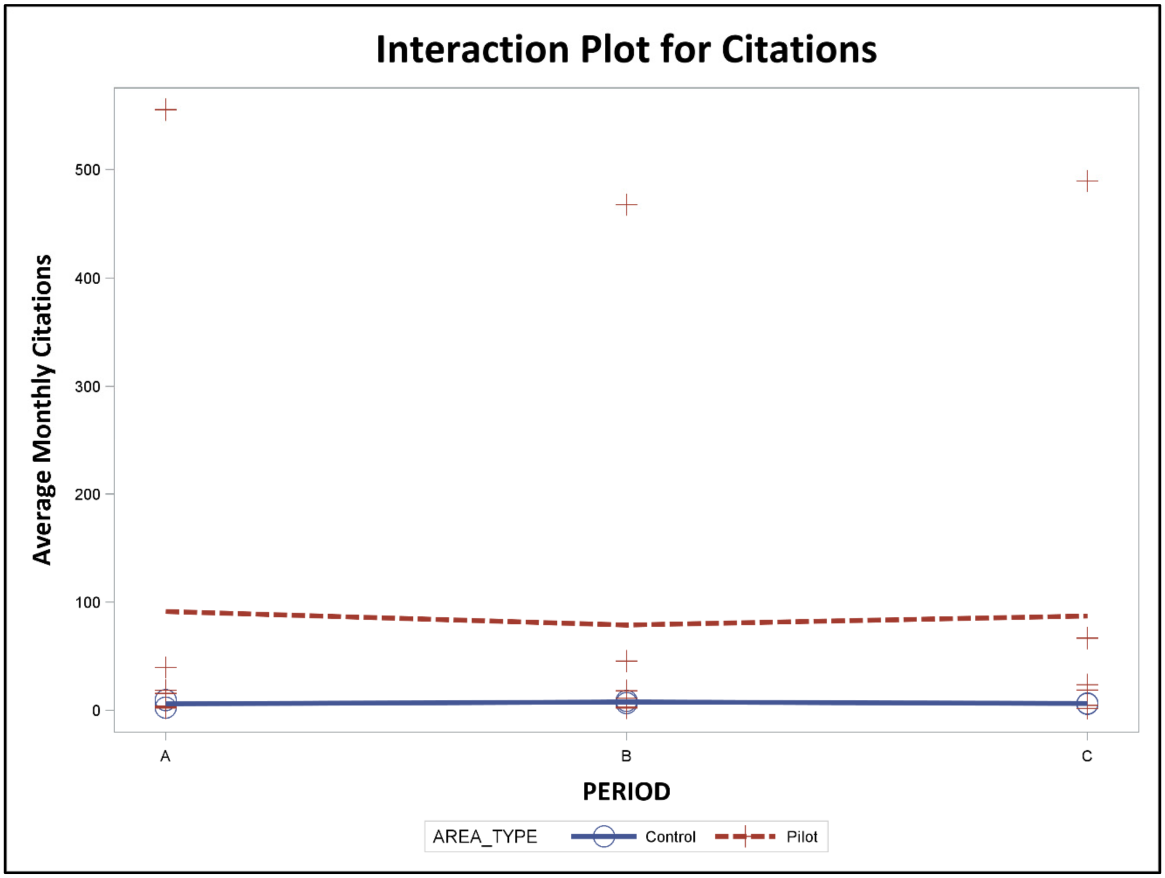
The analysis used average monthly citations in each parking district to mitigate the effect of different numbers of months for each period. The total number of monthly citations was averaged over all months within each period to reduce the potential for correlated observations within each parking district. The average monthly truck loading zone citations (T33.3) by period for each of the 9 parking districts are shown in Table F-3. Note that no truck loading zone citations were recorded for the West Portal control area.

Table F-3. Average Monthly Citations by Parking District for Truck Loading Zone Violations (T33.3)

Parking Area	Parking District	Average Monthly Citations		
		Period A Feb. 2010 – July 2010	Period B Aug. 2010 – Aug. 2011	Period C Sept. 2011 – May 2013
Control	Inner Richmond	3	7	6
	Union	9	9	6
Pilot	Civic Center	3	2	2
	Downtown	555	467	489
	Fillmore	19	18	19
	Fisherman's Wharf	4	3	5
	Marina	2	6	5
	Mission	40	45	67
	South Embarcadero	16	11	24

Source: Texas A&M Transportation Institute based on SFMTA data, 2014.

Figure F-1 shows the mean trends of truck loading zone citations (T33.3) by period and area type. The figure suggests that the effects of period are marginal. The large outliers in the figure belong to the Downtown parking district.



Source: Texas A&M Transportation Institute based on SFMTA data, 2014.

Figure F-1. Trends in T33.3 Truck Loading Zone Citations by Three Time Periods

A two-way mixture analysis of variance (ANOVA) model was fit to the data, with period and area type as fixed effects and parking district as a random effect nested within area type. The results for tests of the fixed effects are shown in Table F-4. Neither the period nor area type was found to be statistically significant at the $P < 0.05$ level. The results of the analysis were the same whether or not the Downtown parking district was excluded from the model. However, it is logical to include the Downtown parking district since it generated the largest number of citations.

Table F-4. ANOVA Results for Monthly Average T33.3 Truck Loading Zone Citations by Area and Period

Type III Tests of Fixed Effects				
Effect	**Numerator Degrees of Freedom**	**Denominator Degrees of Freedom**	**F Value**	**Probability > F**
PERIOD	2	14	0.15	0.8627
AREA	1	7	0.33	0.5827
PERIOD x AREA	2	14	0.26	0.7751

Source: Texas A&M Transportation Institute based on SFMTA data, 2014.

Table F-5 lists the average monthly citations by period and their associated standard deviations in parentheses, as well as the differences and percent changes across periods for each parking area type. Tukey-Kramer multiple comparison tests between means indicated none of the differences in citations across periods in Table F-5 were statistically significant. Reductions in citations in pilot parking areas during period B may reflect the new advanced meters and more liberalized time allowances, as those occurred at the beginning of the evaluation period, whereas the effect of pricing is likely not fully evident until the end of the evaluation period, i.e., period C, as price changes continued for another year after period B. Citations in the control areas remained relatively constant in comparison.

Table F-5. Comparison of Average Citations in Control and Pilot Areas during Pre- and Post-Deployment Periods for Truck Loading Zone Violations (T33.3)*

Parking Area	Period A Feb. 2010 – July 2010	Period B Aug. 2010 – Aug. 2011	Period C Sept. 2011 – May 2013	Change B - A		Change C - B		Change C - A	
				Difference	Percent Change	Difference	Percent Change	Difference	Percent Change
Control	6.8 (4.7)	7.6 (3.3)	6.3 (3.6)	0.8	11.8%	–1.3	–17.1%	0.2	3.3%
Pilot	101.9 (21.1)	87.6 (17.0)	97.3 (16.9)	–14.3	–14.0%	9.7	11.1%	–4.1	–4.5%

* Based on Tukey-Kramer multiple comparison tests of difference in means none were significant at $P < 0.05$.

Source: Texas A&M Transportation Institute based on SFMTA data, 2014.

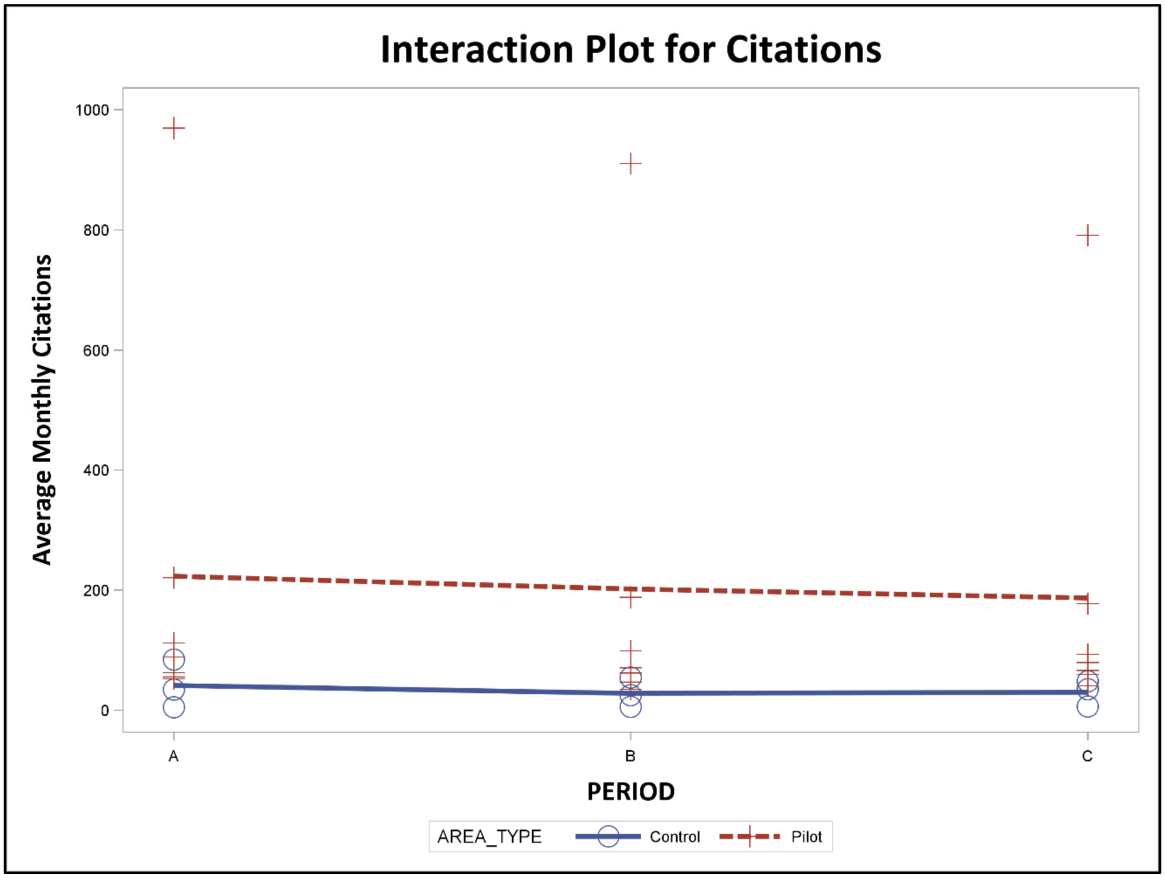
The average monthly yellow zone citations (T38B, T38B.1) by period for each of the 10 parking districts are shown in Table F-6.

Table F-6. Average Monthly Citations by Parking District for Yellow Zone Violations (T38B, T38B.1)

Parking Area	Parking District	Average Monthly Citations		
		Period A Feb. 2010 – July 2010	Period B Aug. 2010 – Aug. 2011	Period C Sept. 2011 – May 2013
Control	Inner Richmond	84	55	48
	Union	35	25	35
	West Portal	5	6	6
Pilot	Civic Center	53	47	59
	Downtown	969	911	791
	Fillmore	89	62	66
	Fisherman's Wharf	56	35	41
	Marina	112	99	80
	Mission	221	188	178
	South Embarcadero	63	71	93

Source: Texas A&M Transportation Institute based on SFMTA data, 2014.

Figure F-2 shows the mean trends of yellow zone citations (T38B and T38B.1) by period and area type. The figure suggests once again that the effects of period are marginal. The large outliers in the figure belong to the Downtown parking district.



Source: Texas A&M Transportation Institute based on SFMTA data, 2014.

Figure F-2. Trends in T38B and T38B.1 Yellow Zone Citations by Three Time Periods

The results for the two-way ANOVA model are summarized in Table F-7. Neither period nor area type was found to be statistically significant at P < 0.05. The results of the analysis were similar whether or not the Downtown parking district was excluded from the model. However, it is logical to include the Downtown parking district since it generated the largest number of citations.

Table F-7. ANOVA Results for Monthly Citation for Yellow Zones (T38B and T38B.1) by Area and Period

Type III Tests of Fixed Effects				
Effect	**Numerator DF**	**Denominator DF**	**F Value**	**Probability > F**
PERIOD	2	16	1.35	0.2872
AREA	1	8	0.86	0.3799
PERIOD*AREA	2	16	0.36	0.7062

Source: Texas A&M Transportation Institute based on SFMTA data, 2014.

Table F-8 lists the average monthly citations by period and their associated standard deviations in parentheses, as well as the differences and percent changes across periods for each parking area type. Tukey-Kramer multiple comparison tests between the means indicated that none of the differences in citations across periods in Table F-8 were statistically significant at P < 0.05.

Table F-8. Comparison of Average Citations in Control and Pilot Areas during Pre- and Post-Deployment Periods for Yellow Zone Citations (T38B, T38B.1)*

(Standard deviations shown in parentheses)

Parking Area	Period A Feb. 2010 – July 2010	Period B Aug. 2010 – Aug. 2011	Period C Sept. 2011 – May 2013	Change B - A		Change C - B		Change C - A	
				Difference	Percent Change	Difference	Percent Change	Difference	Percent Change
Control	41.3 (12.5)	29.0 (7.6)	29.9 (10.0)	–12.3	–29.8%	0.9	3.1%	–11.4	–27.6%
Pilot	223.1 (29.2)	201.7 (13.4)	186.9 (34.6)	–21.4	–9.6%	–14.8	–7.3%	–36.2	–16.2%

*Tukey-Kramer multiple comparison tests of difference in means indicated no significance at P < .05 level.

Source: Texas A&M Transportation Institute based on SFMTA data, 2014.

The analysis of average monthly citations issued for violation of truck loading zones (T33.3) showed a drop in citations in the pilot areas after the installation of smart meters and extension of limits on hours of parking but an increase after the start of variable pricing. The pattern was just the opposite in the control areas. However, the changes across time periods and between pilot and control areas were not statistically different. Average monthly citations issued for violations of yellow zones (T38B and T38B.1) showed a decline across the evaluation period in the pilot areas, whereas the control areas had an initial drop followed by an increase in citations. Again, the differences between control and pilot and across time periods were not statistically significant. The absence of a clear effect of the SF*park* program on citations related to goods movement may be due to a number of factors not related to SF*park.* For example, SFMTA identified potential accuracy and completeness issues with the citation data such that "definitive conclusions regarding trends in citations issued may be difficult to obtain.[2] These included the number of officers deployed, changes in beat and citation type assignments, special events, and loss of some data. Moreover, the variation in the number of commercial meters in operation during the evaluation period in some parking districts may have had an impact. In any event, the citation data were not able to support the hypothesis that citations – the proxy for parking fees -- changed as a result of SF*park*.

F.2.3 Parking Availability

The efficient movement of vehicles moving goods within San Francisco is dependent upon the availability of parking. As demonstrated in Section F.2.1 double parking by commercial vehicles declined after variable pricing was implemented, based on data gathered in the double parking survey. As the Bay Area was recovering from the economic recession during that time, the question is to what extent legal parking spaces for commercial vehicles benefited from variable pricing.

Although occupancy data for truck loading spaces is not readily available for analysis, the impact of variable parking pricing on availability of parking in general was analyzed in Appendix B – Parking Analysis, and the findings are suggestive of the potential effect on commercial vehicles. Figure F-3 taken from Appendix B shows the average hourly on-street parking occupancy for weekdays (A) and the percentage of blocks per month exceeding 85 percent occupancy on weekdays (B) for four pilot areas. As concluded in Appendix B, the data in Figure F-3 indicate that in the pilot areas "SFMTA variable pricing actions generally increased parking availability by lowering parking occupancy. In particular, the prevalence of highly congested blocks declined in these areas. Notably, all of the areas began with high average occupancies above at least 60 percent." Not shown here are two other pilot areas, Fisherman's Wharf and South Embarcadero, that began with lower average hourly occupancy (55-60 percent) and gradually moved toward higher occupancy as variable (generally lower) pricing began to take effect after the first year. Occupancy in the other pilot area, Mission, was heavily impacted by a major construction project such that its occupancy measures were not considered to be reliable indicators of the pricing impact in Appendix B.

The implications of Figure F-3 is that demand-based pricing was making spaces more available on the most popular blocks in the areas where parking was most congested. The effect for commercial vehicles is that there would be less conflict with non-commercial vehicles using loading areas illegally and that commercial vehicles might be able to find other legal parking spaces not designated for commercial vehicles when necessary. The decline in double parking by commercial vehicles reported in Section F.2.1 appears to support this explanation.

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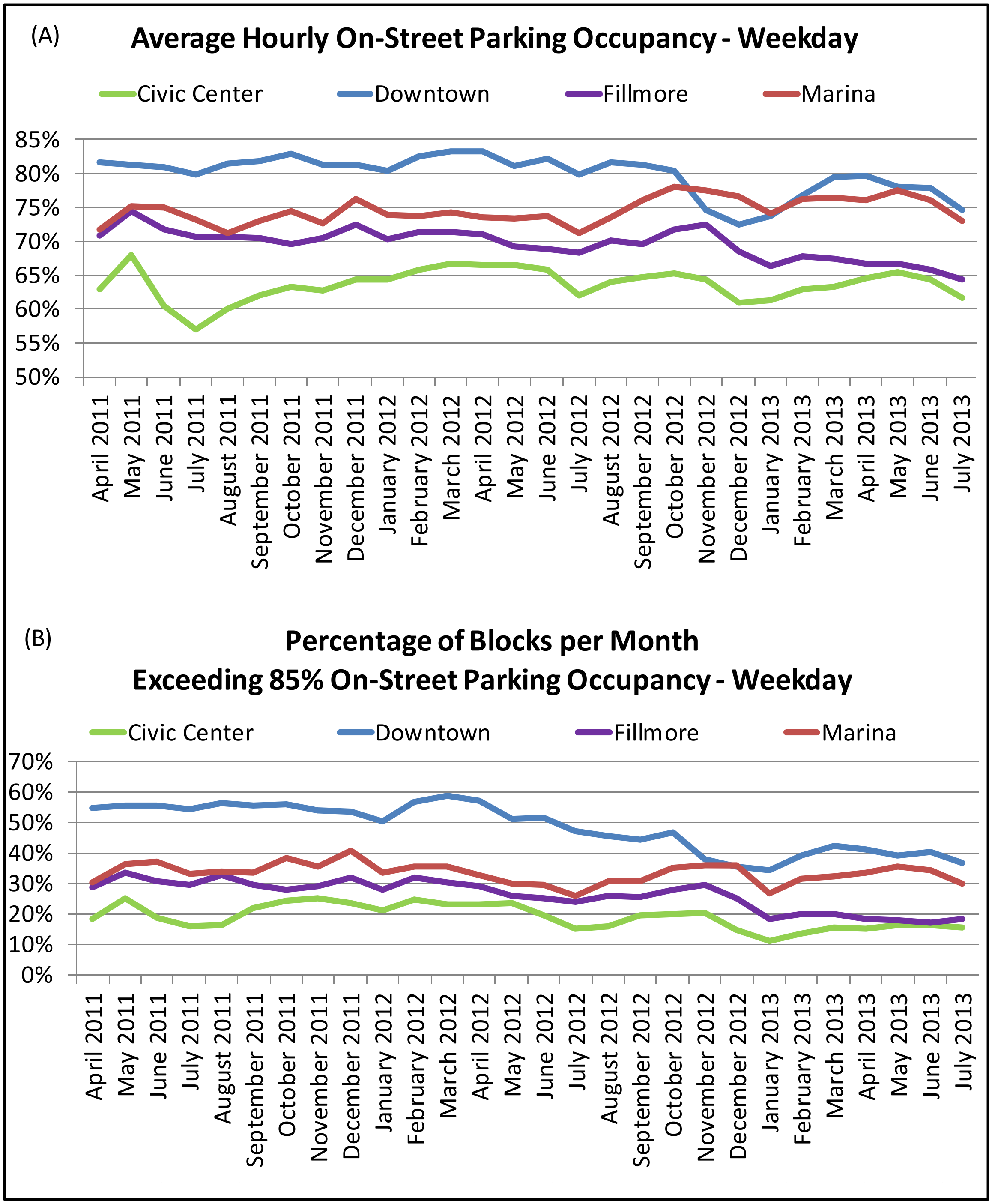
[2] Meter-Related Citations Guide, San Francisco Municipal Transportation Agency, November 22, 2013.



