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Executive Summary

Car-related crimes are a pervasive problem in the United States: each year an estimated 3.3 million people have their cars stolen or broken into. The cost of these crimes is significant: in 2008, the total value of stolen cars was roughly $6.4 billion, while another $1.6 billion was lost through thefts from cars.[1]

Commuter parking facilities, where owners leave their cars unattended for most of the day, have particularly high rates of car crime (Clarke 2002; Clarke and Mayhew 1998). Almost one-quarter (23.7 percent) of car thefts and nearly 12 percent of all thefts happen in parking lots and non-residential garages.[2] Despite the frequency and cost of car crime, strategies to prevent these crimes have not been well studied. This evaluation report examines the impact of digital cameras in reducing car crime in parking facilities serving riders of Washington, DC's commuter rail system.

Washington Metropolitan Area Transit Authority (WMATA) runs the second-largest rail transit system and sixth-largest bus network in the United States.[3] Between 1999 and 2003, before this study began, roughly half of all serious crimes on Metro property took place in parking facilities. Car crimes were roughly split between stolen cars and thefts from cars, but crime rates were not equal across Metro stations: just over one-third (36 percent) of the stations accounted for 80 percent of car crimes in 2003.[4] These data suggest that some stations make better targets than others—and finding out why could help prevent those crimes.

Urban Institute researchers, working with Metro Transit Police (MTP), set out to identify what parking facility characteristics and management practices might create opportunities for crime, analyze those findings in relation to past crimes, and identify promising crime reduction strategies. Noting the limited surveillance of Metro station parking facilities, researchers recommended WMATA use prominently placed cameras to deter offenders. To minimize costs,

[1] Federal Bureau of Investigation. 2010. *Crime in the United States.* Washington, D.C.: U.S. Department of Justice.
[2] Bureau of Justice Statistics. 2007. "Table 61: Selected Personal and Property Crimes, 2007: Percent Distribution of Incidents, By Type of Crime and Place of Occurrence." *Criminal Victimization in the United States.* Washington, D.C.: U.S. Department of Justice.
[3] Washington Metropolitan Area Transit Authority. 2010. "WMATA Facts." Washington, D.C.: Washington Area Transit Authority. http://www.wmata.com/about_metro/docs/metrofacts.pdf. (Accessed April 6, 2011.).
[4] Washington Metropolitan Area Metro Transit Police. 2004. "Metro Transit Police Department Five-Year Crime Report 1999-2003." Washington, D.C.: Washington Area Transit Authority Metro Transit Police. http://www.wmata.com/about/mtpd_crime_stats03.cfm. (Accessed December 1, 2004.)

MTP chose to invest in digital cameras, installing still cameras (not video cameras) at the exits of half of Metro's commuter parking lots, along with signs alerting drivers (and potential criminals) that license plate numbers and exit times were being recorded and monitored. Similar to "red light" traffic cameras, the digital cameras were equipped with motion detectors to take still photos of cars—including their license plates—as they exited the facility. In addition to deterring criminals, the cameras could provide Metro police with information to tailor their patrol schedules (such as the exact times of thefts) and aid in investigations. In reality, however, only a third of the cameras were live due to budget constraints; nevertheless, the dummy cameras were expected to convey the perception of surveillance. This strategy relied heavily on rational choice theory as embodied in situational crime prevention (SCP): by creating the perception of greater surveillance, law enforcement agencies hope to convince potential criminals that they are more likely to get caught and that they should consequently refrain from crime or take their criminal activities elsewhere (Clarke 1997).

Prior Research

Evaluations of efforts to reduce crime in parking facilities can provide guidance about the types of preventive strategies that may be successful. Several methods have been tested, including introduction of security or attendants (Barclay, Buckley, Brantingham, Brantingham, and Whin-Yates 1997; Clarke and Goldstein 2003; Laylock and Austin 1996; Hessling 1995; Poyner 1994), lighting improvements (Painter and Farrington 1997; Poyner 1997), and access control (Clarke and Goldstein 2003; Gleason and Wilson 1990). Most of these studies found reductions in crime using these approaches (Barclay et al. 1997; Laylock and Austin 1992; Painter and Farrington 1997; Poyner 1997; Tilly 1993).

Perhaps one of the more promising methods to prevent crimes in parking facilities is the use of video surveillance cameras. As with other forms of surveillance as means of crime control, the theory underlying video surveillance is that if potential offenders know they are being watched, they will perceive an increased risk of apprehension and will therefore refrain from criminal activity (Ratcliffe 2006; Welsh and Farrington 2002). This hypothesis, however, is highly contingent on potential offenders being aware of the surveillance camera(s). Overt camera systems accomplish this by placing cameras in public view and coupling them with signage and/or flashing lights advertising their presence (Ratcliffe 2006).

While prior evaluations of the impact of cameras on crime have yielded mixed results (Eck 2002; Gill and Spriggs 2005; Maccubbin and Staples 2001; Welsh and Farrington 2003; Welsh and Farrington 2004), their use specifically in parking facilities suggests that camera use helps reduce the occurrence of vehicle crimes (Eck 2002; Farrington, Gill, Waples, and Argomaniz 2007; Poyner 1997; Tilly 1993). However, prior research provides no guidance on the value of digital still cameras in deterring crime in parking facilities, which could prove useful in increasing perceptions of risk of apprehension even in the absence of their surveillance capabilities. The present research study employed the SCP framework that led to the identification and implementation of such a measure—strategic placement of digital cameras and accompanying signage—and conducted a randomized clinical trial to assess its effectiveness. The setting for this study, the WMATA commuter parking facilities, is described below.

Background on Metro Parking Facilities

WMATA runs the second largest rail transit system and sixth largest bus network in the US.[5] WMATA has parking facilities at 42 stations, which are served by over 100 parking attendants who collect parking fees. While WMATA is known for successfully keeping crime rates low on its rail system (La Vigne 1996), crime in Metro's parking facilities has historically posed a more serious public safety concern. Between 1999 and 2003, prior to the beginning of this study, approximately half of all crimes occurring on WMATA property took place in parking facilities; further, 69 percent of all of WMATA's Part I crimes occurred there, and 58 percent of Part I crimes in 2003 were automobile-related. The breakdown between thefts *of* and theft *from* cars was roughly even, with attempted or successful auto thefts accounting for 55 percent of all car crimes, and thefts from cars accounting for the remainder. The following section describes the data collection, analyses, and decisionmaking processes employed to identify the use of digital cameras as the crime prevention measure of choice in reducing these crimes, and outlines the methods used to randomly assign cameras and evaluate their effectiveness.

[5] Washington Metropolitan Area Transit Authority. 2010. "WMATA Facts." Washington, D.C.: Washington Area Transit Authority. http://www.wmata.com/about_metro/docs/metrofacts.pdf. (Accessed April 6, 2011.).

Data and Methodology

This project consisted of three main research components: (1) identification of the magnitude of car crime in commuter parking facilities and possible strategies for prevention of such car crime; (2) identification and implementation of a crime prevention strategy; and (3) evaluation of the strategy's effectiveness. In partnership with the MTP staff, the research team created a blocked randomized experimental design involving 50 matched pairs of commuter parking facilities in which a combination of live and dummy digital cameras was deployed, along with accompanying signage, at the exits of one randomly selected facility from each pairing. After a period of 12 months following camera implementation, the research team analyzed the impact of the cameras on crime occurring in and around Metro's parking facilities.

This research process involved the collection and analysis of crime data from MTP and jurisdictions in which WMATA operates, as well as the physical and environmental characteristics of Metro's parking facilities. Historical incident records for auto-related offenses occurring throughout the Metro system's long-term parking facilities were obtained from MTP's Crime Analysis Unit (CAU). Historical crime incident records were also collected from the seven jurisdictions in which Metro stations and parking facilities are located. Initially, all crime data were collected for calendar years 2004 and 2005 to inform the identification of the strategy to reduce car crime; these data were subsequently updated through August 2009 for the impact analysis. Administrative data on Metro operations related to their parking facilities were also obtained, including hours of operation and staffing, parking facility utilization, and MTP policing practices.

To provide context on the operations of Metro parking facilities, administrative data on Metro operations were collected from MTP and other offices within WMATA. These data include hours of parking facility operation and staffing, parking facility utilization, and policing practices. This information, in conjunction with the crime data and site observations, helped to inform the overall understanding of each parking facility's criminal opportunities.

The administrative and crime data referenced above was complemented by original data collected by the research team on the environmental characteristics and physical structures of the parking facilities. Drawing on prior research on crime prevention in parking facilities (Clarke and Goldstein 2003; Mayhew and Braun 2004; Smith 1996), researchers developed a data collection instrument to identify, through in-person observation, the environmental characteristics of each facility and the immediate area. Characteristics measured included: lighting, layout, natural surveillance (e.g., visibility due to adequate lighting and absence of overgrown landscaping), access control, usability, and the surrounding environment.

These data, along with conversations with MTP on the feasibility of various interventions, informed the choice of intervention (recordable digital cameras) and the random selection process employed to determine which facilities would receive the intervention. After a 12-month intervention period, the effectiveness of the intervention was examined through a variety of statistical tests including Difference-in-Differences (DiD) analysis.

Camera Installation

Once the car crime reduction strategy was identified to be digital cameras at the exits of exactly half of the parking facilities, the next steps were to determine which commuter parking facilities would be assigned to the treatment group versus the control group and then to develop a timetable for deployment of the cameras and signs in each location. Researchers assigned the "treatment"—cameras at exits of Metro facilities—using random assignment after first matching Metro stations in pairs based on surrounding area crime rate[6] (high, medium, low), lot/garage capacity, AM/PM payment policy, facility type (garage, lot, or combination facility), and Metro line (e.g., red, green, orange). MTP ultimately employed a modified intervention consisting of a combination of one live camera and two dummy cameras per facility as a means of reducing intervention costs.

Researchers conducted post-implementation site observations to each of the treatment parking facilities to confirm that cameras and signage were installed, taking photos of each camera and sign. Telephone conversations and e-mail communications with the MTP point of contact on camera installation further confirmed that the intervention at its most basic level—installation of cameras and signage at the selected treatment facilities—was implemented with fidelity. However, researchers were unable to document the degree to which cameras were used

[6] To assess the level of crime in the areas directly surrounding each metro station, the number of Part I crimes was calculated for each station for the period from January 2004 through December 2005. Rather than applying the traditional crime rate calculation using population as a divisor, we applied geographic area as an alternative to provide a concise measure of general crime levels of the area surrounding Metro stations and parking lots and to allow for comparison across all sites. Since we are interested in commuter parking lots, it would be misleading to use the surrounding population as a basis for calculating crime rates (e.g., by 1,000 inhabitants) as it is relatively safe to assume that car crime victims will not be residents of the surrounding area; therefore, the area population would not be an adequate representation of potential victimization. The crime rate was calculated by taking the total number of Part I crimes within a one-half-mile radius of each station divided by Pi × 0.5 $miles^2$.

by MTP and parking facility staff for crime control and investigative purposes. Shortly prior to camera deployment, MTP's Auto Theft Unit was disbanded due to budget cuts. Repeated outreach to MTP staff, including an in-person meeting with the newly appointed chief, yielded no concrete information on the degree to which the camera photos were used for investigative purposes and whether digital camera data were ever linked to license plate recognition software as originally planned. This suggests that the intervention was confined to the placement of cameras (some live, some dummy) and signage and did not involve any enhanced investigations or increase in suspects.

Impact Analysis

Once the cameras were in place for a period of 12 months, the intervention could be evaluated from a statistical standpoint to determine if there was significant change in crime. Given that treatment and control facilities were matched prior to camera installation, pre- and post-intervention comparisons could be completed to measure whether crime was affected as a result of the cameras rather than because of natural fluctuation in crime over time, the type of facility, or crime rates in the surrounding areas. The initial analysis entailed a comparison of pre- and post-implementation means pooled across all facilities, and then run separately for both treatment and control groups, using two-tailed, independent samples t-tests on reported crime data. Researchers then introduced the matched comparison facilities into the same equation by employing DiD analyses.

Overall, the analyses revealed that, after the cameras were added, car crimes specifically and crimes in general remained at pre-camera levels. Researchers also found no evidence of displacement or diffusion to areas surrounding the Metro stations. These findings are consistent with recent research suggesting that video surveillance cameras are more likely to have an impact when they are highly concentrated, actively monitored, and integrated into the broader law enforcement strategy (La Vigne, Lowry, Markman, and Dwyer 2011). The cameras in this study were not used by MTP to aid in investigations or inform patrol allocations. Also, the pictures they recorded could not be monitored from a central location—an option that might have allowed police to interrupt crimes in progress.

Cost-Effectiveness Analysis

Given the fact that there were no impacts on car-related crime identified in the treatment facilities, there were no net benefits of the cameras. However, it is useful to determine what degree of crime reduction would enable the camera system to "pay for itself." Considering potential societal savings (both justice system costs and costs of victimization) associated with motor vehicle theft, a camera system such as the one evaluated here would have to be associated with a reduction of just 12 auto thefts in order to be cost-effective (based on the FBI's 2009 estimate of the average cost per motor vehicle theft of $6,505). In other words, if two motor vehicle thefts were prevented per month across all commuter parking facilities, it would take six months before a savings would occur (12 × $6,505 = $78,060). This calculation does not include anticipated savings from the prevention of *attempted* auto thefts, which often result in vehicle damage, nor does it include expected reductions in thefts *from* cars and increased revenues from greater customer perceptions of safety, which are likely to increase parking facility usage.

Summary and Implications

This project set out to test the application of SCP to identify and evaluate an intervention designed to prevent car-related crimes in commuter parking facilities. The intervention implemented—installation of digital cameras and accompanying signage at the exits of treatment facilities—was selected based on a thorough assessment of the characteristics of Metro's parking facilities that created opportunities for crime. It is important to emphasize that these cameras were not actually surveillance cameras since these cameras only had the ability to capture images as cars exited facilities. Moreover, due to budget limitations, only one-third of the cameras were live, rendering the intervention of limited use for investigative purposes. Nonetheless, the theory that the cameras (whether live or dummy), together with signage, increased *perceptions* of formal surveillance was deemed worthy of testing. Applying a rigorous random assignment design, researchers aimed to isolate the impact of this intervention on car-related crime.

Both theory and prior research support this study's findings that the cameras had no discernable impact on crime. While prominently advertised through signage, the cameras were not integrated into law enforcement patrol or investigative activities. The absence of a closed-circuit component to the cameras precluded staff from viewing them from a central location to intervene on the scene during crimes in progress. Moreover, while a portion of the cameras had the ability to record and thus presented the possibility of aiding in investigations, camera footage had to be downloaded manually from each individual camera location and officers may have had difficulty determining which cameras were live versus dummy. This level of effort likely resulted in minimal use of camera footage.