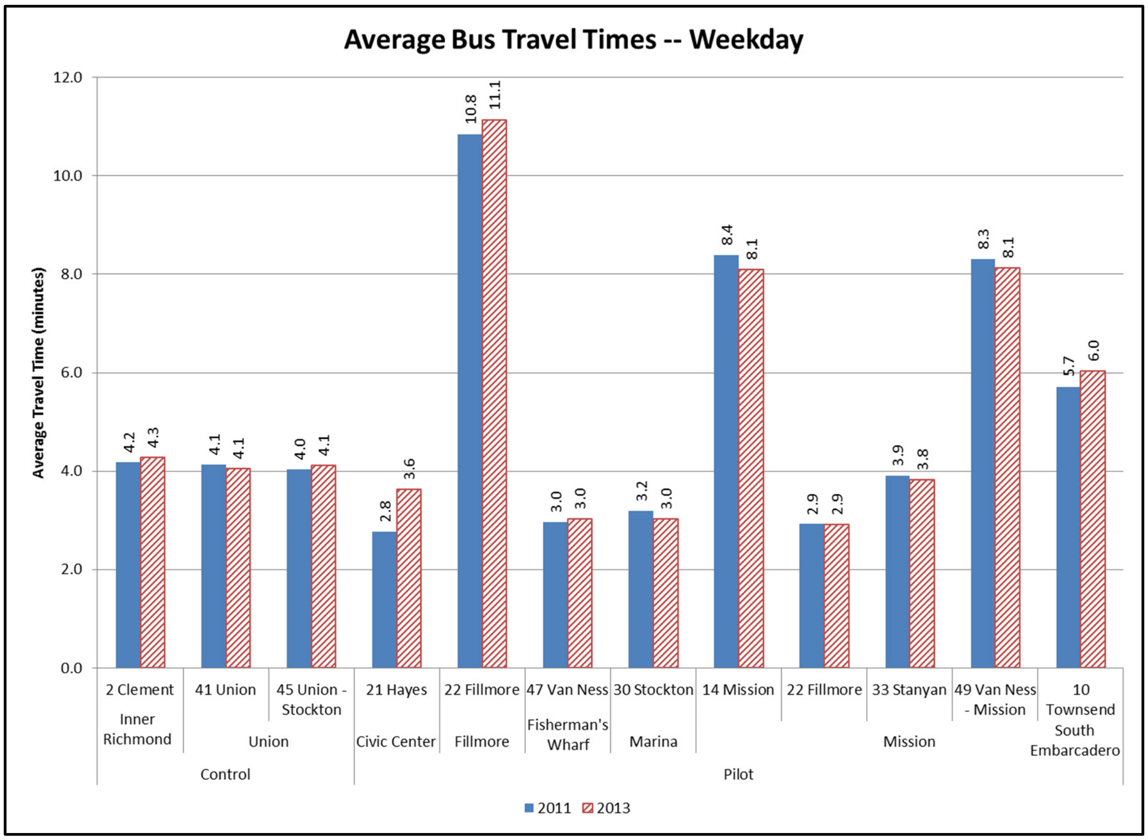
Source: Elliot Martin based on SFMTA data, 2014.

Figure F-3. Weekday Parking Occupancy Trends in Pilot Areas with Increases in Parking Occupancy

F.2.4 Travel Times

Variable pricing in the pilot areas was expected to improve travel times on local streets due to reduced circling by vehicles looking for parking. All traffic, including commercial vehicles, would have benefited from less traffic congestion and consequent travel time reductions. Travel times of Muni buses equipped with APC equipment served as a surrogate for travel times of all traffic. Analysis of transit travel time data is presented in Appendix A – Congestion Analysis, where details about the data and analysis methods are discussed.

Figure F-4 shows the average weekday travel time of buses before variable pricing (spring 2011) and afterward in the spring of 2013. For weekday travel, the figure shows that in the control districts, average travel times remained around four minutes across the evaluation periods. In the pilot areas, despite implementation of variable pricing, average transit travel times also remained relatively constant on all the routes through the pilot parking management districts – never changing more than 0.3 minutes for most districts. The exception was one route in the Civic Center area that experienced a travel time increase. Thus, variable pricing in the pilot areas did not lead to shorter travel times that would have benefited commercial vehicle traffic.



Source: Texas A&M Transportation Institute based on data provided by SFMTA, 2014.

Figure F-4. Weekday Average Transit Travel Times by Routes in Pilot and Control Parking Management Districts

F.3 Summary of Goods Movement Analysis

Table F-9 summarizes the findings for the four goods movement hypotheses. The evidence supports the first hypothesis on double parking. Based on modeling of field surveys of double occupancy in 2011 and 2013 reported in Appendix B – Pricing Analysis, double parking by commercial vehicles fell by 21 percent after variable pricing and other SF*park* enhancements had been made.

The second hypothesis was not supported. Data on parking citations, instead of parking fines which were not available, did not exhibit a statistically significant difference in the before/after changes in average monthly citations between control and pilot areas. The average monthly changes within the pilot areas over time are suggestive of a potential impact of the SF*park* enhancements, but the changes were not statistically significant, and thus the hypothesized effect was not supported.

The third hypothesis on parking availability was somewhat supported. Analysis of parking sensor data in Appendix B indicated that demand-based pricing began to have its expected effect in the later stages of the evaluation period by making space more available for all vehicles on the most popular blocks where parking was most congested. For commercial vehicles the implication is that potential conflict for parking between commercial vehicles and passenger vehicles would have been reduced, thereby making it easier for commercial vehicles to find parking. A decline in double parking by commercial vehicles in pilot areas lent some support the hypothesized decrease, but the finding was not statistically significant.

The fourth hypothesis was not supported. Bus travel times changed very little after variable pricing was deployed (less than 0.3 minutes per route) and this change was not statistically significant.

Table F-9. Summary of Goods Movement Analysis Across Hypotheses

Hypotheses/ Questions	Result	Evidence
CVOs double parking will decrease in the SF*park* pilot areas.	Somewhat supported	Double parking by commercial vehicles dropped by 21% in pilot areas at the end of the evaluation period in 2013. The findings used data from before and after field surveys and were based on modeling techniques that controlled for other variables. However, the difference between the pilot and control areas was not statistically significant and may require a larger sample size owing to the high variability in the observed double parking rates.
CVO double parking fines will decrease in the SF*park* pilot areas.	Not supported	Among the three types of citations for truck parking there were no statistically significant differences between control and pilot areas, although the citations in the pilot areas were fewer in the period after smart meters were installed and parking time limits were relaxed. Citations in the pilot areas continued to fall after variable pricing was implemented for yellow zones but not for truck loading zones, although the changes were not statistically significant.
Parking availability, including loading and freight zones, will increase in the SF*park* pilot areas.	Somewhat supported	The analysis of parking sensor data showed that demand-based pricing made space more available for all vehicles on the most popular blocks where parking was most congested. This may have reduced conflict between commercial vehicles and passenger vehicles, thereby making it easier for commercial vehicles to find parking.
Travel times will decrease in the SF*park* pilot areas for CVOs and other vehicles.	Not supported	Using travel times for buses on streets through pilot and control areas as a proxy for all vehicles, travel times in pilot areas changed very little after variable pricing – never more than 0.3 minutes – not an appreciable amount for CVOs or other drivers.

Source: Battelle, 2014.

Appendix G. Business Impact Analysis

This analysis assessed the impact of the San Francisco UPA projects on businesses. By improving parking availability and reducing time vehicles spend in search of parking, SF*park* was expected to improve travel and parking conditions for people wanting to access stores, offices, and other businesses in the parking districts where variable pricing and other parking improvements were implemented. In doing so, SF*park* could enhance the attractiveness of the area for business activity. Table G-1 shows the hypotheses used to test the impact of the UPA projects on businesses. In the first hypothesis, business activity was expected to increase as measured by increases in the sales in the SF*park* pilot areas, as parking conditions improved. In the second hypothesis, travel for the purpose of visiting stores and other businesses was expected to increase.

Table G-1. Business Impact Analysis Hypotheses

Hypotheses
• Sales will increase in the SF*park* pilot areas.
• Overall travel to access retail and similar businesses will increase in the SF*park* pilot areas.

Source: Battelle, 2014.

The remainder of this appendix is divided into three sections. The data sources used in the analysis are described next in Section G.1. Section G.2 presents the analysis of the data on the impact of the UPA projects on businesses. The appendix concludes with a summary of the findings on business impacts in Section G.3.

G.1 Data Sources

Two principal sources of data were used in the business impact analysis. One source was sales tax data used as a proxy for retail sales in the SF*park* pilot and control areas. The data were compiled by the Controller's Office of the City and County of San Francisco. The Controller's Office summarized the tax revenues for each of the SF*park* pilot and control areas, the Port of San Francisco area, and citywide. The time span of the data encompassed the second quarter (April through June) for each year from 2006 through 2013. For the SF*park* areas the data were provided in two forms: a) sales tax collected from establishments in the "food product," "general retail" and "miscellaneous" categories including chain stores; and b) sales tax collected in the "food product," "general retail" and "miscellaneous" categories excluding chain stores. The national evaluation used the data that included the chain stores.

One caution with the sales tax data reported in this appendix is that the numbers have not been adjusted for inflation. The Bureau of Labor Statistics of the U.S. Department of Labor publishes a Consumer Price Index (CPI) for the San Francisco Area in two forms: a) for all items that they include in the index and b) for all items less food and energy.[1] For the time period being evaluated, the CPI was subject to considerable fluctuation due to energy prices, and so using the CPI including energy prices to adjust the sales tax revenues did not seem appropriate. The alternative CPI that excluded energy prices also excluded food prices, and it was not appropriate to use it with the sales tax revenues that included establishments in the “food products” category. Thus, the reader should recognize that there may be some unavoidable inflationary effect in the sales revenues that are analyzed for this report, although the same effect would be expected in both pilot and control areas.

The second source of data used in the business impact analysis was the survey of visitors and shoppers in the SF*park* pilot and control areas. The survey consisted of two cross-sectional samples, one in the spring of 2011 before the changes in parking pricing, and the other in the spring of 2013, 21 months after demand-based pricing began to be implemented. The on-street intercept survey was administered in a subset of the eleven SF*park* parking areas: five pilot areas and two control areas. All the respondents had either driven and parked in the area that day or had done so on a previous trip within the last year. More details on the survey methodology can be found in Appendix B – Pricing Analysis. For the business impact analysis responses for questions pertaining to trip purpose, frequency of visits, amount of money spent in the area during the visit, mode used, type of parking used, and time of trip were examined.

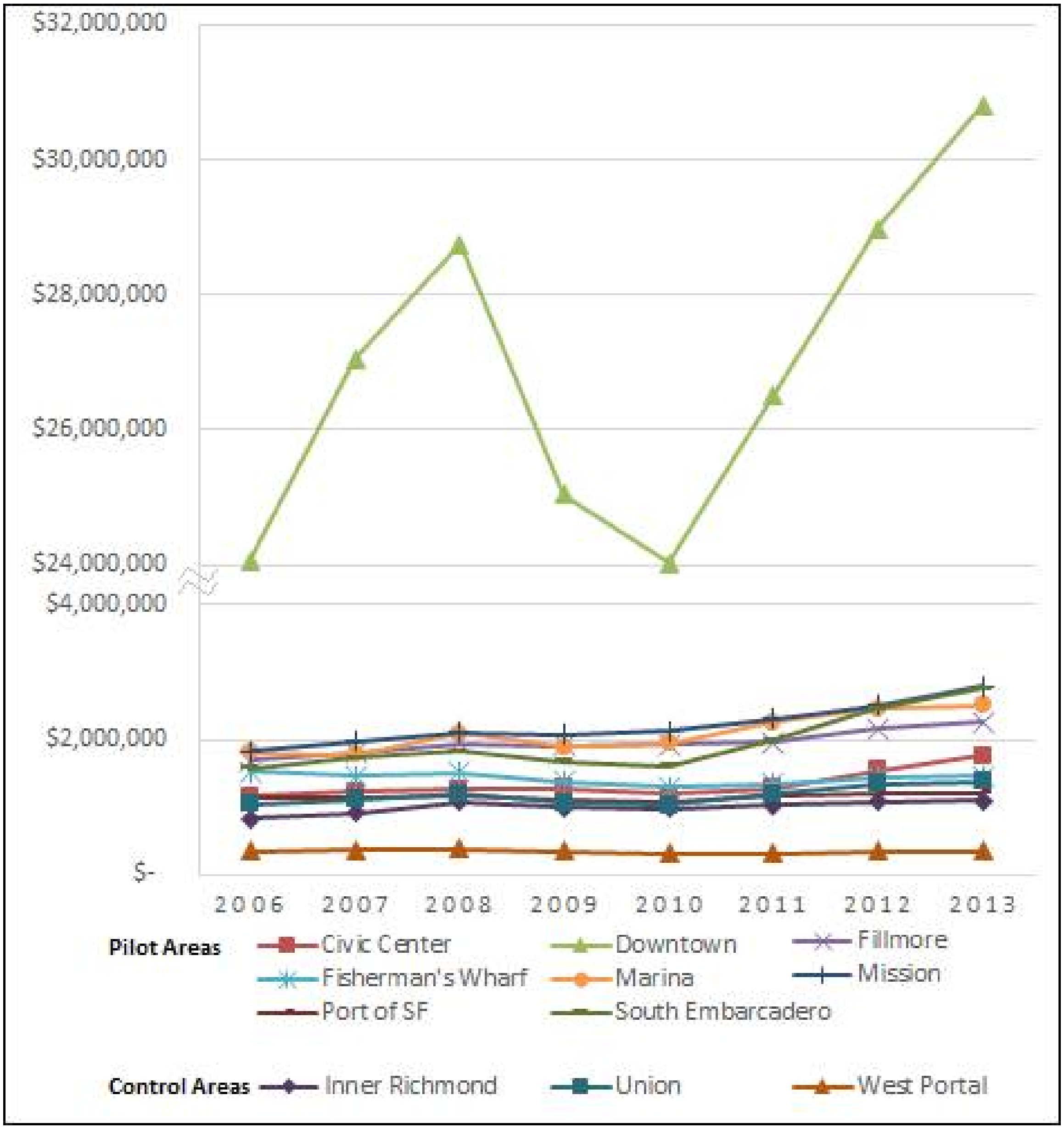
G.2 Analysis of the UPA Impacts on Businesses

G.2.1 Sales Taxes

Sales tax data were used to examine the trend in retail sales before and after the implementation of variable pricing. SF*park* was intended to increase parking availability on the most congested blocks, which could have had a positive impact on sales. On the other hand, raising parking prices in the most popular areas could have discouraged visitation and had a negative impact on sales.

Figure G-1 shows the sales data for the second quarter by calendar year for each pilot and control area. Data required from 2012 and 2013 represent the period after variable pricing was implemented in the pilot areas. Because the taxes for the Downtown pilot area are an order of magnitude greater than taxes for other areas, the y-axis on the graph is split to be able to show the Downtown area along with the other pilot and control areas. Figure G-1 shows that some neighborhoods experienced an increase in sales tax revenue following variable pricing, whereas taxes in other areas appeared to stay relatively flat.

[1] Bureau of Labor Statistics, U.S. Department of Labor. “Consumer Price Index, San Francisco area – April 2014,” accessed from http://www.bls.gov/ro9/cpisanf.htm on June 6, 2014.

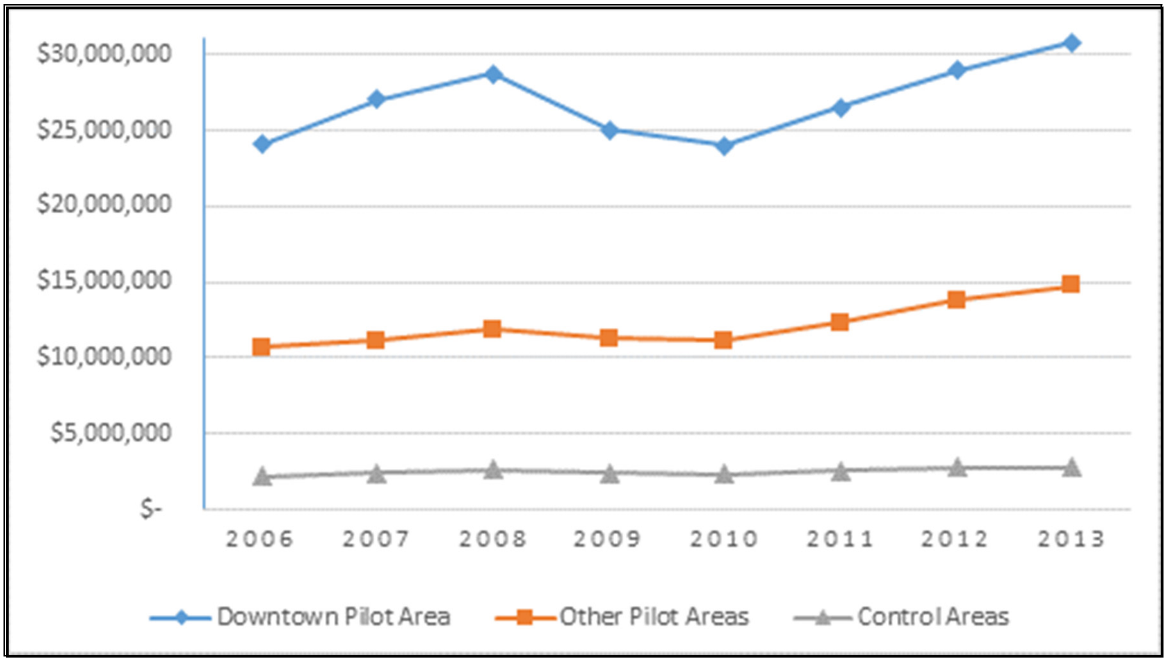


*Taxes for establishments classified in "Food Product," "General Retail," and "Miscellaneous" categories.

Source: Battelle using data from the Controller's Office, City and County of San Francisco, 2014.

Figure G-1. Second Quarter Sales Tax Revenues* by SF*park* Neighborhood, 2006 through 2013

Figure G-2 presents the same data summed by pilot and control areas, with the Downtown pilot area shown separately due to scale. This figure more clearly demonstrates an uptick in the pilot areas starting in 2011, before variable pricing, but continuing afterward. The control areas, on the other hand, did not experience the increase. While variable pricing in the pilot areas might not have been the cause of sales growth as reflected in sales tax revenues, the data certainly show no negative impact of SF*park* pricing on business.



Source: Battelle using data from the Controller's Office, City and County of San Francisco, 2014.

Figure G-2. Second Quarter Sales Tax Revenues by Pilot and Control Areas, 2006 through 2013

G.2.2 Survey Findings

The visitor/shopper survey included several questions that reveal the potential impact of SF*park* on businesses in the areas where variable pricing was implemented. By comparing the survey findings between the pilot and control areas and between the period before price changes were implemented and after pricing changes, the effect of SF*park* could be assessed. For that purpose responses to survey questions on trip purpose, frequency of visits, amount of money spent in the area during the visit, mode used, type of parking used, and time of trip were examined.

<u>Trip Purpose</u>

One measure of business impact is the purpose for which people travel to an area. Some purposes have more potential for revenue generation and, thus, might be seen as more valuable for businesses. The visitor/shopper survey asked the question "What was the reason you came to the area today?" to which respondents could indicate more than one purpose for their trip. Table G-2 presents the results for the question on trip purpose. The responses for shopping, dining or drinking, personal errand or appointment, and entertainment probably have the most direct potential for revenue generation. Table G-3 shows the results of the chi-square test for significance of the distribution of responses between the pilot and control areas and between the time periods.

Table G-2. Summary Statistics (N and Percent) for "What was the reason* you came to the area today?" by Area and Time Period

Area	What was the reason you came to the area today?	Before N (Percent)	After N (Percent)
Control	1. Shopping	213 (33.13%)	187 (27.26%)
	2. Working	81 (12.60%)	95 (13.85%)
	3. Dining or drinking	144 (22.40%)	209 (30.47%)
	4. Personal errand or appointment	172 (26.75%)	191 (27.84%)
	5. Visiting friends in this area	44 (6.84%)	45 (6.56%)
	6. Gym or other Exercise	34 (5.29%)	43 (6.27%)
	7. Entertainment	5 (0.78%)	1 (0.15%)
	8. Site-seeing/Tourist attractions	12 (1.87%)	11 (1.60%)
	9. I live in this area	30 (4.67%)	30 (4.37%)
	10. School or Education	3 (0.47%)	4 (0.58%)
	11. Other	1 (0.16%)	1 (0.15%)
	Total	**738 (114.96%)**	**817 (119.10%)**
Pilot	1. Shopping	172 (25.63%)	149 (20.24%)
	2. Working	216 (32.19%)	252 (34.24%)
	3. Dining or drinking	89 (13.26%)	157 (21.33%)
	4. Personal Errand or appointment	136 (20.27%)	143 (19.43%)
	5. Visiting friends in this area	48 (7.15%)	42 (5.71%)
	6. Gym or other Exercise	25 (3.73%)	24 (3.26%)
	7. Entertainment	21 (3.13%)	9 (1.22%)
	8. Site-seeing/Tourist attractions	33 (4.92%)	18 (2.45%)
	9. I live in this area	25 (3.73%)	31 (4.21%)
	10. School or Education	10 (1.49%)	28 (3.80%)
	11. Other	7 (1.04%)	1 (0.14%)
	Total	**782 (116.54%)**	**854 (116.03%)**

*The respondent could give more than one reason for trip.

Source: Battelle based on SFMTA data, 2014.

Table G-3. Results from Chi-Square Test for Significant Differences in "What was the reason you came to the area today?" by Time Period and Area

Test for Significant Differences Across Areas (Control/Pilot)		Test for Significant Differences Across Periods (Before/After)	
Period	**Chi-Square P-Value**	**Area**	**Chi-Square P-Value**
Before	<0.0001*	Control	0.1051
After	<0.0001*	Pilot	<0.0001*

*The chi-square test of the distribution of data was significant at the 0.05 level.

Source: Battelle based on SFMTA data, 2014.

There were significant differences in response distributions between the pilot and control areas in both periods. The pilot areas tended to be work destinations, with a greater proportion of respondents (around 33 percent) coming to the areas for work compared to the control areas (about 13 percent). A smaller proportion of respondents in the pilot came to the area for shopping, dining or drinking, and personal errand or appointment. Entertainment was a minor purpose for trips in both areas, although somewhat greater in the pilot than control areas.

Given the basic differences in the pilot and control areas, the issue is whether there was an increase in trip purposes of interest to businesses in the pilot areas. The results show that the pilot areas had significant differences in the response distribution between the two periods whereas the control area differences between periods were not significant. As seen in Table G-2 a greater percentage of pilot area respondents after variable pricing came for dining and drinking (up from 13 percent to 21 percent) than before. On the other hand, a lesser percentage of respondents came to the pilot area afterward for shopping (20 percent) compared to before (25 percent). The share of trips for personal errand or appointment was unchanged. Based on data on trip purpose in the pilot areas, no overall impact on businesses, positive or negative, can be attributed to variable pricing. Although shopping trips experienced a relative decline, they were compensated by an increase in trips for dining or drinking. It should also be noted that the analysis does not account for changes in the businesses themselves, such as if there were more restaurants and fewer retail establishments after the implementation of variable pricing.

Frequency of Visit to Area

Another measure of potential business impact was whether the change in parking pricing affected how frequently people visited the area. In the visitor/shopper survey respondents were asked, “Compared to a year ago, do you visit the area more often, the same, or less?”[2] Table G-4 shows the responses to that question for pilot and control areas. After variable pricing was in effect, over three-fourths (77 percent) of the respondents in the pilot area said they visited about the same amount, 16 percent said they visited the area more, and those saying they visited the pilot areas less often was 7 percent. This finding suggests that people continued to visit areas where variable pricing was in effect at least to the extent that they had been visiting and were not discouraged by the change in parking prices.

Table G-4. Summary Statistics (N and Percent) for “Compared to a year ago, do you visit the area more often, the same amount or less?” for Pilot and Control Areas in the After Period

Area	Compared to a year ago, do you visit the area more often, the same amount or less?	After Period N (Percent)
Control	1. More often	102 (14.87%)
	2. Less often	41 (5.98%)
	3. Same amount	543 (79.15%)
	8. Do Not Know	0 (0.00%)
	9. Refused	0 (0.00%)
	Total	**686 (100.00%)**
Pilot	1. More often	115 (15.69%)
	2. Less often	54 (7.37%)
	3. Same amount	564 (76.94%)
	8. Do Not Know	0 (0.00%)
	9. Refused	0 (0.00%)
	Total	**733 (100.00%)**

Source: Battelle based on SFMTA data, 2014.

[2] The after survey was conducted about 21 months after the first price changes, and, therefore, asking respondents about behaviors one year ago wouldn’t have been entirely before any price changes. However, the idea was to see if people had adapted to price changes in this question and others in which the phrase “one year ago” was used. The price changes were incremental, and for most blocks it would have taken several rounds of price changes to reach equilibrium. Thus, survey designers did not believe more precise wording on the pre- and post-pricing dates would have resulted in different responses to the question.

As indicated by the chi-square test result in Table G-5, there was not a significant difference in the response distribution between the pilot and control areas after variable pricing was put into effect in the pilot area. This implies that respondents in the pilot areas behaved in a similar fashion to those in the control areas in terms of their frequency of visits to the area.

Table G-5. Result from Chi-Square Test for Significant Difference in "Compared to a year ago, do you visit the area more often, the same amount or less?" between Pilot and Control Areas After Variable Pricing Went Into Effect

Test for Significant Difference Across Areas (Control/Pilot)	
Period	**Chi-Square P-Value**
After	0.4964*

* The chi-square test of the distribution of data was not significant at the 0.05 level.

Source: Battelle based on SFMTA data, 2014.

Money Spent

Another measure of the potential economic impact of the variable pricing was the amount of money that the survey respondent spent, or expected to spend, in the area in which he or she parked. Table G-6 shows the average dollar amount by area before and after variable pricing along with the 95 percent confidence interval for the mean. The data revealed a drop of about 13 percent in money spent in the pilot areas and a drop of 28 percent in the control areas included in the survey. The Bay Area was not spared in the nationwide recession, and unemployment in the region peaked at around 10 percent in early 2010. However, that was prior to the before survey in the spring of 2011 and the start of variable parking pricing in the summer of 2011, and by the time of the after survey in May of 2013 regional unemployment had declined to 5.3 percent.[3] Nevertheless, the recent recession could still have an impact on personal spending reflected in the after period. However, the analysis of sales tax revenues discussed in Section G.2.1 indicated a continued growth in spending in 2012 and 2013 after variable pricing was implemented. Thus, the drop in reported spending in the survey in both control and pilot areas is surprising.

Table G-6. Summary Statistics (Geometric Mean and 95 Percent Confidence Interval) for "How much money will (did) you spend in the area on your visit?" by Pilot and Control Areas and Neighborhood by Time Periods

Area	Neighborhood	Before		After	
		N	Geometric Mean (CI)	N	Geometric Mean (CI)
Control	Inner Richmond	300	$19.85 ($17.13, $23.01)	340	$16.09 ($13.54, 19.11)
	Union	311	$26.76 ($21.45, $33.37)	337	$17.40 ($14.06, $21.53)
	Total	**611**	**$23.11 ($20.21, $26.42)**	**677**	**$16.73 ($14.59, $19.17)**
Pilot	Downtown	256	$31.99 ($26.00, $39.36)	260	$23.82 ($19.59, $28.96)
	Marina	185	$25.15 ($19.24, $32.87)	247	$26.87 ($21.74, $33.20)
	Mission	189	$23.54 ($18.46, $30.01)	223	$20.73 ($17.19, $25.00)
	Total	**630**	**$27.19 ($23.73, $31.15)**	**730**	**$23.78 ($21.20, $26.67)**

Source: Battelle based on SFMTA data, 2014.

[3] Unemployment statistics presented in Appendix J – Exogenous Factors.

To test the significance of the differences in spending, an ANOVA model was fitted to the base-10 log-transformed data with fixed effects for time and area (pilot/control). A log transformation was necessary to account for the unequal variances in the response variable between periods and to ensure the response data were normally distributed. The difference in variability was due mainly to the number of respondents with very large values. There were 18 respondents overall who said they would spend at least $1,000 on their trip. Thirteen of those were in the before period. These large values inflated the mean values. The log-transformation of the data mitigates the effects of the extreme values in the analysis. Results have been transformed back to their original scale for presentation in Table G-7 and Table G-8.

There was a significant difference in the amount of money that was spent in the before versus the after period in the control area (p-value=0.0007). In the control area, respondents said they had or planned to spend about 38 percent more in the before period compared to respondents in the after period. Despite the apparent drop in spending in the pilot areas shown in Table G-7, there was no statistically significant difference in money spent between the two periods in the pilot area. An interaction term was added to test whether the difference between control and pilot areas was different between the before and after periods. The interaction effect was not significant (p-value=0.1541), which indicates that the mean difference in the money spent during the visit in the control versus pilot areas did not depend on the time period. That is, spending in the areas was fundamentally different regardless of the change in parking pricing.

Table G-7. Results of ANOVA Test for Significant Differences in "How much money will (did) you spend in the area on your visit?" across Time Periods for Pilot and Control Areas

(Results are Ratios of Geometric Means between Time Periods)

Comparison	Ratio of Money Spent	P-Value
Control Area (Before/After)	1.38	0.0007*
Pilot Area (Before/After)	1.14	0.1480
Control Area (Before/After)/Pilot Area (Before/After)	1.21	0.1541

*Comparison significant at the 0.05 level.

Source: Battelle based on SFMTA data, 2014.

Mode Used to Visit the Area

Based on the preceding analysis of frequency of visit to an area, variable parking pricing did not appear to discourage visitation. However, pricing could have affected the mode by which people chose to travel to the area. Several survey questions provided insight into mode choice and pricing. The questions asked about:

- Mode used to get to the area
- How the mode changed
- Why the mode change was made.

For the question “Compared to a year ago, have you changed your transportation mode to get to the area?” Table G-8 summarizes the results and Table G-9 shows the chi-square test result. After variable pricing there was a significant difference in the response distribution between the control and pilot areas. A larger percentage of respondents had changed their mode of transportation in the pilot (24 percent) compared to the control (17 percent) in the post-pricing period.

Table G-8. Summary Statistics (N and Percent) for “Compared to a year ago, have you changed your transportation mode to get to the area?” by Area

	1 – Yes	115 (16.76%)
Control	2 – No	571 (83.24%)
	Total	**686 (100.00%)**
	1 – Yes	179 (24.32%)
Pilot	2 – No	557 (75.68%)
	Total	**736 (100.00%)**

Source: Battelle based on SFMTA data, 2014.

Table G-9. Result from Chi-Square Test for Significant Difference in “Compared to a year ago, have you changed your transportation mode to get to the area?” by Area and Time Period

Test for Significant Differences Across Areas (Control/Pilot)	
Period	**Chi-Square P-Value**
After	0.0004*

*The chi-square test of the distribution of data was significant at the 0.05 level.

Source: Battelle based on SFMTA data, 2014.

For those respondents who said they had changed their mode in the after period, Table G-10 and Table G-11 indicate those who were using particular modes more frequently and less frequently, respectively.

Table G-10. For Individuals Who Changed Their Mode of Transportation by Using a Mode More, Summary Statistics (N and Percent*) "How did your choice of transportation change?" by Area in the After Period

Compared to a year ago, have you changed your transportation mode to get to the area?	Area**	
	Control	Pilot
More public transit	44 (40.37%)	79 (53.02%)
More car	37 (33.94%)	48 (32.21%)
More bike	8 (7.34%)	10 (6.71%)
More taxi	2 (1.83%)	3 (2.01%)
More carpool	11 (10.09%)	3 (2.01%)
More walk	29 (26.61%)	23 (15.44%)
Total Mode Changes	**131 (120.18%)**	**166 (111.40%)**

*Percentages do not add to 100 because individuals could select multiple responses.

**The chi-square test of the distribution of data was significant at the 0.05 level.

Source: Battelle based on SFMTA data, 2014.

Table G-11. For Individuals Who Changed Their Mode of Transportation by Using a Mode Less, Summary Statistics (N and Percent*) "How did your choice of transportation change?" by Area in the After Period

Compared to a year ago, have you changed your transportation mode to get to the area?	Area**	
	Control	Pilot
Less public transit	9 (21.43%)	20 (25.64%)
Less car	29 (69.05%)	52 (66.67%)
Less bike	1 (2.38%)	2 (2.56%)
Less taxi	1 (2.38%)	1 (1.28%)
Less carpool	0 (0.00%)	0 (0.00%)
Less walk	3 (7.14%)	4 (5.13%)
Total Mode Changes	**43 (102.38%)**	**79 (101.28%)**

*Percentages do not add to 100 because individuals could select multiple responses.

**The chi-square test of the distribution had a p-value of 0.9620 was not significant at the 0.05 level.

Source: Battelle based on SFMTA data, 2014.

Among those who used a particular mode more, there was a significant difference in response distributions between the pilot and control areas in the after period (p-value=0.0222). A greater percentage of respondents increased their public transit use in the pilot area compared to the control area and a greater percentage of respondents increased their carpooling and walking in the control area compared to the pilot area. There were no significant differences in response distributions between the pilot and control areas in the after period for those respondents who said they used a particular transportation mode less (p-value=0.9620). Thus, while only about a quarter of the respondents said they changed their mode when traveling to the pilot areas after variable pricing began, over half of the changes made were for greater use of transit.

To determine to what extent parking figured in their decision to change mode in getting to an area, respondents in the after period were asked "Why did you change your transportation mode to the area in the last year?" Table G-12 presents the reasons given. No one aspect of parking was the top reason given, but in one way or another it impacted the mode change among 36 percent of respondents in the control areas and 28 percent in the pilot areas. Of these, only about 3 percent in either area said parking was easier to find or less expensive. However, about twice the percentage in the control areas reported difficulty finding parking as in the pilot areas (29 percent vs. 15 percent respectively). On the other hand, more expensive parking was cited by twice the percentage in the pilot areas compared to control areas: 10 percent vs. 5 percent. While the number of persons on which these percentages are based is small, it suggests that parking was not the reason for most people to change mode. When parking was cited as a reason, availability was not as problematic in the pilot areas where variable pricing occurred compared to areas where pricing did not try to regulate demand. On the other hand, twice as many in the pilot areas gave more expensive pricing as the reason for the mode change, but the reason was cited infrequently – about 10 percent of all the reasons cited in the pilot areas.

Table G-12. Summary Statistics (N and Percent) for "Why did you change your transportation mode to the area in the last year?" by Area in the After Period

Why did you change your transportation mode to the area in the last year?	After N (Percent)	
	Control Area	Pilot Area
1. New school or work location	11 (10.00%)	28 (17.83%)
2. Moved to or from area	17 (15.45%)	16 (10.19%)
3. Improved transit service	2 (1.82%)	5 (3.18%)
4. Worsened transit service	4 (3.64%)	8 (5.10%)
5. Easier to find parking	3 (2.73%)	4 (2.55%)
6. More difficult to find parking	32 (29.09%)	24 (15.29%)
7. Parking more expensive	5 (4.55%)	15 (9.55%)
8. Parking less expensive	0 (0.00%)	1 (0.64%)
9. Purchased vehicle	4 (3.64%)	7 (4.46%)
10. Sold vehicle	0 (0.00%)	6 (3.82%)
11. Other	32 (29.09%)	43 (27.39%)
Total	**110 (100.00%)**	**157 (100.00%)**

Chi-square test for significance of difference between distributions of control and pilot: p-value = 0.0539, marginally significant at the .05 level.

Source: Battelle based on SFMTA data, 2014.

Change in Parking Type

The survey examined potential changes in type of parking that visitors to an area used following the start of variable pricing. Respondents were asked “Compared to a year ago, have you changed the type of parking you use in the area?” such as using unmetered, metered, garage or lot. Fewer than 10 percent made a change in the type of parking they used and no statistical difference was found between control and pilot areas. Of those who had changed their type of parking, Table G-13 shows the reason for the change. Interestingly, in the control areas 33 percent cited more difficulty in finding parking versus 11 percent in the pilot areas. In the pilot areas, 16 percent said they changed because parking was less expensive and only 7 percent said the reason was parking was more expensive. While the number of respondents in these categories is too low for statistical significance, the data do not suggest a major shift in parking patterns in the pilot areas and changes that were made were based more frequently on reasons other than parking pricing and availability.