Recent research on the use of public surveillance cameras in high-crime areas supports the lack of impact found in this evaluation, finding that cameras are most likely to have an impact when they are highly concentrated, actively monitored, and well integrated into law enforcement crime control and investigative activities (La Vigne et. al 2011). These are critical factors that both current and future investors in camera systems should consider when implementing or expanding camera systems. It is equally important for law enforcement agencies to understand that technology is only as good as the manner in which it is employed. If it is employed minimally or is not well integrated into other policing functions, it is unlikely to yield a significant impact on crime. On a positive note, camera systems such as those implemented by MTP need not have a large impact on crime in order to be cost-effective, suggesting that an enhanced version of this type of intervention—cameras with surveillance capabilities—merits consideration by those aiming to prevent car crimes in parking facilities.

Chapter 1. Introduction

Car crime, including both thefts *of* and *from* automobiles, is a national problem affecting an estimated 3.3 million victims each year[7] and accounting for 30 percent of all Part I crimes reported to the FBI in 2008.[8] The costs of car crime are significant: in 2008, the average loss in a motor vehicle theft was $6,751; the total cost of car theft was approximately $6.4 billion, while the total annual loss attributed to thefts from vehicles amounted to approximately $1.6 billion in that same year.[9]

As with most crimes, car crime is more likely to occur in some places than others. For example, prior research indicates that "Park-and-Ride" commuter lots have particularly high rates of car crime (Clarke 2002; Clarke and Mayhew 1998). This stands to reason, given that these types of lots tend to house many cars left unattended by owners for most of the day, affording ample targets and sufficient opportunities to commit crimes undetected. National statistics support these findings, with almost one-quarter (23.7 percent) of motor vehicle thefts and almost 12 percent of larcenies of all kinds occurring in parking facilities (surface lots or parking garages).[10]

Despite the prevalence and cost of car crime, this problem has not been extensively studied and few attempts have been made to evaluate measures aimed at preventing car crime, with most prevention efforts implemented in the absence of theory and the majority of evaluations lacking in rigor. This study aimed to fill that gap by employing the SCP framework to identify a strategy to reduce car crime in commuter parking facilities, implement that strategy, and evaluate its

[7] This statistic combines auto theft with other automobile-related thefts and may be an underestimate based on the fact that the number of victimizations is likely greater than the number of incidents because more than one person may be victimized during an incident.
[8] Federal Bureau of Investigation. 2010. *Crime in the United States.* Washington, D.C.: U.S. Department of Justice.
[9] Estimated by multiplying the average loss of thefts from motor vehicles ($724) by the number of thefts from motor vehicles (1,715,440) plus the average loss of thefts of motor vehicle accessories ($532) multiplied by the number of thefts of motor vehicle accessories (643,225). Data are from Federal Bureau of Investigation 2008 (note above).

[10] Bureau of Justice Statistics. 2007. "Table 61: Selected Personal and Property Crimes, 2007: Percent Distribution of Incidents, By Type of Crime and Place of Occurrence." *Criminal Victimization in the United States.* Washington, D.C.: U.S. Department of Justice.

effectiveness using the most rigorous design feasible. The study, conducted in partnership with MTP, focused on crimes occurring in WMATA commuter parking facilities. The study had the following specific goals:

1. to identify the environmental characteristics and management practices of WMATA's parking facilities and how they may be creating criminal opportunities;
2. to analyze those characteristics and practices in relation to the incidence, prevalence, and distribution of crimes in WMATA's parking facilities using historical crime data;
3. to work with MTP to identify and implement promising strategies to reduce car crime and prioritize those strategies with regard to their anticipated effectiveness;
4. to implement one selected strategy in half of WMATA's 50 commuter lots through a blocked randomized experimental design; and
5. to evaluate the effectiveness of the intervention through a difference-in-differences (DiD) analysis and a cost-benefit analysis.

As described in detail in subsequent chapters, the strategy that MTP chose was the installation of digital cameras—which were similar to red-light traffic cameras—at the exits of parking facilities along with prominent signs alerting parking facility users (and potential offenders) of the presence of cameras and their ability to capture the license plate numbers of their cars.

This report will first explain in more detail why certain prevention efforts are theorized to deter individuals from committing car crime. Research questions based on these theorized preventative effects are then presented, along with methods of data collection and analyses that were used to investigate them. Results of the WMATA car crime evaluation, including site observations and changes in car crime rates around Metro's parking facilities, are then discussed. Last, the implications of these findings for research and practice are presented.

Chapter 2. Theoretical Background and Prior Research

The vast majority of prior research on preventing car crime has been conducted in the United Kingdom employing SCP principles as the guiding framework. SCP is supported by rational choice and opportunity theories of crime that purport both that criminals engage in rational (if bounded) decisionmaking (Becker 1968; Cornish and Clarke 1986) and that environmental characteristics offer cues to the offender that promising opportunities for crime exist (Brantingham and Brantingham 1978, 1981; Cohen and Felson 1979; Harries 1980; Newman 1972; Wilson and Kelling 1982). The practical implications of these theories are that while criminals are motivated, they may nonetheless be deterred from committing crime if they perceive a potential target to (1) involve too much risk, (2) require too much effort, (3) yield too meager a profit, (4) induce too much guilt or shame to make the venture worthwhile, or (5) reduce provocations that create criminal opportunities (Clarke 1997; Clarke and Homel 1997; Cornish and Clarke 2003; Eck 2002). Capitalizing on these deterrents of crime by incorporating SCP measures is known as opportunity blocking because it involves increasing the potential costs of committing a crime and thus, in theory, reduces criminal temptation and the likelihood that an individual will commit a criminal act.

Parking facilities are ideal settings in which to apply SCP measures because they present unique offending opportunities. Mayhew and Braun (2004) identified situational risk factors of parking facilities based on prior research, finding that the presence of available targets, a lack of surveillance, proximity to highways for easy escape, and the presence of pedestrian throughways contribute to the risk of crime in parking facilities. Furthermore, parking facilities are difficult to secure because parked cars provide hiding spaces and impede distribution of light. In addition, parking facilities are typically open to the public, and an offender's car is not likely to be noted as unusual in a public facility (Smith 1996).

One of the central components in SCP is how the design of an environment facilitates surveillance of the activities that occur within it. This surveillance component, whether formal or informal, is likely the most effective environmental characteristic for reducing parking facility crime (Poyner 1997). Because of differences in natural surveillance inherent in the design of parking facilities, different layouts, such as multilevel parking garages and open surface parking lots, offer varying degrees of situational crime prevention. Open parking facilities (surface lots) generally offer more natural surveillance and surveillance provided by hired security staff and other legitimate users, and thus tend to have fewer crimes—both theft of and theft from cars—than multilevel parking garages (Poyner 1997). Despite the difficulty or ease of natural surveillance in any particular parking environment, almost any attempt to enhance a facility's crime prevention attributes will have the common theme of improved surveillance, either indirectly (through improving lighting or increasing the presence of legitimate users of the parking facility), directly (by introducing hired security guards or installing surveillance cameras), or by increasing the perceived threat of surveillance. While these modifications may help to deter crime, the effectiveness of each is worth further investigation.

Evaluations of efforts to reduce crime in parking facilities can provide guidance about the types of preventive strategies that may be successful. Several methods have been tested, including introduction of security or attendants (Barclay et al. 1997; Clarke and Goldstein 2003; Hessling 1995; Laylock and Austin 1996; Poyner 1994), lighting improvements (Painter and Farrington 1997; Poyner 1997), and access control (Clarke and Goldstein 2003; Gleason and Wilson 1990). Most of these studies found reductions in crime using these approaches (Barclay et al. 1997; Laylock and Austin 1992; Painter and Farrington 1997; Poyner 1997; Tilly 1993).