Table G-13. Summary Statistics (N and Percent) for “Why did you change the type of parking you use?” by Area in the After Period

Why did you change the type of parking you use?	After* N (Percent)	
	Control Area	Pilot Area
1. New school or work location	3 (7.50%)	14 (25.00%)
2. Moved to or from area	5 (12.50%)	5 (8.93%)
3. Improved transit service	0 (0.00%)	1 (1.79%)
4. Worsened transit service	0 (0.00%)	0 (0.00%)
5. Easier to find parking	3 (7.50%)	5 (8.93%)
6. More difficult to find parking	13 (32.50%)	6 (10.71%)
7. Parking more expensive	4 (10.00%)	4 (7.14%)
8. Parking less expensive	3 (7.50%)	9 (16.07%)
9. Purchased vehicle	1 (2.50%)	1 (1.79%)
10. Sold vehicle	1 (2.50%)	0 (0.00%)
11. Other	7 (17.50%)	11 (19.64%)
Total	**40 (100.00%)**	**56 (100.00%)**

*Chi-square of difference between control and pilot had p-value = 0.1295, not significant at the 0.05 level.

Source: Battelle based on SFMTA data, 2014.

Trip Timing

Another potential change that travelers could make in response to variable parking pricing was to change the timing of their trip. To explore that possibility, survey respondents were asked the question "Compared to a year ago have you changed the time of your trips to the area in order to find cheaper parking?" Table G-14 shows the results. In the pilot about 14 percent said they changed the time of their trip to find cheaper parking compared to 11 percent in the control areas, but the difference between the two areas was not statistically significant. This suggests that the behavior was similar in both areas regardless of variable pricing.

Table G-14. Summary Statistics (N and Percent) for "Compared to a year ago have you changed the time of your trips to the area in order to find cheaper parking?" by Area in the After Period

Area	Compared to a year ago have you changed the time of your trips to the area in order to find cheaper parking?	After* N (Percent)
Control	1. Yes	72 (10.62%)
	2. No	606 (89.38%)
	Total	**678 (100.00%)**
Pilot	1. Yes	100 (13.87%)
	2. No	621 (86.13%)
	Total	**721 (100.00%)**

*Chi-square of difference between control and pilot had p-value = 0.0643, not significant at criterion level of 0.05.

Source: Battelle based on SFMTA data, 2014.

G.3 Summary of Business Impact Analysis

Table G-15 presents a summary of the business impact analysis for the two hypotheses. On balance, the analysis of the data reveal a neutral to positive impact of demand-based parking pricing on businesses in the pilot areas. The hypothesis on sales increasing in the SF*park* pilot areas was supported, based on the analysis of sales tax revenues from establishments in the "food product," "general retail" and "miscellaneous" categories. Tax revenues increased in the pilot areas but remained relatively flat in the control areas after the implementation of the variable pricing in pilot areas. While the parking changes in the pilot areas may not have caused the sales growth, they clearly did not hurt business. Before/after spending reported by survey respondents on the day they were interviewed dropped in both pilot and control areas, but the drop was statistically significant only in the control areas. Still, respondents in the pilot areas did not show the increase in spending that might have been expected based on the trends in tax revenues.

The second hypothesis dealing with travel to access businesses was analyzed using multiple questions from the visitor/shopper survey. SF*park* appeared to have minimal impact on access in either a positive or negative way. Trip purposes changed somewhat in the pilot areas, but the changes appeared to be small shifts between types of businesses visited (more dining and drinking, and less shopping). Perhaps the most important finding was that the frequency of trips to both the pilot and control areas had not been reduced: over 75 percent of survey respondents reported they visited at about the same frequency as a year ago and a greater proportion of respondents reported more visits than fewer. Among respondents who reported mode changes in pilot areas, increased transit use was the primary response, which can be viewed as a positive impact of SF*park*. Negative aspects of parking were not the primary reasons for mode change, but 10 percent in pilot areas gave that reason. On the other hand, half as many respondents in the pilot areas as the control areas cited difficulty finding parking in the after period. SF*park* did not appear to lead to changes in the type of parking used or in the timing of trips, given that responses in control and pilot areas were similar.

Table G-15. Summary of Goods Movement Analysis Across Hypotheses

Hypotheses/Questions	Result	Evidence
• Sales will increase in the SF*park* pilot areas.	Mixed	Pilot areas, where variable pricing was in effect, showed growth in sales tax revenues in the years following the price changes. Although the trend in the pilot areas started in the year prior to price changes, it continued into the after period, whereas in the control areas sales tax revenues remained relatively flat. Survey respondents in the after period indicated a drop in spending compared to the before period in pilot areas, but it was not statistically significant. Control areas saw a significant before/after decrease in spending.
• Overall travel to access retail and similar businesses will increase in the SF*park* pilot areas		
- Change in trip purposes	Neutral	In pilot areas shopping trips declined by 5% but dining and drinking trips increased by 8%.
- Change in frequency of visits	Neutral	Changes in the frequency of visits were similar for the pilot and control areas. Variable pricing itself did not lead to more frequent visits to the pilot areas but neither did it lead to fewer visits. In the after period, the percentage visiting at about the same frequency as the previous year went up in both the pilot and control areas to over 75%; the percentage visiting less remained 10% or below; those visiting more often dropped to about 15%.
- Change in mode used and reason for change	Positive shift to transit in pilot areas, but mixed in terms of reason for change	More changed modes in pilot areas (24%) than control areas (17%) in the after period. Those who used a mode more frequently changed to transit in the pilot areas (53%) compared to the control areas (40%). In the after period, fewer in the pilot (15%) cited difficulty finding parking as their reason for mode change than in the control (29%), but 10% in the pilot cited more expensive parking versus 5% in the control. Still, the negative aspects of parking were not the primary reasons for mode change.
- Change in parking type and reason for change	Not supported	Fewer than 10% in both pilot and control areas changed the type of parking, and the reasons cited for the change were based more frequently on reasons other than parking pricing and availability.
- Change in trip timing	Neutral	No significant difference between control and pilot areas, with 14% and 11%, respectively, saying they changed the time of trip to find cheaper parking.

Source: Battelle, 2014.

Appendix H. Non-Technical Success Factors Analysis

This analysis examines the non-technical success factors associated with the San Francisco UPA projects. These non-technical success factors include outreach activities, media coverage, political and community support, and the institutional arrangements used to manage and guide implementation of the San Francisco UPA projects. Information on the non-technical success factors is of benefit to the U.S. DOT, state departments of transportation, MPOs, and local communities interested in planning and deploying similar projects.

Table H-1 presents the core question, measures of effectiveness and data sources associated with the analysis of the non-technical success factors. The focus is on understanding how a wide range of variables influenced the success of the San Francisco UPA project deployments. The variables are grouped into five major categories: (1) people, (2) process, (3) structures, (4) media, and (5) competencies. A second question on public support for the San Francisco UPA projects and their effectiveness in reducing congestion had been intended, but data were not available for addressing this question, and, therefore, it was not included in the evaluation.

Table H-1. Non-Technical Success Factors Analysis Approach

Question	Measures of Effectiveness	Data
• What role did factors related to these five areas play in the success of the deployment? 1. People (sponsors, champions, policy entrepreneurs, neutral conveners) 2. Process (forums [including stakeholder outreach], meetings, alignment of policy ideas with favorable politics and agreement on nature of the problem) 3. Structures (networks, connections and partnerships, concentration of power and decision-making authority, conflict-management mechanisms, communications strategies, supportive rules and procedures) 4. Media (media coverage, public education) 5. Competencies (cutting across the preceding areas: persuasion, getting grants, conducting research, technical/technological competencies; ability to be policy entrepreneurs; knowing how to use markets)	• Observations from UPA participants	• One-on-one interviews followed by group workshops: – End of planning and implementation phase – End of UPA one-year operational evaluation period
	• Partnership documents (e.g., memoranda of understanding)	• UPA partners' documents
	• Outreach materials (press releases, brochures, websites, etc.)	• UPA partners' outreach materials
	• Radio, TV and newspaper coverage	• Internet-based tracking of media coverage • UPA partners' files

Source: Battelle, 2014.

This appendix is divided into six sections. The data sources used in the analysis are described in Section H.1. Information on the multi-agency organizational structure of the San Francisco UPA is presented in Section H.2 followed by a discussion of the communications and outreach activities in Section H.3 and a content analysis of news media coverage of the San Francisco UPA in Section H.4. The major themes from the interviews and workshops with the local partners are presented in Section H.5. In conclusion, a summary of the San Francisco UPA non-technical success factors is presented in Section H.6.

H.1 Data Sources

A variety of data sources was used in the non-technical success factors analysis. First, two rounds of interviews and workshops were conducted by the national evaluation team with representatives of the local partners. Second, news media coverage of the San Francisco UPA projects collected by SFMTA were reviewed and analyzed. Third, San Francisco UPA partners shared with the national evaluation team formal partnership documents and outreach materials and activities for examination and analysis.

H.2 San Francisco UPA Multi-Agency Organizational Structure

There are three main agencies involved in the San Francisco UPA: the San Francisco Municipal Transportation Agency (SFMTA), the San Francisco County Transportation Authority (SFCTA), and the Metropolitan Transportation Commission (MTC). The UPA award made to San Francisco in 2007 originally included congestion pricing on traffic entering San Francisco from the Golden Gate Bridge via Doyle Drive. When this element of the UPA fell through, the project scope and agreement were rewritten in October 2008 to focus on SF*park*, the variable parking pricing element from the original project plan, as the main pricing strategy for the region. The revised scope of the San Francisco UPA positioned the SFMTA at the center of the project structure as it holds the authority to price and manage parking in San Francisco. The role of the SFCTA was to plan and manage the telecommuting/TDM element of the UPA[1] and the role of the MTC was to make enhancements to its 511 traveler information system to support the new SF*park* program.

[1] The telecommuting/TDM element was intended to incorporate SF*park* and 511 parking information in an existing alternate commute outreach program run by the San Francisco's Department of Environment, a sister agency of the SFCTA. However, the outreach program changed and the UPA information was no longer included, and as a result the evaluation of the telecommuting/TDM project was discontinued in the national evaluation.

H.3 Public Information and Outreach Activities

Through interviews with the local San Francisco UPA partners, it became clear to the national evaluation team that SFMTA was essentially the only entity that planned and executed an outreach strategy during the evaluation period.[2] Thus, while this analysis considers the planning, implementation, and outcomes of an outreach strategy for the San Francisco UPA, the focus of this section is on the public information and outreach activities implemented by SFMTA for SF*park*.

The following section describes the outreach approach and activities employed by SFMTA as evidenced through the outreach materials and activities shared by SFMTA with the national evaluation team and through the interviews and workshops with local partners conducted by the national evaluation team. The section concludes with a discussion of the strategies and activities employed by the SFMTA on behalf of the San Francisco UPA and its implications for the region.

Purpose and Approach to Outreach and Marketing Communications

1. *Informing*: the most basic reason for outreach was that people needed to be informed of a new, possibly confusing, project. As was stated in SF*park*: Putting Theory into Practice (a guide published by the SFMTA), SF*park* “fundamentally changes the way a city thinks about parking…” (p. 100). Therefore, materials were created and meetings were held to explain what the project was, why it was being done, and what the benefits were to commuters and residents.
2. *Persuading*: additionally, SFMTA was attempting to persuade people with its outreach activities. One interviewee from the agency alluded to the sometimes negative reputation of SFMTA. To some, they are only known as the ones who set the “citation and meter rates” (UPA interviews). A marketing campaign would, therefore, not only attempt to convince people of the benefits of SF*park*, but also of the good will of SFMTA.

Strategies for Outreach and Marketing Efforts

1. *Clarity*: SFMTA was trying to avoid technical jargon in its messaging. Instead, it tried to be very clear about how the system worked and what the benefits were by using simple, easy-to-understand language.
2. *Customer-centric approach*: the agency believed that messaging about the environmental or social impact of the project would not be as resonant as a frame that highlighted the benefits to individuals, e.g. convenience in finding and paying for parking.
3. *Consistency*: wording and visuals were quite similar across all forms of marketing materials, whether the website, fliers, or videos.
4. *Get out ahead*: staff conducted hundreds of one-on-one meetings before the project rolled out in order to facilitate understanding and early project buy-in. Press releases, web announcements, and mass emails were also used for this purpose.

[2] The MTC planned to launch a campaign in the fall of 2013 to promote parking information on their 511 phone and website, but that schedule fell outside the national evaluation time frame.

Key Activities & Messaging

The most direct method of outreach was through one-on-one meetings with key stakeholders. Agency staff held presentations and meetings with personnel from the mayor's office, city supervisors, community organizations, businesses, and many others. The intent of the meetings was to inform, persuade, and answer any concerns from stakeholders. Other marketing activities included:

- Website (www.sf*park*.org)
- Twitter account
- Facebook account
- Videos on Vimeo
- Flickr account
- Press releases
- Fliers and posters distributed throughout the city
- "Meter Greeters": staff who aided customers trying to use parking meters.

These materials were used before and during the launch of various phases of the project. They were also, at times, written for specific neighborhoods. For instance, a poster would be created that informed people in the Civic Center neighborhood about impending parking rate increases. Some of the materials were in multiple languages. Figure H-1 through Figure H-4 present several examples of outreach and advertising materials produced by SFMTA for SF*park*.

Source: SFMTA, 2013

Figure H-1. Video Still from SF*park* Overview Video

Source: SFMTA, 2013.

Figure H-2. Examples of Branding & Communication Materials

Source: SFMTA, 2013.

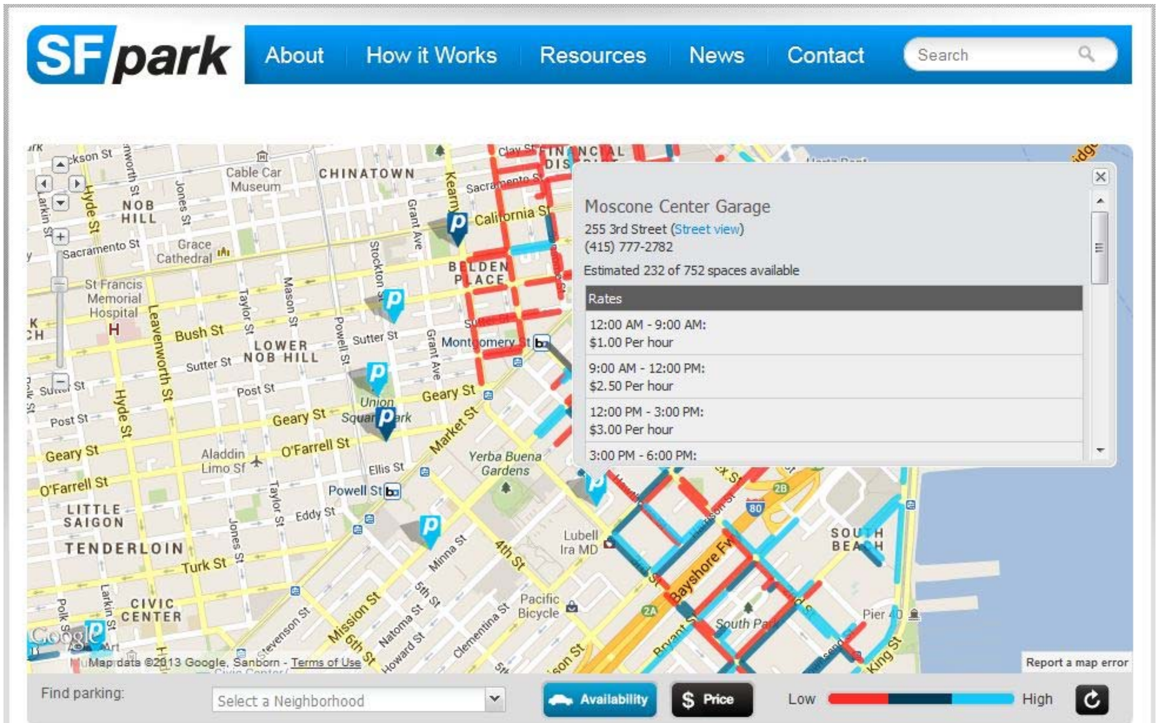
Figure H-3. Examples of Advertising Posters

Source: SFMTA, 2013.

Figure H-4. Example of an Advertising Bus Wrap

Interviews with local partners underscored that creating the right messaging matters in establishing project buy-in from key stakeholders and the general public and that communicating about SF*park* was as much about culture change (i.e., changing San Franciscsan's expectations about parking price and availability and changing public perception of SFMTA) as it was about educating users on where to find and how to pay for parking. To strike this balance, SFMTA implemented a communications and marketing plan that included close, personal interactions and clearly branded messaging of the purpose and goals of SF*park*. Its brand tagline, "*Circle less, Live more*" and its description, "*Find parking faster. Pay more easily. Avoid getting tickets.*" permeated all outreach and communications materials and activities for SF*park*. The SFMTA also marketed itself as keeping an open and transparent process throughout the SF*park* pilot, making data and other resources readily available on its SF*park*.org website.

With SFMTA in control of the branding and messaging of SF*park*, the scope of communications on the federal funding of the San Francisco UPA remained narrowly defined to the SF*park* pilot. By SFMTA making the conscientious decision to focus the San Francisco UPA messaging on SF*park*, it in essence made the decision to leave other congestion mitigation efforts out of the picture (TDM, for example) as well as other communication venues (511.org, for example). Perhaps drawing connections to the larger regional congestion mitigation efforts may have made communicating SF*park* less clear to potential users; however, it seems there may have been a missed opportunity to frame the SF*park* pilot project within a larger urban regional planning context, or at least to have more closely partnered with the other UPA local partners to communicate this. Where this is most evident is with two of the San Francisco UPA partners simultaneously developing a public communication tool that delivers real-time parking information to drivers looking for parking in San Francisco. SF*park* communicates real-time parking information through its SF*park* website and app and the MTC communicates real-time parking information through its 511 phone and parking website. Figure H-5 presents screen shots from each website.



Source: SFMTA and MTC, 2013.

Figure H-5. Screen Shots of Real-time Parking Information from SF*park*.org and 511.org

Conclusion. The SFMTA implemented a comprehensive outreach and marketing strategy to communicate the purpose and goals of the SF*park* pilot project to key stakeholders and San Francisco drivers. The SFMTA invested in both direct, one-on-one communication with community stakeholders as well as a widely distributed and succinct branding strategy. Underlying its strategy, the SFMTA worked to influence the culture of parking in San Francisco by educating people about how demand-pricing works to create a better working system rather than as a shear revenue producing mechanism for the city. While the San Francisco UPA projects included enhancements to the regional 511 traveler information system and TDM strategies, SFMTA's outreach efforts focused almost exclusively on the SF*park* pilot project. MTC promoted its 511 parking enhancements separately after the evaluation period as part of other 511 enhancements.

H.4 News Media Content Analysis

The following section describes the content analysis of news media for the period that spans planning through post-deployment of the San Francisco UPA projects in order to understand the nature and occurrences of media coverage and its potential role in both providing information as well as shaping public opinion.

Methods. The national evaluation team limited the selection of news media coverage to articles related to the San Francisco UPA projects. It should be noted, however, that during this same time period, there was considerable coverage of Doyle Drive, a tolling project that was part of the originally proposed San Francisco UPA projects. While Doyle Drive was not funded by the UPA program, many of the infrastructure improvements to the aging road system were still implemented during this period. There was also considerable coverage during this time period on the introduction of variable priced tolling on the San Francisco-Oakland Bay Bridge. Although both of these topics are relevant to congestion mitigation in the San Francisco Bay Area, the evaluation team did not include coverage of these topics.