Perhaps one of the more promising of SCP strategies to prevent crimes in parking facilities is the use of video surveillance cameras. As with other forms of surveillance as means of crime control, the theory underlying video surveillance is that if potential offenders know they are being watched, they will refrain from criminal activity because they will perceive an increased risk of apprehension (Ratcliffe 2006; Welsh and Farrington 2002). This hypothesis, however, is highly contingent on potential offenders being aware of the surveillance camera(s). Overt camera systems accomplish this by placing cameras in public view and coupling them with signage and/or flashing lights advertising their presence (Ratcliffe 2006). In the environment of a parking facility, notice regarding the use of surveillance cameras may help deter crime, but further, outside of the facility, media and publicity campaigns can serve to communicate information more generally to potential offenders (Mazerolle, Hurley, and Chamlin 2002; Ratcliffe 2006). Moreover, while publicity regarding surveillance may make potential offenders aware that a camera system exists, they may not know the extent of the system's capacity. This imperfect knowledge about where the cameras are located and their capabilities may actually magnify their deterrent impact. As is evident with other crime prevention measures, such as "hot spot policing" (Weisburd, Wyckoff, Ready, Eck, Hinkle, and Gaiewski 2006), cameras may prevent crime in areas beyond the immediate area of intervention, a phenomenon known as diffusion of benefits (Clarke and Weisburd 1994; Gill 2006; Gill and Spriggs 2005; Ratcliffe 2006; Weisburd et al. 2006).

It is important to note that for video surveillance or any form of SCP to be effective, its implementation must be targeted and crime-specific. Every crime has a different "opportunity structure" which should guide the selection of SCP measures to prevent it (Cornish and Clarke 1986). Parking facilities, as previously mentioned, present many opportunities for potential offenders, in large part because surveillance is difficult. Thus, a surveillance camera in a parking facility would likely prove to be an effective deterrent of crime within the facility. In other settings however, such as private or semiprivate locations where crimes such as extortion, check fraud, or domestic violence occur, video surveillance would not be expected to be particularly useful. A middle ground of video surveillance efficacy also exists, whereby the technology may not capture the crime itself, but can nonetheless yield evidence regarding potential offenders entering and exiting the crime location.

Another crime deterrent effect surveillance cameras may have is that they can serve to increase perceptions of safety among legitimate users of public areas monitored by cameras, encouraging people to frequent places they may have previously avoided (Gill 2006; Ratcliffe 2006). As more people use these spaces for lawful social purposes, their presence may serve as a further deterrent to crime, providing natural surveillance as informal guardians and potential witnesses (Welsh and Farrington 2002, 2004).

Advocates of public camera use also theorize that the technology's surveillance capabilities can enhance criminal justice system efficiency. Camera monitors can alert police of crimes and potentially dangerous situations as they occur, providing crucial information that can help police determine the safest, most effective response, including how many officers to deploy and how to respond on the scene (Goold 2004, Levesley and Martin 2005). Video footage documenting crimes that have transpired and identifying perpetrators and witnesses may aid in investigations and prosecutions, increasing police and prosecutorial efficiency, benefiting victims of crimes whose cases are able to be closed through the use of video evidence, and incapacitating a greater number of offenders from committing future crimes (Chainey 2000; Gill and Hemming 2004; Ratcliffe 2006).

Detractors of the technology, however, point to the likelihood that potential criminals will "wise up" and simply move to locations beyond camera coverage. This argument depends on two assumptions: that criminals have an accurate perception of the extent of a camera's reach, and that cameras will not discourage opportunistic offenders from refraining from a particular criminal act altogether. Prior research, however, indicates that displacement is by no means a certainty and when it does occur, it is nowhere near 100 percent (i.e., only a fraction of the crime prevented in one location is displaced to another) (Barr and Pease 1990; Eck 1993; Guerette and Bowers 2009; Hesseling 1994). This argument also fails to acknowledge the possibility that implementers of SCP strategies anticipate where and when crime is likely to be displaced and take measures to prevent it from occurring. Indeed, such measures could not only prevent potential displacement associated with camera use, but could also increase the likelihood of a diffusion of benefits. Furthermore, keeping potential offenders aware of an intervention, but unaware of its scope, offers a diffusion of potential benefits for other potential targets (Eck 2002). Theoretically, in a controlled experimental situation, diffusion may lead to the underestimation of actual observed effects of an intervention by lowering the occurrence of crime in the control facility. Empirical data regarding the external effect of SCP measures in parking facilities is mixed, with some studies showing diffusion and others showing displacement (Eck 2002; Welsh and Farrington 2003; Welsh and Farrington 2004).

Evaluations of public surveillance camera impact both in the United Kingdom and the United States have produced uneven support for the theories described above. One early study based in the United Kingdom produced promising results in reducing street crime with the absence of displacement (Chainey 2000), while another demonstrated consistent evidence of reduced fear of crime but scant evidence of crime decline, and differential impacts by crime type (Gill and Spriggs 2005). Welsh and Farrington (in 2002, 2004, and 2008) conducted studies of previous public surveillance evaluations worldwide, of which 41 were identified as having sufficient methodological rigor to be included in a formal meta-analysis. Overall, the authors found that cameras reduce crime to a small degree, although impact varied based on location of cameras and country of intervention, with significant reductions in crime found in UK settings, but no effect in other countries.

A subsequent meta-analysis, combined with an evaluation of two public surveillance locations in Los Angeles, echoes the mixed findings of Welsh and Farrington (Cameron, Kolodinski, May, and Williams 2007). Of the 44 sites included in the meta-analysis (11 of which were of sites in the U.S.), almost 41 percent (18) showed a statistically significant decrease in crime, with the remainder demonstrating either a rise in crime or no change. The impact was slightly more positive for camera systems implemented specifically in commercial areas, where just under half (12) of 25 sites experienced a positive impact. By contrast, cameras placed in residential areas typically failed to reduce crime. Of the nine sites included in this category, the vast majority (seven) had no significant impact, while a significant rise in crime was found in the remaining two sites. None of the 11 US sites showed a significant decrease in crime in any category.

Three recent studies have taken a closer look at public surveillance use and impact in U.S. cities. In Los Angeles, neither crime nor arrest data changed significantly after the city's camera system was implemented (Cameron et al. 2007). In the other two cities, however, results were more mixed. Philadelphia's camera evaluation found a significant reduction in crime within a month of camera installation at half of the camera locations (Ratcliffe and Taniguchi 2008). Four of the eight sites included in the study experienced a statistically significant decrease in disorder incidents in the target areas and witnessed a reduction of crime in the buffer area, which researchers deemed a diffusion of the benefits associated with the camera installation. The evaluation does not address the question of why some camera sites had an impact on crime while others did not.

A more comprehensive study of San Francisco's public surveillance system found similarly mixed results (King et al. 2008). The study examined 19 camera sites, each with multiple cameras, from 209 days before installation to 264 days afterward. In that period, there were no statistically significant changes in drug offenses, vandalism, prostitution, or violent crime. Property crime rates, however, declined significantly (23 percent) within 100 feet of the cameras with no signs of displacement to areas adjacent to but not within the direct view of the cameras. The effect was driven entirely by declines in larceny theft.

While prior evaluations of the impact of cameras on crime have yielded mixed results (Eck 2002; Gill and Spriggs 2005; Maccubbin and Staples 2001; Welsh and Farrington 2003; Welsh and Farrington 2004), their use specifically in parking facilities suggests that camera implementation helps reduce the occurrence of vehicle crimes (Eck 2002; Farrington et al. 2007; Poyner 1997; Tilly 1993). However, prior research provides little guidance on the value of digital still cameras in deterring crime in parking facilities, which could prove useful in increasing perceptions of risk of apprehension even absent their surveillance capabilities.