Media coverage was tracked from the first occurrence beginning in 2007 through May 31, 2013. All news media coverage was collected by the San Francisco Municipal Transportation Agency (SFMTA), which is responsible for SF*park*, and distributed to the national evaluation team on a monthly basis throughout the evaluation data collection period. A total of 596 individual pieces of news media coverage were collected during this period and the national evaluation team sorted all news media coverage into the following four categories:

- Mainstream: Included coverage from the major neighborhood, local, regional, national, and international news media outlets.
- Blogs: Included coverage created and/or disseminated by private, or organization-affiliated, blogs.
- Op-Ed: Included coverage in mainstream newspaper outlets from the Opinion and Editorial section. Authors may include editorial staff from the newspaper or guest writers who are members of the readership community.
- Industry Publications: Included coverage from national, non-peer reviewed publications from the transportation field.

Due to the volume of media coverage and resource constraints in the national evaluation, in-depth content analysis was limited to a 10 percent stratified simple random sample of the coverage. The news media sample was stratified twice, first by media type and then by year. Within each subsample of media type, a proportionate amount of media was chosen from each year of the study to be represented in the sample. Table H-2 shows the sample distribution by media type and year. The total sample is slightly more than 10 percent (63 individual news media pieces out of 596 total) to accommodate in some instances where the sample amount would have been zero, but was rounded up to one in order to include at least one news media piece in the final sample. A random number generator was used to collect the stratified sample.

Table H-2. 10 Percent Stratified Sample of San Francisco News Media by Media Type & Year

	Mainstream	Mainstream Sample	Blogs	Blogs Sample	Industry	Industry Sample	Op-Ed	Op-Ed Sample	Total # of Articles	Total # of Artiles in Stratified Sample
2007	2	2	0	0	0	0	0	0	**2**	**2**
2008	26	3	5	1	1	0	2	0	**34**	**4**
2009	21	2	25	2	1	0	2	0	**49**	**4**
2010	79	8	72	7	4	1	4	1	**159**	**17**
2011	96	9	137	13	17	2	1	0	**251**	**24**
2012	40	4	29	3	6	1	1	1	**76**	**9**
2013	16	1	2	1	7	1	0	0	**25**	**3**
Total	**280**	**29**	**270**	**27**	**36**	**5**	**10**	**2**	**596**	**63**

Source: University of Minnesota, 2013.

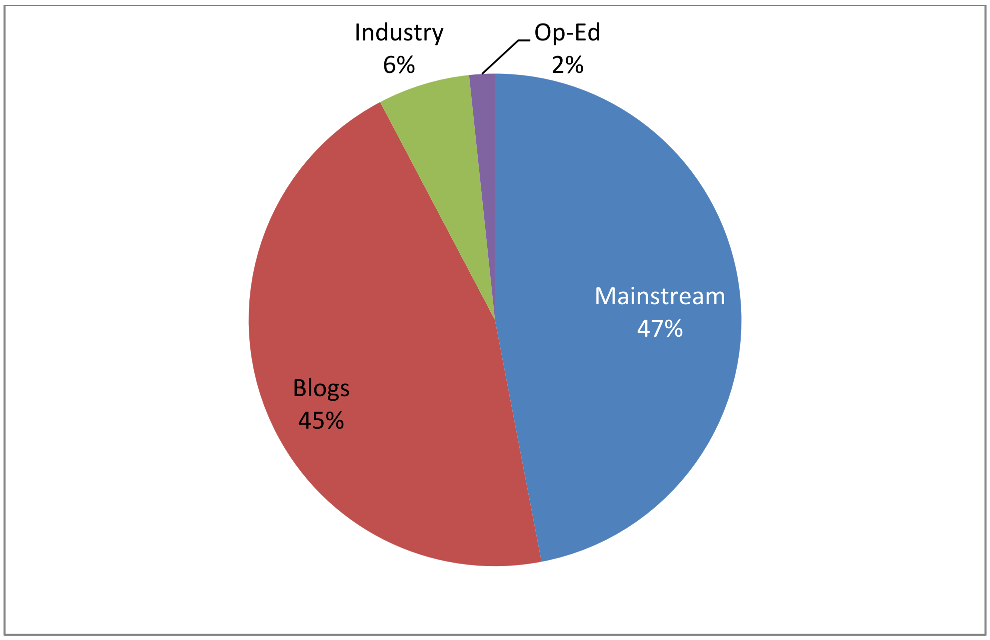
The content analysis of the sampled news media coverage involved first coding the articles into positive, negative, balanced, and neutral categories. By categorizing the articles, an assessment was made to determine whether the media was shaping opinion in a certain attitudinal direction (the assumption being that news media both informs and influences its readership). A definition of each category is as follows:

- Positive: The coverage presents an overwhelmingly positive case for the San Francisco UPA project(s), typically giving detailed information about the benefits of the project (e.g. reduced congestion, better ability to find parking, innovative use of technology). Sources and quotations come from only a positive perspective.
- Negative: The coverage presents an overwhelmingly negative case for the San Francisco UPA project(s), typically giving detailed information about the costs of the project (e.g. implementing demand-based pricing will cost the user more to park). Sources and quotations come from a negative perspective, or are put into a negative context.
- Balanced: The coverage presents a balanced story of both the potential benefits and costs of the San Francisco UPA project(s). Sources and quotations may come from positive and negative perspectives and the author does not give a final verdict on whether the project is a net positive or negative.
- Neutral: The coverage presents information simply to inform the reading audience of some phenomenon or event without a particular viewpoint.

Next, the major themes and categories of ideas that arose from the topics in the news media coverage were identified by reading each sampled media item and coding for common themes using NVivo software.[3]

Findings. With few exceptions, the majority of news media coverage gathered by SFMTA and distributed to the national evaluation team for the period 2007 through May 31, 2013 focused on the SF*park* project, which is the variable parking pricing program of the San Francisco UPA.

SF*park* attracted national and international news media coverage, including coverage from popular national media outlets such as The New York Times, The Los Angeles Times, The Wall Street Journal, National Public Radio, and The Huffington Post. However, most media coverage was produced locally with just over 50 percent coming from local mainstream print and television and local bloggers. Figure H-6 shows that of the total amount of news media coverage from all locations, the majority of coverage came from mainstream news reporting outlets (47 percent) and blogs (45 percent).

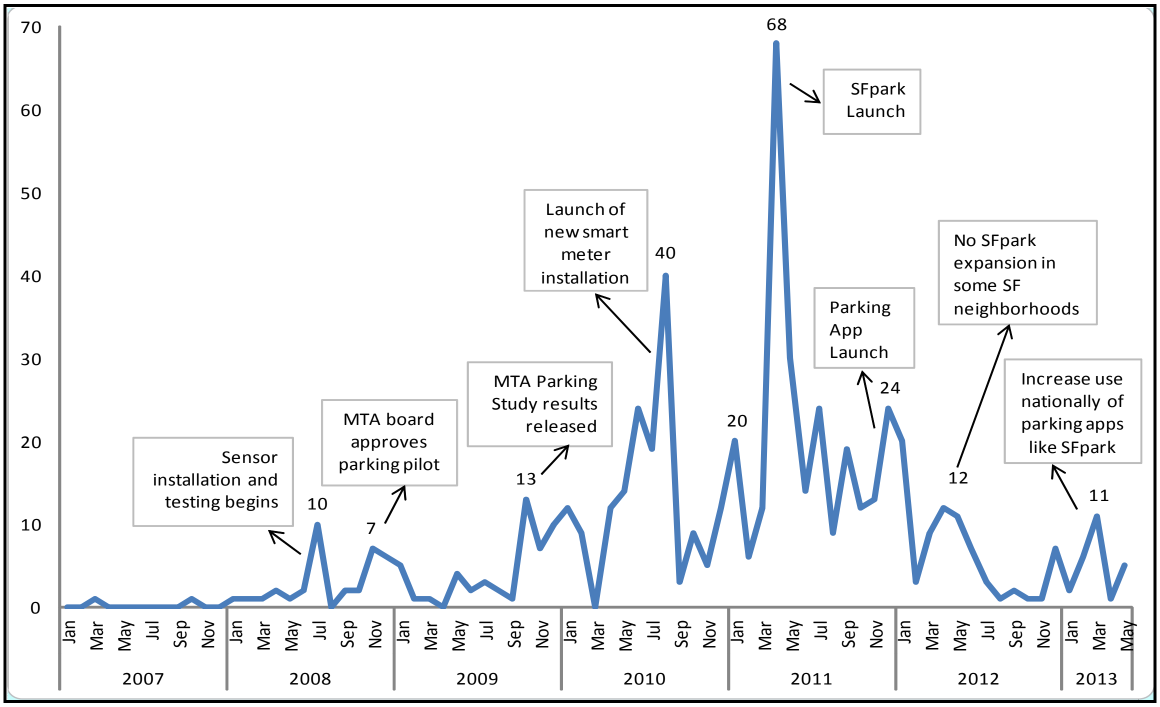


Source: University of Minnesota, 2013.

Figure H-6. Distribution of Total News Media Coverage by Media Type

[3] NVivo 10, a computer assisted qualitative data analysis software (CAQDAS), was used to conduct a descriptive coding analysis of all news media coverage and an in-depth content analysis of key themes of the news media coverage sample.

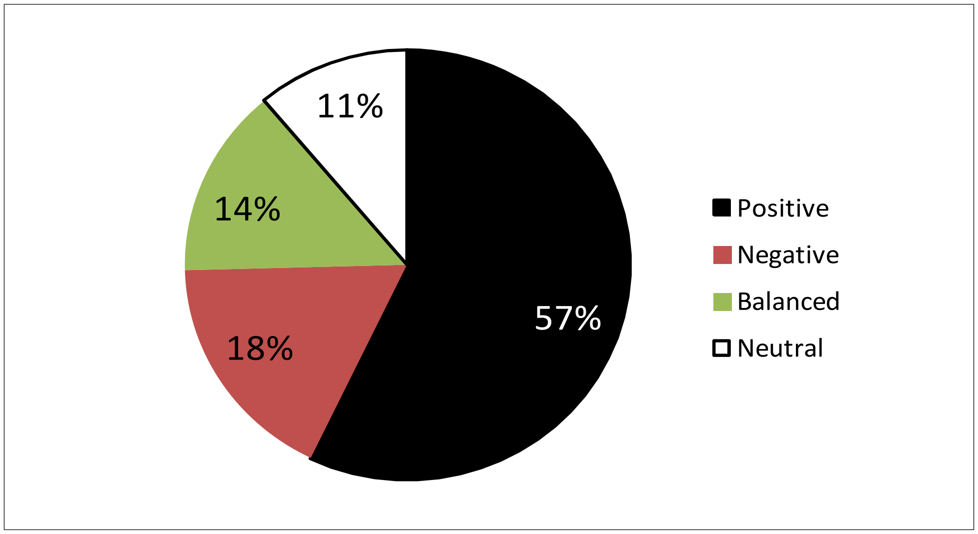
Figure H-7 shows the distribution of all media coverage by tracking the number of individual pieces of media content by month over the entire data collection period. The greatest peak in coverage came in spring 2011 when SF*park* launched. Figure H-7 tracks other key project events and other explanatory phenomenon in boxes above the peaks in media coverage.



Source: University of Minnesota, 2013.

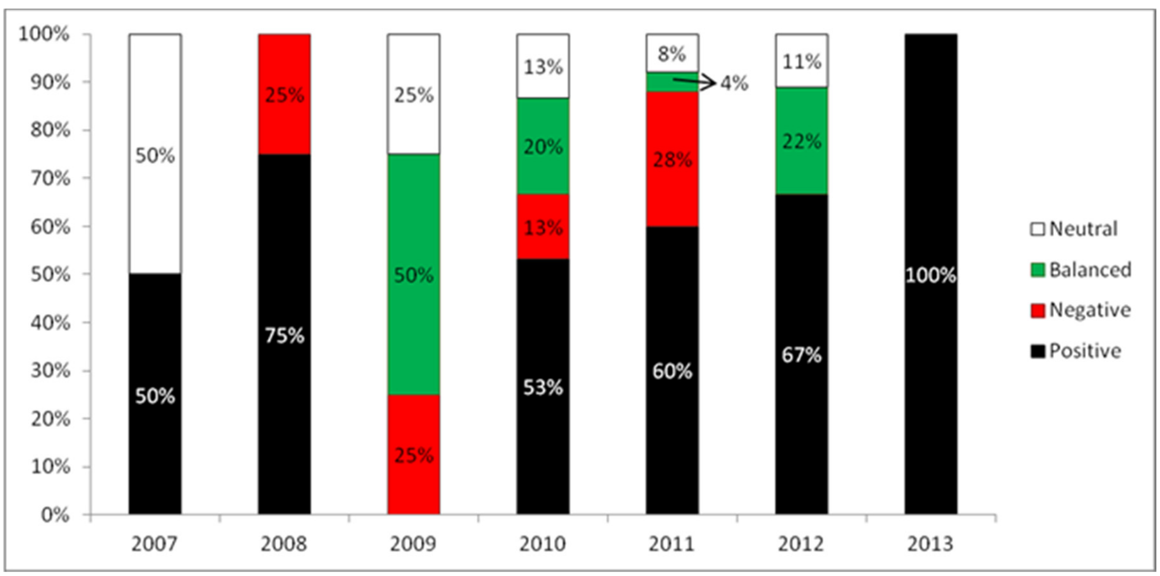
Figure H-7. Total Number Media Coverage by Month (2007-May 2013) and Key Events

Figure H-8 displays the distribution of the 10 percent sample of media coverage by attitudinal direction, with additional detail in Figure H-9 by year of coverage. Of the 63 pieces of media examined in the sample, 57 percent was positive, while 18 percent was negative, with 14 percent balanced, and 11 percent neutral.



Source: University of Minnesota, 2013.

Figure H-8. Percent Sample Media Coverage by Attitudinal Category



Source: University of Minnesota, 2013.

Figure H-9. Percent Sample Media Coverage by Attitudinal Category & Year

Figure H-8 and Figure H-9 show that media coverage over the data collection period is overwhelmingly positive (this includes the balanced and neutral coverage that supports the arguments made in the positive coverage), with negative coverage only accounting for 18 percent (or 11 out of 63 articles in the sample). As Figure H-9 shows, the proportions in attitudinal direction vary by year, but once SF*park* was fully operating, negative media coverage declined to zero in the sample. Prior to the launch of SF*park*, the content of the negative media coverage framed SF*park* either as a mechanism for the city to *earn more money* in order to balance its budget or that SF*park* would cause the city to *lose money*, thereby harming its budget. In both of these scenarios, the media framed SF*park* primarily in terms of its influence on the city budget. It should be noted, however, that the sample sizes by year were small and not large enough for the apparent trend in coverage to be statistically significant. Thus, it is not known to what extent the sample reflects the entire set of coverage, or if the media coverage became more positive over time.

Negative media coverage after the launch of SF*park* focused primarily on two topics: illegal use of cell phones while driving and controversies around SF*park* expansion. Coverage on the first topic of cell phone use portrayed an irony in SF*park*'s success on the need for drivers to illegally use their cell phones to access the SF*park* phone app in order to find a parking spot. Coverage on the second topic described the public outcry against SF*park* expanding to neighborhoods where there were previously no parking meters. The media described the public's outcry both in terms of having to pay for something that is currently free and in terms of feeling left out of any public outreach and engagement by SFMTA in making the decision to expand to their neighborhoods. Additionally, there was brief mention in the negative media coverage post-launch about the *high cost* of parking in reference to the highest amount drivers may have to pay during high-peak times. Interestingly, at the same time there was more positive media coverage on this same issue that focused instead on the *low cost* of parking during low-peak times.

Positive media coverage throughout the data collection period detailed the short and long-term benefits of SF*park*, including reducing congestion, convenience to users for finding and paying for parking, and improvements to transit with the hopes of changing travel mode from cars to transit. After the SF*park* launch, media coverage also highlighted the national and international attention SF*park* received for the project. Coverage in 2013 began to describe some early results of the pilot, including the decrease in parking citations as more people were paying for their parking (the media credits this change to the ease of payment and to the increase in parking time limits).

Additionally, a central theme to almost every article about SF*park* was its use of innovative technology and also the use of economic principles of supply and demand to create parking availability and reduce circling of vehicles by providing real-time information on the price and location of available parking. The language and topics of these articles largely reflected the marketing and messaging of SF*park* by the SFMTA. That is, it framed the project as the answer to solving the "parking problem" in San Francisco. There is no debate in the media over the fact that parking is difficult in San Francisco and the rhetoric in the media coverage extolled the virtues of SF*park* as the way to "remove the misery from parking in San Francisco." This rhetoric not only framed SF*park* as the solution, but held up the project as a technological innovation using phrases like: *groundbreaking*, *pioneering*, *revolutionizing*, *reimagining*, *magical*, *smart*, and *gold standard*.

Conclusion. Media coverage of the San Francisco UPA projects focused on the SF*park* pilot project totaling 596 individual pieces of media, with the highest peak in coverage occurring around the spring 2011 launch of variable pricing. The majority of the sampled media coverage over the evaluation data collection period (2007-May 2013) was positive, focusing on the potential benefits SF*park* could bring to improving convenience for drivers parking in San Francisco while delivering a nationally and internationally acclaimed technologically innovative pricing project. Negative media coverage in the sample was limited and focused primarily on the rising cost of parking and on the dangers of drivers using their cell phones to search for available parking.

H.5 Interviews and Workshops with Local Partners

This section provides an analysis of the interviews and workshops conducted with representatives of the local San Francisco UPA partners. The purpose of the interviews and workshops was to gain additional insights into the institutional arrangements, partnerships, outreach methods, and other activities contributing to planning, deploying, and operating the San Francisco UPA projects.

Two rounds of in-depth interviews were conducted by the national evaluation team. The first round of interviews occurred in fall 2010 prior to SF*park* deployment and the second round in summer 2012, approximately one year after the first price adjustments of SF*park*.

Interviewees were identified by the national evaluation team with input from the San Francisco UPA local partners. Once interviewing began, the national evaluation team asked interviewees for their recommendations of other stakeholders to interview. Table H-3 identifies the number of individuals from different agencies and organizations participating in the interviews and workshops. As Table H-3 shows, there was a greater concentration of interviewees from MTC in the first round of interviews, which reflects its role in planning and submitting the original UPA application. In the second round of interviews there was a greater concentration of interviewees from SFMTA, which reflects the shift in scope of the San Francisco UPA project to the parking pricing program, SF*park* (which is managed and implemented by SFMTA), and the desire of the national evaluation team to have a more in-depth understanding of how SFMTA implemented SF*park*.

Table H-3. Stakeholders Interviewed and Workshop Participants

Organization	Number of Participants			
	First Round Stakeholder Interviews	Second Round Stakeholder Interviews	First Round Stakeholder Workshop	Second Round Stakeholder Workshop
San Francisco Municipal Transportation Agency	2	7	1	8
San Francisco County Transportation Authority	2	2	2	0
Metropolitan Transportation Commission	5	3	2	0
San Francisco Department of the Environment	0	1	0	0
U.S. Department of Transportation	0	0	4	1
Total	**9**	**13**	**9**	**9**

Source: University of Minnesota, 2013.