Despite the evidence supporting SCP measures, past evaluations have employed relatively weak cross-sectional or quasi-experimental designs (Ekblom and Pease 1995; Rosenbaum 1988; University of Maryland 1997) and often do not examine the possibility of displacement (University of Maryland 1997): the shifting of crime to different places, times, targets, or tactics in response to an intervention. These weak designs are exacerbated by the fact that SCP is often implemented as a combination of interventions (e.g., increased lighting, plus target hardening, plus employee surveillance), making it difficult to determine which measures are actually effective (Ekblom and Pease 1995). Thus, many leaders in the field of criminology call for greater use of randomized experimental designs for all types of crime prevention efforts (Sherman 1996; Weisburd 1997) as well as for parking facility studies specifically (Clarke and Harris 1992).

Further complicating the evaluation of SCP measures is the number of unintended and often unexpected effects an intervention may have on crime. The placement and coverage of parking facility security measures can influence the types of crimes that occur within it. For example, while stationing security at entrance and exit barriers may deter the theft *of* a car, it alone will have little effect on theft *from* cars (Poyner 1997). This effect occurs because while there is surveillance over the ingress and egress of cars in the lot, activity within the lot may proceed unsupervised. Thus, the effect of any security measure may be heavily dependent on how and where it is implemented. The caveat, then, is that, because environments create opportunities for certain crimes, care should be taken in drawing conclusions about the effect of individual SCP measures on crime deterrence (Eck 2002). The effect may not be due to the measure implemented, but to the situation in which it was implemented. Furthermore, crime prevention measures within a facility should be seen as a system, either creating opportunities for or deterring crime.

The preceding review of car crime prevention theory and evaluation research points to important gaps in both research and methodology. Specifically, while SCP measures hold promise for yielding significant reductions in car crime, applications in the U.S. are rare and merit further exploration. In terms of methodology, scholars widely agree that controlled experiments are a superior method for evaluating the impact of an intervention, yet they remain the exception rather than the rule (Weisburd 2005). In an effort to fill these knowledge gaps, the present research study employed the SCP framework to identify a measure to reduce car crime (strategic placement of recordable cameras), implemented that measure, and conducted a randomized clinical trial to assess its effectiveness. The setting for this study, the WMATA commuter parking facilities, is described below.

Background on WMATA

WMATA runs the second largest rail transit system and sixth largest bus network in the U.S.[11] On most workdays, 42 percent of those who work within the WMATA system's core service area (Washington, D.C. and parts of Arlington County, Virginia) use WMATA for transportation. Because of the nature of Washington, D.C.'s business community and its large suburban-based ridership contingent, the general flow of traffic within WMATA's rail system is heavy use in the morning, with riders heading toward the city, and heavy use in the evening, with riders generally heading away from the city. To facilitate these large rush hour fluctuations in ridership and to make Metrorail more accessible to an increasingly suburban population, WMATA had constructed parking facilities at 42 stations (as of 2010), all of which provided daily and hourly parking, motorcycle and bicycle parking, and accessibility at all hours of the day, every day of the week. Of these stations, 34 offer reserved parking where customers are able to purchase permits (for a $65 monthly rate in addition to the daily rate) to park in a reserved spot. Daily parking fares vary by station (with an average approximate cost of $4.50) and, at the majority of facilities, are collected upon exit between 10:30 am and the station's closing. At six stations, parking fees are paid upon entrance between the hours of 5:00 a.m. and 2:00 p.m. Parking is free on weekends and federal holidays. Depending on the station, customers can pay parking fares via SmarTrip card, cash (coins for metered spots), and credit cards.[12]

The parking facilities throughout the WMATA Metro system are served by over 100 parking attendants who collect parking fees on weekdays. At least one attendant is assigned from 9:00 a.m. until rail closing (midnight on Monday through Thursday, 2:00 a.m. on Friday)

[11] Washington Metropolitan Area Transit Authority. 2010. "WMATA Facts." Washington, D.C.: Washington Area Transit Authority. http://www.wmata.com/about_metro/docs/metrofacts.pdf. (Accessed April 6, 2011.).
[12] Ibid.

for exit payment policy stations; additional attendants are assigned to these stations from 2:00 p.m. to 10:00 p.m. to accommodate the evening rush hours.[13] For the entrance payment stations, additional attendants are available from 5:00 to 10:00 a.m. to accommodate the morning rush hours.[14] Attendants are stationed at a kiosk in the parking lot or, in the case of stations with multiple parking facilities, they roam on foot.

Overall, WMATA is known for successfully keeping crime rates low on its rail system, and prior research has attributed low crime rates to the design, management, and maintenance of the system (La Vigne 1996). Crime in Metro's parking facilities, however, has historically posed a more serious public safety concern. Between 1999 and 2003, prior to the commencement of this study, approximately half of all crimes occurring on WMATA property took place in parking facilities and 69 percent of all of WMATA's Part I crimes occurred there. More than half—58 percent—of Part I crimes in 2003 were automobile-related. The breakdown between thefts of and theft from cars was roughly even, with attempted or successful auto thefts accounting for 55 percent of all car crimes, and thefts from cars accounting for the remainder.

Car crimes are not distributed equally across Metro's stations: Just over one-third (36 percent) of the stations accounted for 80 percent of car crimes in 2003.[15] This suggests that certain factors make some WMATA facilities more desirable targets for crime than others, presenting an opportunity to achieve reductions in car crime if such factors are identified and if effective preventive measures are employed. The following chapter describes the decisionmaking processes, data collection, analyses employed to identify digital cameras as the crime prevention measure of choice, and outlines the methods employed to randomly assign cameras and evaluate their effectiveness.

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[13] Raymond Stoner, personal communications with the author, October 13 and November 2, 2005.
[14] Ibid.
[15] Washington Metropolitan Area Metro Transit Police. 2004. "Metro Transit Police Department Five-Year Crime Report 1999-2003." Washington, D.C.: Washington Area Transit Authority Metro Transit Police. http://www.wmata.com/about/mtpd_crime_stats03.cfm. (Accessed December 1, 2004.) While Part I crimes occurring on WMATA property have increased annually since 2003, the percentage of Part I crime occurring in parking facilities remained consistent at roughly 57 percent leading up to this study's camera installation, decreased to 53 percent in 2008, and dropped dramatically to 40 percent in 2009. From Washington Metropolitan Area Transit Authority Metro Transit Police. 2010. "Metro Transit Police Department Five-Year Crime Report 2005-2009." Washington, D.C.: Washington Area Transit Authority Metro Transit Police. http://www.wmata.com/about_metro/transit_police/mtpd_crime_stats0 3.cfm. (Accessed April 6, 2011.).

Chapter 3. Research Design and Methods

This project consists of three main research components: (1) identification of the magnitude of car crime in commuter parking facilities and possible strategies for prevention of such car crime, (2) identification and implementation of a crime prevention strategy, and (3) evaluation of the strategy's effectiveness. In partnership with the MTP staff, the research team created a blocked randomized experimental design involving 50 matched pairs of commuter parking facilities in which a combination of live and dummy digital cameras were deployed, along with accompanying signage, at the exits of one randomly selected facility from each pair. After a period of 12 months following camera implementation, the research team analyzed the impact of the cameras on crime occurring in and around Metro's parking facilities.

The study had the following specific goals:

1. to identify the environmental characteristics and management practices of WMATA's parking facilities and how they may be creating criminal opportunities;

2. to analyze those characteristics and practices in relation to the incidence, prevalence, and distribution of crimes in WMATA's parking facilities using historical crime data;

3. to identify promising strategies that could be employed to reduce car crime and prioritize those strategies with regard to their anticipated effectiveness;

4. to implement one selected strategy in half of WMATA's 50 commuter parking facilities employing a blocked randomized experimental design; and

5. to evaluate the effectiveness of the intervention through a DiD analysis and a cost-benefit analysis.