Interviews were conducted one-on-one over the phone using questions developed by the national evaluation team with input from local partners and federal agency representatives. The questions were included in the *San Francisco UPA Surveys and Interviews Test Plan*.[4] Interviews lasted between 30 and 90 minutes. In most interviews, two members of the national evaluation team were present. One individual led the interview, asking the questions and jotting down notes. The second individual took notes using a laptop computer. All interviews were audio-recorded to produce a verbatim transcript. Interview transcripts were stored, organized, and analyzed using NVivo, a qualitative data analysis software. The software provides document coding and tracking capabilities based on key words and other characteristics.

After each round of interviews, the national evaluation team convened a workshop where all of the individuals interviewed were invited as well as other agency representatives. In addition, U.S. DOT personnel managing the San Francisco UPA national evaluation and other national evaluation team members were in attendance. Both workshops were held in San Francisco, the first in March 2011 and the second in September 2012.

[4] Zimmerman, Carol et al., June 28, 2011. San Francisco Urban Partnership Agreement, National Evaluation: Surveys and Interviews Test Plan. Publication Number FHWA-JPO-11-07.

The purpose of the workshop was to follow-up on the individual interviews by discussing the common themes that emerged and to draw lessons learned. To facilitate discussion during the workshop, the common themes from the interviews were summarized and presented. Workshop participants were encouraged to provide additional comments, including highlighting new points or clarifying or reinforcing the identified themes and topics presented by the national evaluation team. The following bullets describes key themes from the interviews and workshops:

- Unique UPA project and partnership context. During the planning and application phase of the San Francisco UPA project, SF*park* was only one element of a larger congestion reduction demonstration that included tolling Doyle Drive, the access point to downtown San Francisco from the Golden Gate Bridge. At the planning and application phase, the SFCTA and the MTC were the key local partners in bringing the project plan together. It was after San Francisco received UPA program funding that the Doyle Drive congestion pricing element became unworkable and was abandoned.

  Unlike New York City and Chicago (also UPA program funding recipients that ultimately had unworkable projects), San Francisco was able to keep a portion of its UPA funds to continue with the implementation of SF*park*. A new agreement was established in 2008 between the federal government and the San Francisco local partners putting the parking pricing program at the center of the San Francisco UPA, thus raising the role and position of the SFMTA as the central partner of the UPA while the SFCTA and MTC took back-seat positions within the partnership.

  During the first phase of data collection, interviewees spoke about the shift in project scope and agency responsibilities as a turning point in the agencies' ability to collaborate. From SFMTA's perspective, because Prop A gave them sole authority to set parking pricing in San Francisco, they also had the sole responsibility to plan, implement and deliver an innovative and highly technical project with no existing path or protocol to direct their work. However, from SFCTA and MTC's perspective, there was a desire to coordinate the efforts of SFMTA with their related efforts in order to ensure regional benefits and maximize the effectiveness of the project. This did not happen.

  In addition, SFCTA and MTC still retained pieces of the UPA project, albeit small in comparison to the scope of parking pricing. Therefore, their desire to coordinate came from a need to understand what was happening at SFMTA in order to inform their own project implementation. Because there was a lack of coordination at the local level and a disagreement among the three agencies over the value of coordination, the local agencies looked to U.S. DOT to serve in a coordinating role. Interviewees expressed concern that during the beginning of the project implementation period, U.S. DOT was absent from this role and each local agency was expected to communicate independently and directly to U.S. DOT. However, at the point of the workshop in March 2011, U.S. DOT had become aware of the desire among the local agencies for them to play a coordinating role and they began to serve in this capacity.

At the point of the second phase of data collection in 2012, more than one year since the launch of SF*park*, interviewees who had been frustrated in the past, were more accepting of what had occurred. Now that the project was launched and they ultimately got the information they needed, they felt that SF*park* was hugely successful despite past coordination hurdles. Questions still remained among some interviewees about whether a more collaborative project may have had a more positive impact on the region's congestion reduction efforts, but this reflection did not detract from the local partners' sense that SFMTA had successfully implemented SF*park*.

- An evolution in parking culture. As SFMTA approached the task of piloting demand-based parking pricing in San Francisco, it faced a public that held general distrust of the organization and its motives for changing parking policy. The fact that this pilot project was about parking meant that it touched on a very emotional and politically charged topic among San Franciscans. In addition, given the historically negative view that is held of SFMTA, people were skeptical of any price increase because it is seen as an attempt to balance city revenues on the backs of individuals. Therefore, SFMTA made it their job to communicate through outreach and marketing their project goals of creating a managed parking system as a way to improve the overall city's transportation system rather than as a budget balancing tool. They did this by addressing the question of revenues head on, showing that if the project works, then it would actually be revenue neutral because of a decrease in citations and the lower meter rates in low-demand areas. SFMTA also recognized that if parking behaviors were to change, then it was their job to appeal to the customers' interests in addition to the community-level benefits of reduced congestion, lower emissions and a more reliable transit service. To do this, SFMTA underwent its own evolution in thinking that public services should be delivered in a smart, easy, and convenient way while maintaining respect for the customer. This approach was infused throughout the SF*park* branding and communications efforts. At the time of the second phase of data collection, interviewees were contemplating whether SFMTA could bring this public service delivery approach to its transit service.
- An evolution in organizational culture. SF*park* was born out of the Finance and Information Technology division of SFMTA, but many of its functions are overseen by other divisions of SFMTA, most notably the Sustainable Streets division. This project structure required SFMTA to work in new ways within the agency and included creating project buy-in and acceptance much like the external outreach work the SF*park* team was implementing in San Francisco. There was also a lot of pressure on the agency overall to deliver a successful project, which put pressure internally on individual staff to operate and deliver on project elements in ways that were different from typical operations. Interviewees commented that building and managing good internal agency relationships helped mitigate any territorial feelings and negative perceptions that whole operations had to transform just to meet SF*park*'s project goals. This required communication and compromise among SFMTA staff as well as recognition from all parts of the agency that some changes to overall operations were a necessary part of making improvements that were good for the city.

- A deeply technical project. On the surface, SF*park* was seen primarily as a parking policy project that transformed how parking rates were set from elected policymakers to market demand. However, once the project began, it became evident to all involved that it was a deeply technical project. This viewpoint was captured by one interviewee's comment, "[We were] moving from a machine with springs to a high-tech IT device" as they reflected on the leap in technology of the new parking meters. Interviewees believed that SF*park* pushed parking pricing technology beyond where it would have been without the project. To do this required close management by SFMTA of the performance of technology vendors. It also emphasized to SFMTA the importance of building strong partnerships with vendors beyond the point of sale.
- An incubator for learning. As one interviewee put it, "…it's like having a kid. Yeah, it's rough in the beginning. Would you do it all over again? Sure. Would you do it differently? Not a whole lot differently, but it will be easier going forward because of lessons learned." Everyone interviewed had similar reflections that what they had gained would benefit both their own and their agency's work moving forward. Key lessons learned from interviewees across all partner agencies are found below.
    - ***Funding mechanism.*** There was a significant delay in SF*park* receiving its project funding, which put pressure on SFMTA to move as quickly as possible to implement in order to compensate for the delay. Interviewees commented that the delay was due to the fact that the federal UPA funds had to go through the state. In the future, the local partners would accommodate their project schedules to reflect a more realistic funding timeline. Additionally, a recommendation was made that if the federal government continues to fund local government innovations, then it should consider giving its money directly to the local agencies.
    - ***Account for your worst-case scenario.*** Many interviewees expressed that they should have built in a worst-case scenario timeline. Given the amount of new technology and new vendor relationships, SF*park* experienced considerable pressure to meet their project timeline while facing significant. While SFMTA learned it could significantly speed up its processes as an agency, the myriad technical challenges faced ultimately resulted in project delays causing interviewees to lament that these delays had not ever been considered a possibility at the beginning.
    - ***Build in time for collaboration and communication.*** To achieve an urban partnership, a project structure and plan should include time and resources for collaboration and communication across agencies. Clear definitions of roles and responsibilities should be established from the beginning.
    - ***Brand confusion.*** Piloting SF*park* while continuing with traditional parking operations led to confusion among internal and external audiences as to what was "SF*park*" versus just "SFMTA parking operations." Interviewees held varying degrees of comfort with the melding of these two things.
    - ***Outreach. Outreach. Outreach.*** Multiple interviewees stressed the importance of communicating openly and frequently about the project status and its purpose and goals. Interviewees from SFMTA expressed great pride in its outreach efforts, and recognized that they made a deliberate investment in it. Interviewees from other partner agencies spoke highly of SFMTA's outreach efforts and regretted their lack of resources to conduct similar outreach efforts.

Next Steps. At the time of the post-deployment data collection, SFMTA was looking toward expanding SF*park* to other parts of the city, with support from SFCTA and MTC because of its congestion-reducing potential. MTC, in particular, was starting to look to other cities within the region to begin to adopt similar strategies and technologies and also to enable the 511 traveler information system to provide real-time availability information to drivers in other parts of the region.

H.6 Summary of Non-Technical Success Factors

As highlighted in Table H-4, people, process, structures, the media, and competencies all played supporting roles in the implementation, deployment, and operation of the San Francisco UPA projects. For the most part, the San Francisco UPA projects did not require a strong multi-organizational structure and SFMTA did not promote collaboration among partners while developing SF*park*. But this was not a deterrent to the agency's ability to deliver an innovative, customer-centric parking pricing pilot in a city that is traditionally skeptical of the motives of local government. SFMTA deployed an ambitious communications and outreach plan, recognizing their responsibility in effectively communicating to the public a project that would significantly change the culture of parking in the city. The media often served in a complementary way to the messaging produced by SFMTA on the project's purpose and goals. In a mostly positive or balanced way (based on a small sample of the coverage), the media was able to describe the effects SF*park* would have on traffic congestion and it fueled excitement around the innovative technologies developed for the project. Interviewees expressed a desire to continue to develop a comprehensive congestion reduction plan for the city of San Francisco and for the Bay Area, citing the UPA as benefitting the region's ability to move forward with this goal.

Table H-4. Non-Technical Success Factors

Questions	Results	Evidence
What role did the following areas play in the success of the San Francisco UPA projects? 1. People 2. Processes 3. Structures 4. Media 5. Competencies	1. Effective 2. Problematic 3. Adequate 4. Effective 5. Effective	1. & 5. Agency staff held technical expertise and project management skills needed to successfully implement the projects. 1. & 5. Agency leadership influenced policy and process to keep projects on track. 2. Communication and information sharing among agency partners was minimal. Once SF*park* launched, it became easier for project partners to access needed information. 3. SFMTA did not promote a multi-agency organizational structure; however, this did not impede their ability to deliver a successful project. 4. Media kept the projects in the public eye, and their contribution to public opinion remained mostly positive before, during, and after project deployment, based on the sampled coverage.

Source: University of Minnesota, 2013.

Appendix I. Benefit Cost Analysis

The purpose of the benefit cost analysis (BCA) was to quantify and monetize the societal benefits and costs of implementing the San Francisco UPA projects. The difference between the total societal benefits and the total societal costs represents the net societal benefit of this public investment. As presented in Table I-1, the BCA focuses on quantifying the overall benefits, costs, and net benefits from the San Francisco UPA projects. The term cost benefit analysis (CBA) was originally used in the San Francisco UPA evaluation plan, but the use of BCA has become the commonly accepted term in the transportation community and is used in this appendix.

Table I-1. Question for the BCA

Question
What are the overall benefits, costs, and net benefits from the San Francisco UPA projects?

Source: Battelle, 2014.

The timeframe used for the BCA encompassed the planning, implementation, and ten years of post-deployment operation. This approach included all costs of the San Francisco UPA projects from their planning stages to 10-years post-implementation and all benefits of the projects for a 10-year period after implementation. Within this evaluation time frame, the BCA estimated and compared the total benefits and costs between two scenarios – with and without the implementation of the San Francisco UPA projects.

The remainder of this appendix includes four sections. The San Francisco UPA projects included in the BCA along with the data sources used in the BCA are presented in Section I.1. Cost information on the San Francisco UPA projects included in the BCA is presented in Section I.2. The estimation of the benefits from the projects is described in Section I.3. The appendix concludes with a summary of the analysis in Section I.4.

I.1 San Francisco UPA Projects and Data Sources

The San Francisco UPA projects included in the BCA were:

- **SF*park* Variable Pricing.** SF*park* is the name given to the parking pricing system implemented by SFMTA. The primary goal of SF*park* was to use intelligent parking management technology and techniques, in particular demand-responsive pricing, to manage the on-street and off-street parking supply and demand. The pilot areas for SF*park* consist of approximately 6,500 metered on-street parking spaces (about one-quarter of the city's total supply) and 12,250 parking spaces in fifteen city-operated garages and one surface lot. Control areas were equipped with traffic sensors for monitoring the use of the parking supply where variable pricing was not implemented. To assist travelers in making choices about parking pre-trip and en-route, SFMTA disseminated parking availability and pricing information on SFMTA's website and to applications on mobile devices.

- **511 Upgrades.** The 511 phone and website in the San Francisco Bay Area, operated by MTC, is one of the most advanced in the country. However, parking information on 511 was limited to static information about park and ride lots and rail stations (on the web) and airport parking (on the phone). The San Francisco UPA project upgrades provided parking space availability and pricing information for SFMTA parking facilities in San Francisco by 511 phone and web.

Data on the capital, operation, and maintenance costs of the projects listed above were obtained from the SFMTA and MTC. Real time parking data became available in April of 2011 and this BCA uses this date as the start of the 10-year timeframe for the estimation of benefits. Information on 10-year projections of benefits in travel-time savings and savings in vehicle operating costs savings were obtained from empirical measurement of travel time (see Appendix A – Congestion Analysis, Appendix B – Pricing Analysis and Appendix E – Environmental and Energy Analysis). Emissions reductions were obtained from analysis of parking turnover rates and field test data on parking search time and distance and were calculated as shown in Appendix E – Environmental and Energy Analysis.

I.2 San Francisco UPA Projects – Costs

Data on the capital costs, the implementation costs, the operating and maintenance costs, and the replacement and re-investment costs for the San Francisco UPA projects were obtained from SFMTA and MTC. To convert any future year costs to year 2011 dollars,[1] a real discount rate of 7 percent per year was used based on federal guidance.[2]

As outlined in the San Francisco UPA *National Evaluation Plan*,[3] a 10-year post-deployment timeframe was used for the BCA since many aspects of the projects were technology- or pricing-related, and such systems have relatively short life spans. Thus, only expenditures prior to April of 2021 incurred as a result of implementing the UPA projects were considered. In addition, only the marginal costs associated with the UPA projects were included in the cost data. The BCA timeframe began with the first expenses incurred and ends in April 2021, after 10 years of operations. None of the San Francisco UPA project components were considered to have salvage value in year 10.

The U.S. DOT provided funding to the local partners to plan, design, and construct the various projects – along with operating the new parking pricing system in the early years. Operating and maintaining the projects over the BCA timeframe of 10 years requires additional funding. Costs incurred in years after 2011 were adjusted to a common year using a discount rate of 7 percent per year. Cost estimates for future operations and maintenance for the 511 system and the parking pricing system were inflated by 2 percent per year. The following section, along with Table I-2, provides details regarding the cost estimate of the San Francisco UPA projects in 2011 dollars for the purpose of the BCA.

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[1] The real time pricing information went live in April of 2011. The BCA used this as the start date for the benefits analysis.

[2] Office of Management and Budget guidance (http://www.whitehouse.gov/omb/assets/a94/a094.pdf (page 9)) and current FHWA guidance (Federal Register, Vol. 75, No. 104, p. 30476)).

[3] San Francisco UPA National Evaluation Plan, FHWA-JPO-10-022, December 22, 2009. Available at http://www.upa.dot.gov/docs/fhwajpo10022/.

Table I-2. San Francisco UPA Project Planning, Design and Construction Costs

UPA Project Component	Planning, Design, and Construction/Purchase Costs (2011 dollars)
SF*park* – SFMTA	
Automated data feeds, storage and analysis	$12,547,000
Staffing and project management	$9,589,000
Parking meters	$7,177,000
Marketing and communications	$3,182,000
Parking sensors	$5,761,000
Manual data collection and analysis	$1,051,000
Parking garages	$784,000
Roadway sensors	$562,000
Sub-Total	**$40,653,000**
511 - MTC	
Parking information portion of the 511 system	$1,079,316
Sub-Total	**$1,079,316**
GRAND TOTAL	**$41,732,316**

Source: Texas A&M Transportation Institute.

The SFMTA stopped the data feed from its on-street parking sensors at the end of December, 2013. Data from the sensors had been used to determine price changes and to provide real-time information on parking availability and prices to travelers. The SFMTA continues to provide real-time parking rate information for on-street and garage parking and information on space availability in its garages, and they will periodically update parking prices based on estimated space utilization. To do this, the SFMTA is estimating parking space utilization based on current parking meter data combined with historical data on the difference between actual space use (as measured by parking sensor data) and parking meter data. This new system – known as Sensor Independent Rate Adjustment (SIRA) – has much lower costs than the sensor system. However, there are some costs associated with this method of parking pricing, such as periodically recalibrating the difference between actual space use and meter data. The SFMTA estimated the annual effort this new system will require and, thus, could estimate the annual cost of keeping the parking pricing system operational. This was $171,800 per year in 2014 dollars. This estimate was then inflated by 2 percent for the years 2015 to 2021 and then all of those annual costs were discounted by 7 percent to get a figure in 2011 dollars. The total operation and maintenance cost for this system for the next 7 years is estimated to be $954,612 in 2011 dollars

The MTC also projected the operation, maintenance, and replacement costs for the parking information on the 511 system, over and above the operation, maintenance, and replacement costs of the 511 system if the San Francisco UPA had not happened. The operation and maintenance costs were projected to be approximately $117,000 per year in year 2013 dollars.

The replacement costs were projected to be approximately $6,000 per year in year 2012 dollars. Both of these estimates were inflated by 2 percent for future years and then those future year estimates were discounted to the year 2011 using a 7 percent discount rate. The resulting MTC operation, maintenance, and replacement costs were $842,371.

Therefore, the resulting 10-year costs from the San Francisco UPA projects were $40,653,000 + $954,612 + $842,371 + $1,079,316 = $43,529,299.

I.3 San Francisco UPA Projects – Benefits

The benefits of the San Francisco UPA projects were similar to benefits from many transportation projects, and the calculation methodology followed standard practice as provided by the Transportation Research Board committee on transportation economics[4] and the Federal Highway Administration.[5] This section highlights how the benefits were calculated for the UPA projects.

The preferred option to estimate the impacts, and therefore benefits, of the UPA projects was to use the SFCTA's San Francisco Travel Demand Forecasting Model (SF CHAMP model). Unfortunately, the model is unable to accurately estimate the impacts of the San Francisco UPA projects. This is primarily the impact from changing parking pricing. Thus, the model could not be used to capture the change in travel time and vehicle operating costs caused by the UPA projects. Therefore, this analysis relies instead on empirical data collected in San Francisco by the project evaluation team and local partners. This includes changes in travel times and vehicle operating costs and emissions (Appendix A – Congestion Analysis, Appendix B – Pricing Analysis, and Appendix E – Environmental and Energy Analysis). It was not possible to estimate any change in crashes due to parking pricing. These data show the impact of parking pricing by comparing 2013 travel conditions with parking pricing versus 2011 data prior to parking pricing. These changes were assumed to remain the same over the 10-year life of the BCA.

I.3.1 Benefits – Travel Time Savings

For most transportation projects the largest societal benefits are a result of the travel time savings gained through reduced congestion. The amount of travel time savings from the project was measured in the field during the evaluation period for SF*park*. The data were developed from three sources. The first two were roadway sensors and transit travel times. These were used to estimate overall travel time and speed changes for all vehicles traveling in the pilot and control areas. Note that the roadway sensors had data collection problems as discussed in Appendix A. The third method was based on how long it took drivers to find a parking space and focused on travelers who were parking. These data are found in Appendix B – Pricing Analysis.

[4] http://bca.transportationeconomics.org/.

[5] Federal Highway Administration, TIGER BCA Resource Guide, http://www.dot.gov/sites/dot.dev/files/docs/USDOT%20BCA%20Guidance.pdf.

Based on the sensor and transit travel time data it was found that the changes in overall speeds for all vehicles were relatively small and generally within the margin of error of the sensors. This does not mean that parking pricing did not have an impact on travel time and speed. The amount of vehicle miles traveled (VMT) spent looking for parking is very a small percentage of total VMT (see Appendix E – Environmental and Energy Analysis). It is estimated that searching for parking in the pilot neighborhoods represents approximately 0.2 percent of total San Francisco VMT (see Appendix E). Therefore, the change in travel time for vehicles looking for parking may not have had enough impact on travel times overall to be measured using the sensors or transit travel time methods. Therefore, this BCA analysis focused on the reduced travel time spent looking for parking based on estimates from Appendix E. These changes were estimated for the time from 9 a.m. to 6 p.m. each day – the same times of day most city parking meters are operational.

As shown in Appendix E, Table E-8, the number of hours of reduced travel for finding parking was found to be 402.3 hours per weekday. Assuming 250 weekdays per year, 100,575 fewer hours of travel were estimated per year due to variable parking pricing. For the life of this project, it is assumed that variable parking pricing will only be on Saturday. The results from Appendix E represent Saturday only as well. Therefore, this analysis assumes no benefits from the UPA projects on Sunday. For Saturdays there was a savings of 439 hours per day or 22,807 hours per year assuming 52 Saturdays per year. Thus, there was a total travel time savings of 123,382 vehicle-hours per year. To convert this to person-hours required multiplying by the average number of persons per vehicle. This was 1.83 persons per vehicle in the SF*park* pilot areas based on the visitor/shopper survey. Thus, there were a total of 225,789 person hours saved annually. This is based on empirical data taken between 2011 (before parking pricing) and 2013 (after parking pricing was implemented). As no other data is available, this BCA analysis assumes that travelers will continue to save the same number of hours for all 10 years of the BCA. This is likely a conservative assumption as increased traffic and congestion in future years will likely mean efficient parking pricing will save additional travel time.

The 225,789 hours per year saved by travelers was converted to monetary benefits based on FHWA guidance and local values of time.[6] The FHWA determines values of time (VOT) for auto travelers based on 50 percent of the median hourly household income. Nationally, this equates to $12.50 per hour in 2009. This analysis uses locally adjusted values of time as supplied by the MTC.[7] The MTC also bases the value of time on median household wage rate. In 2011 the MTC used a value of time of $16.03/hour in year 2013 dollars. This 2013 value was adjusted for future (past) year values of time by increasing (decreasing) it by 1.6 percent per year as outlined in the FHWA value of time guidance document.[8] Next, the discount rate of 7 percent was applied to convert all values to year 2011 dollars. This resulted in a local value of time of $17.22 per hour in 2009, 38 percent higher than the $12.50 per hour national average, but not surprising given the high cost of living and high wage rates in San Francisco.

As shown in Table I-3, automobile drivers saved a total of 2,257,894 hours over 10 years with a benefit of $28,082,631 in 2011 dollars. It should be noted that the vast majority of vehicles saving travel time were automobiles and, thus, only the value of time for automobile travelers was used. This provides a conservative value of time saved as commercial vehicles have a higher value of

[6] Federal Highway Administration, http://www.dot.gov/sites/dot.gov/files/docs/USDOT%20VOT%20Guidance_0.pdf.

[7] Personal communications, July 2013.

[8] Federal Highway Administration, http://ostpxweb.dot.gov/policy/reports/vot_guidance_092811c.pdf.

time. Since analysis of Muni buses traversing the pilot areas exhibited no real before/after difference in transit travel times, travel time savings for transit riders was not calculated.

Table I-3. Travel Time Benefits of SF*park* Pricing

Year*	Median Household Wage Rate ($)	Auto VOT** ($)	Auto VOT** (2011 $)	Hours Saved	Benefit (2011 $)
2011		15.53	15.53	225,789	3,506,305
2012		15.78	14.75	225,789	3,329,351
2013	32.06	16.03	14.00	225,789	3,161,328
2014		16.29	13.29	225,789	3,001,784
2015		16.55	12.62	225,789	2,850,292
2016		16.81	11.99	225,789	2,706,446
2017		17.08	11.38	225,789	2,569,859
2018		17.35	10.81	225,789	2,440,165
2019		17.63	10.26	225,789	2,317,017
2020		17.91	9.74	225,789	2,200,083
TOTALS				**2,257,894**	**$28,082,631**

*For the sake of simplicity the same hours saved were applied to each year. This overstated the benefits in 2011 and 2012, as only a few price changes had occurred, but likely understated benefits near the end of the ten-year period.

**VOT = value of time (one hour)

Source: Texas A&M Transportation Institute, 2014.

I.3.2 Benefits – Emissions

The reduction in VMT and improved travel speeds, resulting from reduced searching for parking spots, will result in a reduction in harmful emissions. The reduced VMT and improved travel speeds are calculated in Appendix B – Pricing Analysis. The associated changes in emissions are calculated in Appendix E – Environmental and Energy Analysis. These changes were estimated from 9 a.m. to 6 p.m. each day – the same times of day most city parking meters are operational.

The reductions in emissions shown in Table I-4 were derived from estimates of changes in parking search times and speeds. These are the best estimates of emissions changes due to parking pricing and as such were used throughout the 10-year timeframe of the BCA. This is likely a conservative estimate as increased traffic and congestion in future years will likely mean efficient parking pricing will further reduce emissions. On the other hand, as vehicles become cleaner, emission would come down.

Table I-4. Volume of Reduced Emissions from SF*park* Pricing

Pollutant	Reduction in Emissions (pounds per weekday)	Reduction in Emissions (pounds per Saturday)	Reduction in Emissions (pounds per year)
VOC	2.5	2.3	733.56
NO_X	2.5	2.3	745.64
$PM_{2.5}$	31.7	29.4	9455.78
CO	0.4	0.3	104.14
CO_2	8,714	8,076.7	2598488.4

Source: Texas A&M Transportation Institute, 2014.

The current year value of the societal benefit from reduced pollution was derived from the U.S. Environmental Protection Agency estimates of the value of health- and welfare-related damages (incurred or avoided) and are recommended for use in current FHWA guidance.[9] The values were found in the report “Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks”[10] and are shown in Table I-5. Future year values were taken from the Highway Economic Requirements System documentation[11] and are also shown in Table I-5. Neither of the references used in Table I-5 provides a value per ton of CO, and, therefore, CO was not included in the calculation.

Table I-5. Values Per Ton of Reduced Emissions (in 2007 $)

Pollutant	Cost in 2009	Cost in 2015	Cost in 2020
CO	NA	NA	NA
VOC	$1,700 per ton	$1,200 per ton	$1,300 per ton
CO_2	$21 per metric ton	$24 per metric ton	$26 per metric ton
NO_X	$4,000 per ton	$4,900 per ton	$5,300 per ton
$PM_{2.5}$	$168,000 per ton	$270,000 per ton	$290,000 per ton

NA=not available

Source: Texas A&M Transportation Institute, 2014.

[9] Federal Register, Vol. 75, No. 104, p. 30479.

[10] Office of Regulatory Analysis and Evaluation, National Center for Statistics and Analysis, National Highway Transportation Safety Administration, March 2009 (http://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/CAFE_Final_Rule_MY2011_FRIA.pdf, Table VIII-5, page VIII-60).

[11] Highway Economic Requirements System, Federal Highway Administration http://www.fhwa.dot.gov/infrastructure/asstmgmt/hersdoc.cfm.

The values in Table I-5 were interpolated (assuming a linear change in values per year) to obtain the monetary benefit of the four pollutants in each year from 2011 to 2020. Multiplying these values by the amount of pollution reduced (Table I-4), then adjusting the 2007 dollars to 2011 dollars using a discount rate of 7 percent, resulted in a total benefit of $6,314 from VOC, $23,799 from NO_x, $176,776 from $PM_{2.5}$ and $372,275 from CO_2. Combining the values of these individual emissions benefits resulted in a total environmental benefit of $579,164.

I.3.3 Benefits – Fuel and Operating Costs

A reduction in travel to find a parking space had the potential to change the vehicle operating cost of light duty vehicles and trucks. These reduced operating costs were comprised of items such as maintenance, reduced wear and tear on a vehicle, reduced fuel use, and other factors due to reduced travel in search of a parking space. The reduction in fuel use is often the largest change from a monetary perspective. For this analysis, the change in fuel use, maintenance, tires, and depreciation were the vehicle operating costs included. The analysis also assumed only light duty vehicle benefits since the vast majority of travelers benefitting from lower parking search times were light duty vehicles.

The change in fuel use for light duty vehicles was calculated based on the reduced travel distance and time spent searching for parking spaces (see Table I-6 and Appendix E – Environmental and Energy Analysis). Similar to emissions and travel time savings, these values were derived from data from 2011, shortly before parking pricing began, and from 2013, with parking pricing well established. It was estimated that 153 gallons of gas was saved per weekday and 142 gallons per Saturday for a total of 45,666 gallons per year. These are the best estimates of fuel use changes due to parking pricing and as such were used throughout the 10 year timeframe of the BCA. This is likely a conservative estimate as increased traffic and congestion in future years will likely mean efficient parking pricing will further reduced fuel use, although vehicles are also likely to become more efficient.

The cost of fuel (minus taxes) for 2011 to 2013 was obtained from the U.S. Energy Information Administration and was for all grades of gasoline for an entire year for the San Francisco area.[12] Taxes of 18.4 cents (federal) and 52.9 cents (state and local taxes) on gasoline were then removed from the final amount shown in Table I-6. The estimated cost of fuel for future years was obtained from the Annual Energy Outlook produced by the U.S. Energy Information Administration.[13] The values from the U.S. Energy Information Administration included all taxes. Therefore, a country-wide average of 18.4 cents per gallon federal and 31.5 cents per gallon state taxes were subtracted from the values in this report.[14] The total benefits from reduced fuel used were $1,551,531 (2011 dollars).

[12] U.S. Energy Information Administration, http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_y05sf_a.htm.

[13] U.S. Energy Information Administration, Annual Energy Outlook 2014, http://www.eia.gov/forecasts/aeo/pdf/0383(2014).pdf, Table A12.

[14] http://www.api.org/oil-and-natural-gas-overview/industry-economics/fuel-taxes/gasoline-tax.

Table I-6. Gasoline Savings from SF*park* Pricing

Year	Actual Gasoline Price Excluding Taxes	Actual Gasoline Price Excluding Taxes Adjusted to 2011 $/gallon	Gas Saved (Gallons)	Benefits (2011 $)
2011	3.167	3.167	45,666	144,624
2012	3.375	3.154	45,666	144,040
2013	3.235	2.826	45,666	129,032
Year	**Forecast Gasoline Price Excluding Taxes in 2007 $/gallon**	**Forecast Gasoline Price Excluding Taxes Adjusted to 2011 $/gallon**		
2014	3.02	3.23	45,666	147,369
2015	2.94	3.15	45,666	143,827
2016	2.87	3.07	45,666	140,284
2017	2.80	2.99	45,666	136,742
2018	2.73	2.92	45,666	133,199
2019	2.65	2.84	45,666	129,657
2020	2.58	2.76	45,666	126,114
		TOTALS	456,659	**1,374,888**

Source: Texas A&M Transportation Institute, 2014.

Vehicle operating costs were based on the American Automobile Association (AAA) values that are published annually.[15] These benefits from the parking pricing project included reduced maintenance of 4.97 cents per mile, reduced costs of tires at 1 cent per mile, and reduced depreciation of 23.81 cents per mile. These were based on the average vehicle as calculated by AAA. The costs did not include ownership costs, as it was assumed that those costs remained. The only change was reduced travel when looking for a parking space. Thus, drivers were expected to save an average of 29.78 cents for each mile no longer driven. In Appendix E it was calculated that drivers would reduce their miles traveled by 3,308 for each weekday and 3,066 for each Saturday. Assuming 250 weekdays and 52 Saturdays per year, drivers were expected to travel just under one million fewer miles per year. Multiplying the number of fewer miles traveled by the average cost per mile then provides the amount of savings from reduced travel searching for parking spots. Converting this to year 2011 dollars, the savings from 10-years amounts to $2,207,423.

[15] https://exchange.aaa.com/wp-content/uploads/2013/04/Your-Driving-Costs-2013.pdf, page 7.

I.4 Summary of BCA

The benefits of the San Francisco UPA projects are summarized below:

- Travel time savings: $28,082,631
- Reduced emissions: $579,164
- Reduced fuel use: $1,374,888
- Reduced operating costs: $2,207,423
- TOTAL: $ 32,244,107

The cost of the UPA projects, in 2011 dollars, was $43,529,299.

This BCA examined the net societal costs and benefits of the San Francisco UPA projects. As presented in Table I-7, the benefit-to-cost ratio for the San Francisco UPA projects was 0.74 and the net societal benefit was -$11,285,192.

The analysis had several limitations and required numerous assumptions. For example, data on possible reduction in fuel used by buses were not available. Potential reductions (or increases) in crashes were not measured. An important goal of SF*park* was to enhance bicycle and pedestrian safety, and, if that did occur, it would have added significant project benefits. However, the evaluation period was considered too brief for national evaluation to include safety benefits, which typically take several years of data for a trend to be reliably measured.

All of the benefit estimates were based on 2011 and 2013 empirical data. Future years will likely yield larger benefits than what was measured in 2013 versus 2011. This is particularly true if the program is expanded to additional areas of the city using the SIRA method to price parking. This will keep costs low while benefits from parking pricing should increase in a similar manner to what was found in this analysis. In addition, the use of parking sensors in a large scale deployment such as this was experimental and the first of its kind, resulting in higher costs than what future implementations should experience. Moreover, the extensive data collection and storage for the evaluation added to the cost of the project. The future year costs and benefits represented the best estimates available, but they are only estimates, and the actual costs and benefits could vary substantially.

It is worth emphasizing that the level of measured benefits are unique to SF*park* and are affected by policy decisions and laws that reduce its effectiveness. The two biggest policies reducing its effectiveness are shutting off meters after 6 p.m., prior to dinner, when some neighborhoods experience their greatest parking shortfalls, and providing free parking all day on Sundays. In addition, California's state law prohibits charging parking patrons with disabled placards, which SF*park* staff has said that they are trying to change. SFMTA's own June 2014 evaluation showed much better performance in achieving desired occupancy levels (and the related benefits that they yield) on blocks with high payment rates than lower payment rates, with the degree of disabled placard usage on particular blocks being a key determinant of payment rates.

Table I-7. Question for the BCA

Hypotheses/Questions	Result	Evidence	
What are the overall benefits, costs, and net benefits from the Atlanta CRD projects?	Negative societal benefits	Benefits:	$32,244,107
		Costs:	$43,529,299
		Net Benefits:	-$11,285,192
		Benefit-to-cost ratio:	0.74

Source: Texas A&M Transportation Institute, 2014.

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Appendix J. Exogenous Factors

The effectiveness of the San Francisco Urban Partnership Agreement (UPA) strategies may have been influenced by factors external to the projects themselves, although the use of control areas, which would be subject to many of the same influences, helps to remove some of the effects. To account for these factors and provide context, the national evaluation team monitored exogenous factors throughout the pre- and post-deployment periods. The baseline data collection period began on September 1, 2010 and went through August 31, 2011. The post-deployment period timeframe began on September 1, 2011 and lasted through May 31, 2013. Information on gasoline prices, unemployment rates, system impacts and local changes, and construction events affecting the UPA project implementation area were examined. Information in this appendix, regarding external influencing factors, provided a resource for use in the other analysis areas.

This appendix is divided into four sections. Gasoline prices, which have fluctuated over the course of deploying the UPA projects, are discussed in Section J.1. Unemployment rates in San Francisco County, the state of California and the United States are described in Section J.2. SF*park* system changes, local events, and weather events are described in Section J.3. Lastly, construction events are included in Section J.4.

J.1 Gasoline Prices

Gasoline prices were monitored by the national evaluation team as changes in price could have influenced the demand for travel, which in turn would have influenced vehicles miles of travel (VMT) and total trips. Increases in gasoline prices may have also influence commuters who typically drove alone to take transit or to telecommute.