This research process involved the collection and analysis of crime data from MTP and jurisdictions in which WMATA operates, as well as the physical and environmental characteristics of Metro's parking facilities. These data, along with conversations with MTP on the feasibility of various interventions, informed both the choice of intervention (recordable digital cameras) and the random selection process employed to determine which facilities would receive the intervention. After a 12-month intervention period, the effectiveness of the intervention was examined through a variety of statistical tests including a DiD analysis.

This chapter covers each step of the research design, from the data that were used to inform the selection of what crime prevention strategies were most promising, to implementation of digital cameras in selected parking facilities, to the analytic techniques that were employed to evaluate the impact of camera use. A description of the data that were collected and employed for this study is presented first, followed by a discussion of the parking facilities' environmental features conducive to crime and a description of historical crime trends in those facilities. This chapter then outlines the decisionmaking process for selecting and implementing digital cameras, followed by an in-depth presentation of how the parking facilities were chosen as treatment and control sites. The remainder of the chapter is dedicated to a discussion of the methods employed to assess the impact of the cameras and to identify any diffusion or displacement of crime as a result of the intervention. The impact findings are detailed in the following chapter.

Data Collection

To support the identification of a specific intervention designed to prevent car crimes, researchers first examined the nature of vehicle-related theft throughout Metro's commuter parking facilities as well as the environment and contexts in which those crimes occurred. A variety of crime data were obtained from multiple sources, including Metro Transit Police and area police jurisdictions. Historical incident records for auto-related offenses occurring throughout the Metro system's long-term parking facilities were obtained from MTP's Crime Analysis Unit (CAU). Historical crime incident records were also collected from the seven jurisdictions in which Metro stations and parking facilities are located. Initially, all crime data were collected for calendar years 2004 and 2005 to inform the identification of the strategy to reduce car crime; these data were subsequently updated through August 2009 for the impact analysis. Administrative data on Metro operations related to their parking facilities were also obtained, including hours of operation and staffing, parking facility utilization,[16] and MTP policing practices. Finally, researchers conducted pre-intervention site observations of environmental characteristics of each of Metro's long-term parking facilities. The data collected through these observations were analyzed along with the historical crime data to discern any relationships between certain environmental characteristics and crimes. The results of this pre-intervention analysis, in combination with a thorough review of situational crime prevention

[16] These data were only available for the pre-intervention analysis.

literature and consultation with experts, led to the identification of an array of crime prevention measures from which to choose and implement in one half of WMATA's randomly chosen parking facilities. From among those options, MTP chose to install digital cameras at the exits of parking facilities.

Crime Data from MTP

UI researchers worked with MTP's CAU to access a variety of data on crime location, incidence, prevalence, and trends within WMATA parking facilities. The data provided by CAU included full official records as transcribed from the officers' official reports. CAU provided an electronic data file containing incident-level records for all crimes reported to occur in parking facilities and including the following fields: case number, jurisdiction, offense description, station location, date of event, and time of event.

The research team examined CAU parking facility records extensively. Review of this incident-level file, however, generated concern about the lack of locational specificity. A significant share of the incidents occurring in stations with multiple parking facilities (which account for 8 of the 34 stations with parking facilities that were used in this study) did not have enough offense location detail to determine the specific parking facilities in which an offense occurred. Therefore, for the pre-intervention analysis, staff reviewed an electronic file including case number and full officer narratives for crimes occurring in the stations with multiple parking facilities (including Huntington, Vienna, Branch Avenue, Landover, New Carrollton, Shady Grove, and Twinbrook stations) for locational specificity that the incident-level records did not provide.[17] Unfortunately, approximately 100 incident locations remained unknown. UI researchers worked with MTP to collect more specific locational information by contacting the victims of these crimes, but this effort did not yield sufficient results.

To avoid losing valuable data, cases without parking facility location information were assigned a parking facility based on the distribution of location-specific offenses in each facility.[18] That is, staff proportionally assigned cases at the same station for which specific

[17] Eight cases that were added to the file from information obtained from the officer narratives were ultimately removed from the data set. Narratives were only consulted for stations with multiple lots, thus their inclusion in analyses may create overrepresentation of crime at stations with multiple facilities when compared to crime at stations with single facilities.

[18] Following the pre-intervention analysis, the research team worked with CAU staff to determine how MTP's incident record system could best capture facility-specific information and to inform MTP officers that incidents

information was available based on the known distribution across facilities for each station: if half of known cases in Station 1 occurred in Lot A, researchers assigned half of unknown cases to Lot A.[19] Given that facility-specific crime data were only available for car crimes for 2004 and 2005, the distribution used for proportional assignment was calculated by averaging the monthly crime counts for 2004 and 2005. This was determined to be the best approach for correcting the data without overestimating the potential effects. The monthly trend in the overall crime for the parking facilities followed a similar pattern to that of car crimes and thus justified the use of car crime proportions for assignment of each individual crime type to parking lots. The limitation of this technique is that it could mask the effect of the intervention by erroneously assigning crime that occurred in the control facilities to the treatment facilities, and vice versa. Ultimately, the research team chose this conservative route to present the smallest potential impact rather than inflating the results.

Crime Data from Surrounding Jurisdictions

In order to control for crime rates in areas surrounding WMATA parking facilities that may have an influence on crime occurring there, the research team collected reported crime data from each of the eight jurisdictions in which Metro parking facilities are located: Washington, D.C.; Montgomery County, Maryland; Prince George's County, Maryland; Arlington County, Virginia; Fairfax County, Virginia; and the cities of Alexandria, Fairfax, and Falls Church, Virginia. Incident-level records for all Part I and II crimes occurring within a one-mile radius of the Metro stations were requested for January 2004 through December 2005. Follow-up data from January 2006 through May 2009 were requested in spring 2009. Although each jurisdiction's data file was slightly different, all included date of incident and a description and location of the offense. Where multiple jurisdictions existed within one mile of a station, the records were mapped together and joined to create the station file for analysis. Station files were reviewed for duplicate cases and corrective action was taken as appropriate to prevent duplication within any jurisdiction or between a jurisdiction and MTP's crime data.

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should be recorded at the facility-level. This strategy was employed both to assist MTP with future analysis of crime in specific parking facilities and to allow for facility-level evaluation following camera installation.

[19] After obtaining the post-intervention data from CAU, locational specificity was still lacking in incident records, and therefore, proportional assignment was used to place each incident at the multi-lot stations in a specific lot based on the known distribution of crime, as was completed for the pre-intervention data.

Administrative Data

To provide context on the operations of WMATA parking facilities, administrative data on WMATA operations were collected from MTP and other offices within WMATA. These data include hours of parking facility operation and staffing, parking facility utilization, and policing practices. This information, in conjunction with the crime data and site observations, helped to inform the overall understanding of each parking facility's criminal opportunities.

Site Observations

The administrative and crime data referenced above was complemented by original data collected by the research team on the environmental characteristics and physical structures of the parking facilities. Drawing on prior research on crime prevention in parking facilities (Clarke and Goldstein 2003; Mayhew and Braun 2004; Smith 1996), researchers developed a data collection instrument to identify, through in-person observation, the environmental characteristics of each facility and the immediate area. Characteristics measured included: lighting, layout, natural surveillance, access control, usability, and the surrounding environment (see Appendix B for Site Observation Instrument). Individual facility characteristics served to determine if certain factors contributed to higher or lower rates of crime. Likewise, an understanding of what environmental elements were already in place aided in determining the final intervention strategy that was implemented.

The research team conducted a field test of the observation data collection instrument on November 10, 2005 at the Vienna-Fairfax facilities, which included five distinct parking facilities.[20] The instrument was then modified and used for the remainder of parking facilities. The observations were conducted between 10:00 a.m. and 4:00 p.m. on Tuesdays, Wednesdays, and Thursdays during a one-month period in late 2005. The days and times for the site observations were selected to coincide with the peak hours of operation of the facilities and the average time ranges for the commission of car crime in the facilities as recorded by MTP. Nevertheless, the site observation data captured facility characteristics at one moment in time and may not be an accurate representation. Most facilities were visited by the research team alone; however, a Metropolitan Transit Police Officer joined the team on December 14, 2005 for

[20] A parking facility was determined its own entity when a vehicle had to enter or exit through automatic gates to get to and/or from one parking lot or garage to another. In this case, separate charges would incur for such an action.

the Green Line facilities of Branch Avenue, Suitland, Naylor Road, Southern Avenue, and Anacostia stations.

Description of Metro Stations and Parking Facilities

In conducting the site observations, researchers visited a total of 35 different stations on the red, orange, yellow, green, and blue lines. The majority of the stations (26) had only one parking facility each, while the remaining 9 stations had multiple parking facilities. The stations visited had several common characteristics. All of the stations had bus bays located near the entrance, storage areas for bicycles, and “Kiss and Ride” accommodations enabling drivers to drop off passengers near the Metro entrance without parking their vehicles. In addition, all but one of the stations (White Flint) had metered parking spaces located near the all-day parking facilities. For classification purposes, the facilities were placed in one of three categories: (1) garages, (2) surface lots, and (3) combination facilities, which have a parking garage that is partially or completely surrounded by a surface lot that shares the same set of vehicle entrances and exits. The site observation instrument contained 60 questions that applied to all types of facilities, 12 questions specific to parking garages, and 3 questions specific to parking lots (see Appendix B for the Site Observation Instrument). In total, researchers conducted observations at 52 facilities: 32 surface lots, 15 garages, and 5 combination facilities. At the time of the site observations, the capacities of the WMATA-owned parking facilities ranged from 194 spaces to 5,069 spaces. During the site visits, 35 percent of the facilities were completely full (100 percent of spaces utilized), 46 percent of the facilities were mostly full (80-99 percent of spaces utilized), and 19 percent of the facilities were less than 80 percent full.

Distributions, means, and correlations of site observation data were reviewed for all variables (see Appendix C for Detailed Summary of Site Observations). Given the large number of possible variables in the site observation data, the research team employed data reduction techniques to decrease the number of variables used in regression analyses. Initially, the site observation variables were assigned to an adaptation of Clarke’s Opportunity Reducing Techniques Matrix (1997) (see Appendix D). Clarke’s 16-cell matrix classifies opportunity-reducing techniques through four SCP tenets: increasing perceived effort, increasing perceived risk, reducing anticipated rewards, and removing excuses. Within each cell, more specific classifications of the tenets were outlined, including access control, surveillance, controlling facilitators, and others. The research team’s modified matrix included the SCP tenets of increasing the effort, increasing the risks, and other. The opportunity reducing techniques were classified under "access control" and controlling facilitators were included under "increasing the effort." Formal surveillance, natural surveillance, and perception of surveillance (in terms of elements of social disorder) were included under "increasing the risks." Target removal, land use, current utilization, and facility type were included "other."

Data reduction with factor analysis was based on this theory-driven matrix to determine if, and how, related parking lot characteristics combine to form topical factors based on previous research and theory. All variables were factor analyzed together at the same time to determine how the variables distributed across multiple factors. The resulting factors loosely supported the matrix groupings emphasized through theory: for example, variables describing formal surveillance characteristics of facilities (e.g., number of attendants, presence of intercoms or emergency buttons) loaded highly on the same factor. Given this trend, the data were factored again. However, each matrix grouping was subject to its own factor analysis; analysis was run separately for variables classified as formal surveillance, natural surveillance, perception of surveillance, access control, and controlling facilitators. These factor analyses resulted in one factor for each category except for perception of surveillance, which yielded three factors: signage, health, and disorder-related perceptions of surveillance. Researchers then merged the facility-level site observation data with facility-level counts of car crime incidents and station-level crime rates in order to identify causal factors contributing to car crime.[21]

Identification of Car-Crime Reduction Strategies

This section discusses the data collection and analysis activities that contributed to the identification of criminal opportunities and yielded recommendations for crime prevention strategies targeted at reducing vehicle-related incidents. This aspect of the study is referred to as the "pre-intervention analysis" and thus, the date ranges for the crime data that are used are confined to 2004 to 2005 only, the dates just prior to selection of the intervention.

[21] In anticipation of conducting Ordinary Least Squares (OLS) regression, the dependent variables (theft of, theft from, total theft) were reviewed for normality; the natural log of each was taken to approximate a normal distribution appropriate for OLS regression. Due to zero dependent variable values, each observation was adjusted by adding one before being logged.

Parking Facility Characteristics and Crime

The distribution of car-related crime incidents throughout Metro's commuter parking facilities for January 1, 2004 through December 31, 2005 is unbalanced in several different ways. First, the types of parking facilities (lot, garage, and combination) experience different levels of crime. As prior research indicated and our data confirmed, garages experienced the most crime while lots experienced the least (see Table 3.1). The major characteristic of garages (i.e., multiple levels) creates difficulty for anyone to directly observe suspicious activity. The many unstaffed levels create ideal, unsupervised opportunities for offenders to commit crimes. Furthermore, the crime experienced at stations with multiple parking facilities is slightly different from that occurring at stations with only one parking facility (see Table 3.2). Single facilities tend to experience more *theft of* vehicles, on average, while multiple facility stations, on average, experience more *theft from* vehicles.

Table 3.1: Percent of Total Car-Related Thefts by Facility Type, 2004-2005

	N	Theft of	Theft from	Total Theft
Lot	32	9.2	9.6	18.8
Garage	15	11.7	16.1	27.7
Combination	5	11.6	13.4	25.0

Table 3.2: Percent of Total Car-Related Thefts by Station Type, 2004-2005

	N	Theft of	Theft from
Single Facility	817	50.8	49.2
Multiple Facility	325	34.8	65.2

A closer look at the distribution of car crimes by Metro station revealed that eight stations, representing one-quarter of all stations with commuter parking facilities, were host to 50 percent of all car-related thefts.[22] In fact, one station experienced 9 percent of all thefts. In addition, the distribution of *theft of* cars versus *theft from* cars varies within each station; some stations, on average, experience higher levels of *theft of* cars while others are more subject to

[22]Suitland, New Carrollton, Greenbelt, Southern Avenue, Deanwood, Addison Road, Vienna, and PG Plaza (listed from highest to lowest respectively, with each containing more than 50 car-related thefts on average).

theft from cars. Incidentally, the station that experienced the greatest amount of car crime had only one parking facility, and only two of the top eight stations were multi-facility stations. Across all multiple parking facility stations, *theft from* cars was more frequent an offense than *theft of* cars.

Identifying Promising Car-Crime Reduction Strategies

Facility Characteristics Associated with Car Crime

In order to determine specific characteristics of Metro's parking facilities that were associated with higher rates of car crime, researchers employed Ordinary Least Squares (OLS) regression analysis. The analysis dataset included station-level crime rates for surrounding areas as well as facility-level site observation data and counts of car crimes. Researchers employed the latter to create three difference dependent variables for modeling purposes: *thefts of* vehicles, *thefts from* vehicles, and total thefts (all of which were logged to ensure a normal distribution). Factor scores, derived from site observation data, including controlling facilitators, formal surveillance, natural surveillance, perception of surveillance (signage, health, and disorder-related perceptions of surveillance), and access control were used as independent variables. For garage facilities, the number of levels, presence and height of fencing, number of attendants on duty, view into the attendant booth, view of pedestrian entrances and exits from the attendant booth, view of vehicle exits and entrances from the attendant booth, and presence of signs encouraging patrons to lock up valuables were also included.