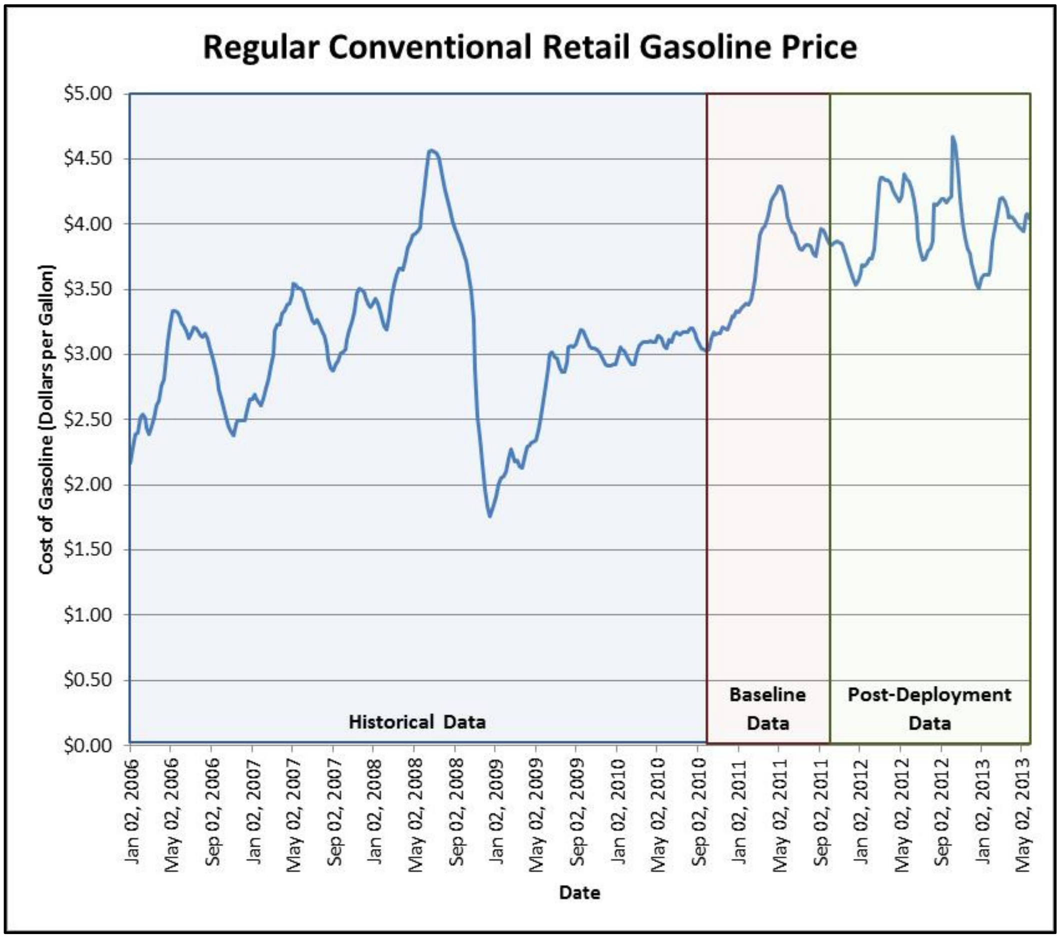
The U.S. Energy Information Administration monitors gasoline prices for selected regions, states and cities, including San Francisco County[1]. Data on weekly regular retail gasoline prices (from the U.S. Energy Information Administration) were provided to the national evaluation team by the San Francisco Municipal Transportation Department (SFMTA). Table J-1 presents the monthly average regular conventional retail gasoline prices in San Francisco County from September 2010 through May 2013. This time period captured the one year pre-deployment period prior to the start of the first of the UPA-funded projects (mid-2010 through mid-2011); and the post-deployment period (mid-2011 through mid-2013). Figure J-1 presents the weekly average price of a gallon of regular conventional retail gasoline in San Francisco County from January 2006 through 2013, which includes historical context.

[1] For more information see: http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMM_EPMR_PTE_Y05SF_DPG&f=Whttp://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMM_EPMR_PTE_Y05SF_DPG&f=W

Table J-1. Monthly Average San Francisco County Regular Conventional Retail Gasoline Price

Period	Year	Month	Gasoline Prices ($ per Gallon)
Pre-Deployment Period	2010	September	$3.05
		October	$3.12
		November	$3.18
		December	$3.29
	2011	January	$3.36
		February	$3.55
		March	$3.98
		April	$4.18
		May	$4.20
		June	$3.93
		July	$3.82
		August	$3.81
Post-Deployment Period		September	$3.94
		October	$3.85
		November	$3.78
		December	$3.58
	2012	January	$3.68
		February	$3.98
		March	$4.35
		April	$4.23
		May	$4.32
		June	$4.10
		July	$3.77
		August	$4.08
		September	$4.19
		October	$4.43
		November	$3.87
		December	$3.59
	2013	January	$3.62
		February	$4.03
		March	$4.14
		April	$4.01
		May	$4.03

Source: U.S. Energy Information Administration Website, 2013.



Source: U.S. Energy Information Administration Website, 2013.

Figure J-1. San Francisco Historical Weekly Regular Retail Gasoline Prices – January 2006 to May 2013

Throughout the evaluation period the price of gasoline fluctuated with prices reaching a low of $3.03 per gallon in September 2010 during the pre-deployment phase and hitting a high of $4.68 per gallon in October 2012 during the post-deployment phase as shown in Figure J-1. During the pre-deployment period gas prices generally increased from $3.03 per gallon in September 2010 to a peak of $4.29 in May 2011 and ended the period at $3.87 per gallon in August 2011. During the post-deployment period gas prices were more volatile, ranging from $3.51 per gallon in December 2012 to $4.68 per gallon in October 2012. There were several peaks and valleys throughout the post-deployment period. There was a trough in gas prices in mid-December 2011 at $3.54 per gallon. Prices then increased to $4.39 by mid-May 2012 but fell again by December 2012 hitting $3.51 per gallon. By May 2013 prices again rose, hitting $4.08 by the middle of the month.

J.2 Unemployment Rates

Unemployment rates[2] were monitored throughout the pre- and post-deployment periods as the change in the number of people traveling to and from work influences traffic levels and transit ridership and also discretionary cash to pay for parking. Information on unemployment rates was used in various analyses to examine the potential effects of the economic downturn on the UPA projects.

The State of California Employee Development Department's Labor Force Data Search Tool tracks historic unemployment data at various levels including statewide and at the county level. The information was available through the State of California Employee Development Department website[3] and provided to the national evaluation team by SFMTA. For the San Francisco UPA National Evaluation, the not-seasonally-adjusted unemployment statistics for San Francisco County and the state of California were examined from January 2006 through May 2013. In addition, data from the United State Labor Department, Bureau of Labor Statistics were gathered on not-seasonally-adjusted national unemployment rates during this same period[4].

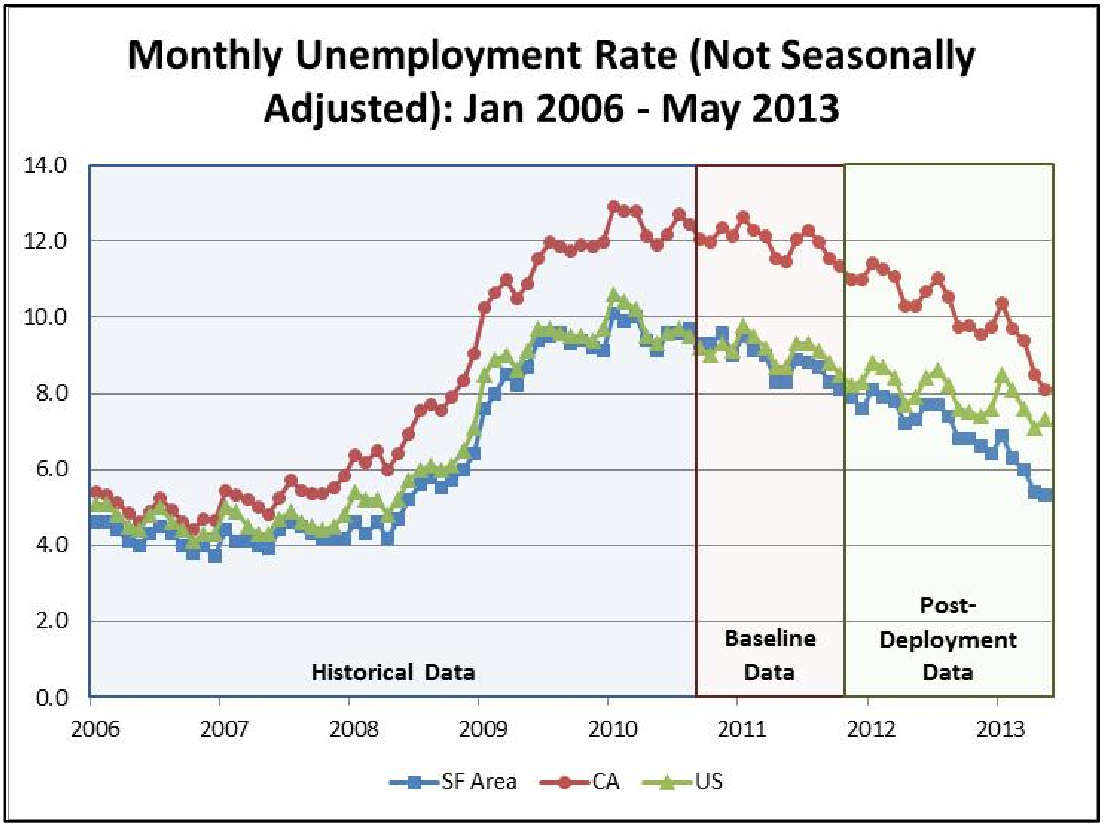
Figure J-2 presents the monthly not-seasonally-adjusted unemployment rates for San Francisco County, the state of California, and the United States. Table J-2 presents the monthly average not-seasonally-adjusted unemployment rate for a time period that captures the one year pre-deployment period prior to the start of the first of the UPA-funded projects (mid-2010 through mid-2011) and the post-deployment period (mid-2011 through mid-2013).

As shown in Table J-2, the San Francisco County not-seasonally-adjusted unemployment rate steadily decreased throughout the pre- and post-deployment periods, falling from the high of 9.6 in November 2010 to a low of 5.3 in May 2013 for these periods. The San Francisco County not-seasonally-adjusted unemployment rate was 8.3 in September 2011 at the beginning of the post-deployment period. As shown in Figure J-2 the United States and California not-seasonally-adjusted unemployment rates generally follow similar trends, reflecting the nationwide recession in 2008 and 2009 and the gradual recovery thereafter.

[2] Unemployment defined as all individuals not working but able, available, and actively looking for work

[3] For more information, see: http://www.labormarketinfo.edd.ca.gov/cgi/dataanalysis/areaselection.asp?tablename=labforce

[4] For more information, see: http://data.bls.gov/timeseries/LNU04000000.



Source: U.S. Department of Labor's Bureau of Labor and Statistics Website, State of California Employee Development Department Website, 2013.

Figure J-2. Monthly Unemployment Rates, Not-Seasonally-Adjusted

Table J-2. San Francisco, California State, and the National Monthly Average Unemployment Rate, Not-Seasonally-Adjusted

Period	Year	Month	Unemployment Rate		
			SF Area	CA	US
Pre-Deployment Period	2010	September	9.3	12.0	9.2
		October	9.3	12.0	9.0
		November	9.6	12.4	9.3
		December	9.0	12.1	9.1
	2011	January	9.5	12.6	9.8
		February	9.1	12.3	9.5
		March	9.0	12.1	9.2
		April	8.3	11.5	8.7
		May	8.3	11.5	8.7
		June	8.9	12.0	9.3
		July	8.8	12.3	9.3
		August	8.7	12.0	9.1
Post-Deployment Period		September	8.3	11.6	8.8
		October	8.1	11.3	8.5
		Nov	7.9	11.0	8.2
		Dec	7.6	11.0	8.3
	2012	Jan	8.1	11.4	8.8
		Feb	7.9	11.3	8.7
		Mar	7.8	11.1	8.4
		Apr	7.2	10.3	7.7
		May	7.3	10.3	7.9
		Jun	7.7	10.7	8.4
		Jul	7.7	11.0	8.6
		Aug	7.4	10.5	8.2
		Sep	6.8	9.8	7.6
		Oct	6.8	9.8	7.5
		Nov	6.6	9.6	7.4
		Dec	6.4	9.8	7.6
	2013	Jan	6.9	10.4	8.5
		Feb	6.3	9.7	8.1
		Mar	6.0	9.4	7.6
		Apr	5.4	8.5	7.1
		May	5.3	8.1	7.3

Source: U.S. Department of Labor's Bureau of Labor and Statistics Website, State of California Employee Development Department Website, 2013.

J.3 SF*park* System Changes, Local Events, and Weather Events

In addition to fuel prices and unemployment, other exogenous factors may have impacted the SF*park* pilot project area during the duration of the UPA project. SFMTA manually and qualitatively logged major events including changes to the SF*park* system, local events and weather events. The inventory of events was primarily derived from weekly SFMTA traffic advisory emails. In addition, daily weather data (temperature range and precipitation) across San Francisco during the pre- and post-deployment periods were gathered by SFMTA using the National Oceanic and Atmospheric Administration's National Climate Data Center.[5]

Table J-3 includes a listing of UPA-related potential system impacts throughout the post-deployment period. System impacts included the launch of Sunday metering, extended transit hours, and special events pricing.

Table J-3. SF*park* System Changes Potentially Impacting the SF*park* Pilot Area during the Pre- and Post-Deployment Periods

Time Period	Event	Description
Post-deployment only; Began January 6, 2013	Sunday metering launched	Sunday metering begins
Post-deployment only; Began March 4, 2013	Extended transit hours launched	Mission Bay/SoMa extended hours goes into effect
Post-deployment only; Began March 17, 2013	Special events pricing launched	Mission Bay/SoMa special event pricing begins

Source: SFMTA, 2013.

A number of local events were recorded for the region during the pre- and post-deployment periods for consideration as exogenous factors that might impact the SF*park* pilot project area. This included Major League Baseball San Francisco Giants games resulting in high-demand for parking; street fairs, festivals, and parades (e.g., World Series Parade and street party) resulting in street closures; major concerts, large conferences, and large events (e.g., Pride Weekend, Oracle Open World Conference) leading to a high-demand for parking; and races/marathons (e.g., Nike Marathon, San Francisco Marathon) resulting in street closures. Other events included holidays (e.g., Christmas) which created transit service disruptions and large parties (e.g., 4th of July, New Year's) which led to high-demand parking. The "Sunday Streets" program resulted in regular street closure disruptions across different areas of the city. Other events included BART protests which resulted in transit service disruptions and Bike to Work Day considered a major transportation event which impacted mode usage. Other transportation network events were service disruptions due to the Transbay Tube fire and delays due to third rail repair on the Transbay Tube. There were also data collection losses due to IPS meter data feed outages and parking sensor outages.

[5] For more information see: http://www.ncdc.noaa.gov/.

Finally, according to SFMTA, the annual average precipitation level for San Francisco is just under 14 inches. All instances of mild to severe precipitation that occurred during the evaluation period from September 2010 through May 2013 were recorded for consideration during analysis, if needed.

Local events and weather events were collected for the national evaluation in case anomalies appeared in the data that might merit further investigation. However, because of the macroscopic nature of the analyses and large datasets utilized, the collected local events and weather events were not used for the national evaluation. It is unlikely that the high-level conclusions drawn by this analysis would be altered by consideration of local events or weather events.

J.4 Construction Events

Six major construction events were recorded during the UPA evaluation period and included in Table J-4. The first three construction events included Bay Bridge closures for 2-3 consecutive days (two during the pre-deployment period between February and May 2011 and one during the post-deployment period, mid-February 2012). The fourth event, which occurred at the end of April 2012, was the Doyle Drive closure lasting three consecutive days. The fifth event was a major building construction project in the Mission pilot area that caused re-routing of buses and discontinuation of about a third of the blocks that were part of the pricing pilot. Lastly, the sixth event which occurred on January 1, 2013 was described as central subway construction which potentially impacted transit commuters. Of these events only the major Mission area construction project was thought to have an impact on a pilot area and not on any control areas and, as discussed in the main report, is the likely reason that parking pricing in the Mission did not yield a statistically significant change in occupancy.

Table J-4. Construction Events Potentially Impacting the SF*park* Pilot Area during the Pre- and Post-Deployment Periods

Time Period	Event	Description	Impact
Pre-deployment only; February 18 - 20, 2011	Construction	Bay Bridge Closures	Construction
Pre-deployment only; May 28 - 29, 2011	Construction	Bay Bridge Closures	Construction
Post-deployment only; February 17 - 20, 2012	Construction	Bay Bridge Closures	Construction
Post-deployment only; April 27 - 30, 2012	Construction	Doyle Drive Closure	Construction
Post-deployment only; Most of 2012	Construction	Mission Area	Rerouting of Muni bus routes 14 and 49. Parking sensors on 9 of 28 blocks removed from service.
Post-deployment only; Began January 1, 2013	Construction	Central Subway Construction	Construction

Source: SFMTA, 2013 and 2014.

Appendix K. Compilation of Hypotheses/Questions for the San Francisco UPA National Evaluation

Evaluation Analysis	Hypothesis/ Question Number	Hypothesis/Question
Congestion	SFCong-1	The deployment of SF*park* and the 511 improvements will reduce traffic congestion on selected travel routes in the pilot areas
	SFCong-2	Travelers will perceive that congestion has been reduced
Pricing	SFPricing-1	Parking pricing will increase parking availability
	SFPricing-2	Parking pricing will lead to reduced search time and variability
	SFPricing-3	Parking pricing will reduce double parking
	SFPricing-4	Parking pricing will shorten the duration of the average on-street parking session
	SFPricing-5	Parking pricing will improve reliability and speed of public transit
	SFPricing-6	Parking pricing will cause a shift to other routes, modes, and other parking garages
Technology	SFTech-1	Implementing advanced parking technology will improve agency ability to manage parking
	SFTech-2	Improving the dissemination of parking information via 511 phone, websites, and text messaging, will reduce parking search times
Equity	SFEquity-1	What are the direct social effects (parking fees, travel times, adaptation costs) for various transportation system user groups?
	SFEquity-2	What is the spatial distribution of aggregate out-of-pocket and inconvenience costs, and travel-time and mobility benefits?
	SFEquity-3	Are there any differential impacts on certain socioeconomic groups?
	SFEquity-4	How does reinvestment of parking pricing revenues impact various transportation system users?

Evaluation Analysis	Hypothesis/ Question Number	Hypothesis/Question
Environmental	SFEnv-1	SF*park* will improve air quality by reducing parking search times and shifting trips from car to transit
	SFEnv-2	The public will perceive an improvement in air quality resulting from SF*park*
	SFEnv-3	SF*park* will reduce fuel consumption by reducing parking search times and shifting trips from car to transit
Goods Movement	SFGoods-1	Commercial vehicle operator (CVO) double parking will decrease in the SF*park* pilot areas
	SFGoods-2	CVO double parking fines will decrease in the SF*park* pilot areas
	SFGoods-3	Parking availability, including within loading and freight zones, will increase in the SF*park* pilot areas
	SFGoods-4	Travel times will decrease in the SF*park* pilot areas for CVOs and other vehicles
Business Impact	SFBusiness-1	Sales will increase in the SF*park* pilot areas
	SFBusiness-2	Overall travel to access retail and similar businesses will increase in the SF*park* pilot areas
Non-Technical Success Factors	SFNonTech-1	What role did factors related to "people" play in the success of the deployment? People (sponsors, champions, policy entrepreneurs, neutral conveners)
	SFNonTech-2	What role did factors related to "process" play in the success of the deployment? Process (forums including stakeholder outreach, meetings, alignment of policy ideas with favorable politics, and agreement on nature of the problem)
	SFNonTech-3	What role did factors related to "structures" play in the success of the deployment? Structures (networks, connections and partnerships, concentration of power and decision-making authority, conflict-management mechanisms, communications strategies, supportive rules and procedures)
	SFNonTech-4	What role did factors related to "media" play in the success of the deployment? Media (media coverage, public education)
	SFNonTech-5	What role did factors related to "competencies" play in the success of the deployment? Competencies (cutting across the preceding areas: persuasion, getting grants, doing research, technical/technological competencies; ability to be policy entrepreneurs; knowing how to use markets)
	SFNonTech-6	Does the public support the UPA strategies as effective and appropriate ways to reduce congestion?
Benefit Cost	SFCBA-1	What is the net benefit (benefits minus costs) of the UPA strategies?

Source: Battelle, 2014.

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