Through the use of OLS regression, car crime models accounted for many variations by including and removing different independent variables as well as modeling three different dependent variables. Throughout the multiple analyses, analysts paid particular attention to tolerance and collinearity of the models to ensure the best-fit model, while focusing on elements that could be altered through a prevention strategy. The base predictive model that was initially employed appears in Equation 3.1.

(Eq. 3.1)

$$\begin{matrix}\text{Theft of Cars}\\ \text{Theft from Cars}\\ \text{Total Theft}\end{matrix} = \text{Area Crime Rate} + \text{Capacity}$$

From this basic equation, additional variables were included and the model's significance was tested. Below are results from both the base model (see Table 3.3) and the expanded model (see Table 3.4).

Table 3.3: Base Model Results

Independent Variables	Theft of	Theft From	Total Theft
Intercept	0.79***	0.85***	1.11***
Crime Rate	0.0006***	0.0004*	0.0005**
Multiple Lot	-0.19*	-0.06	-0.13
Capacity	0.0002**	0.0001**	0.0001**
Utilization	-0.11*	-0.04	-0.08
Payment Policy	0.12	-0.04	0.07
F Value	13.47***	4.09**	8.92***
R^2 (Adj.)	0.63 (0.58)	0.34 (0.26)	0.53 (0.47)
N	46	46	46

Note: * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 3.4: Expanded Model Results

Independent Variables	Theft of	Theft From	Total Theft
Intercept	0.82**	0.95***	1.18***
Crime Rate	0.0007***	0.0003	0.0005**
Natural Surveillance	0.07	0.09	0.09
Formal Surveillance	0.01	0.003	0.001
Controlling facilitators	-0.04	0.006	-0.01
Access Control	-0.14	-0.04	-0.09
Perception of Surveillance: Signs	-0.06	-0.02	-0.03
Perception of Surveillance: Disorder	-0.01	0.04	0.02
Multiple Lots	-0.22	-0.08	-0.15
Capacity	0.0002*	0.0001	0.0001
Utilization	-0.14**	-0.05	-0.10
Payment Policy	0.11	-0.09	0.04
R^2 (Adj.)	0.67 (0.56)	0.41 (0.21)	0.57 (0.43)
N	46	46	46

Note: * $p < .05$, ** $p < .01$, *** $p < .001$.

Based on these analyses, the research team found that surrounding area crime rate, parking facility capacity, and parking utilization were the strongest predictors of car-related theft in Metro's parking facilities. Unfortunately, all three variables represent factors that were beyond the control of the study. Without explicit analytical evidence suggesting an intervention strategy, research staff proceeded to employ a theory-driven approach for intervention identification, which is discussed below. Nonetheless, the above analyses provided guidance on what facility characteristics should be used to randomly assign facilities to treatment and comparison groups (see Random Assignment section below).

Situational Crime Prevention Interventions

Parking Facilities and Criminal Opportunity

The environmental characteristics of Metro's parking facilities described above pointed to several opportunities for car crime or other criminal activities, including minimal formal surveillance, lack of signage, and limited access control. In terms of formal surveillance, the locations of attendant booths and the actual number of attendants typically on duty at each facility were both found to be lacking. Many of the attendant booths had little to no view of at least half of the parking facility, and no booth had a complete view of all spaces, pedestrian access points, and vehicle access points, thus restricting the ability to observe criminal activity in the facility. Views from attendant booths were further hampered by various obstructions, including large signs and blinds on booth windows. Minimizing obstructions in and near the booth would help to improve the ability of employees to survey the parking facilities.

Site observations also revealed that while Metro's parking garages had relatively thorough signage, the surface lots had little if any public awareness signage to educate and encourage commuters to follow general common sense guidelines such as locking up valuables or storing them out of plain view. Although prior research indicates that public awareness campaigns alone do not yield strong impacts, their existence in combination with other preventive measures could be beneficial.

Access control also has potential consequences for car theft. In 2004, WMATA gained unintended access control with the introduction of SmarTrip cards as the only method of payment for daily parking fees. In the majority of parking facilities customers must swipe their SmarTrip cards upon exit of the facility (between 10 a.m. and rail closing) in order to pay. This exit screening could increase the perceived effort for vehicle thefts, as offenders would need a SmarTrip card to exit the facility with the stolen vehicle. However, SmarTrip cards are not required to exit the facilities around-the-clock, enabling thefts to occur with ease during certain times of day. Furthermore, the six WMATA facilities that operate under a "pay as you enter policy" leave the gates open after 2:00 p.m. so anyone may come and go without any barriers. One potential way to increase access control of parking facilities would be to require the use of SmarTrip cards to enter and exit a facility, which adds an additional layer of control 24 hours a day.

Because statistical analyses did not point to a specific intervention, the evaluation team revisited the theoretical foundation of the study, situational crime prevention, to generate ideas for effective interventions. Staff identified several potential strategies for reducing vehicle crime in the Metro parking facilities based on anticipated effect, ranking strategies according to greatest anticipated impact. The top recommended strategies were reviewed by various WMATA and MTP staff (Table 3.5 includes all proposed strategies and their limitations). The first promising intervention strategy recommended to MTP was improving access control in the facilities through the use of SmarTrip cards or credit cards upon both entry to and exit from the parking facilities. The MTP Chief was enthusiastic about the idea, which was presented at a meeting with the Executive Team Leaders of WMATA in May 2006. While WMATA was already in the process of considering installation of credit card readers in the parking facilities, concerns about the intervention creating traffic congestion into facilities rendered it infeasible. UI staff learned that several other proposed strategies would be infeasible for a number of reasons, including physical infrastructure limitations, possible disruptions to WMATA operations, and time constraints in implementation. Based on further discussions with the MTP Chief and the WMATA Executive Team Leaders, the study team revisited the initial intervention ideas to generate a new list of intervention possibilities with specific consideration to timing, cost, and feasibility.

With a renewed focus on cost, timing, and feasibility, the study team investigated the possibility of installing still digital cameras at the exits of each facility in the treatment group. The cameras would be installed at treatment facility exits to take photos of license plates as each vehicle exits. In order to enhance the crime prevention impact of these cameras, the cameras would be accompanied by prominent signs saying: "In the interests of protecting Metro users' vehicles, our security cameras are recording your license plate number and time of exit from this facility."

Table 3.5: Potential Intervention Strategies to Address Car Crime in Metro's Parking Facilities

Intervention	Advantages	Disadvantages	Other Issues
Require all SmarTrip users to register their cards.	• Big impact on crime, especially by deterring theft of cars. • Commuters with registered SmarTrip cards whose employers offer pre-tax or subsidized Metro fares can add value electronically with ease. • Registered commuters can replace lost or stolen cards through Metro for a $5 admin fee.	• Customer inconvenience: may cause customer confusion and annoyance. • Customer perception: may be perceived as too "Big Brotherish." • Tourist Challenge: How would tourists register cards when they buy them in the station? • Little impact on theft from cars. • Cost associated with increasing attendant hours to help tourists.	• Signs could be posted saying, "As of 6/30/06 this lot will only accept registered SmarTrip cards. SmarTrip cards may be registered by calling xxx-xxx-xxxx or going online to www.WMATA.com." • Tourists could be exempted, but would be required to show their drivers licenses to the parking attendant (thus deterring thieves from posing as tourists).
Install video cameras at entrances and exits that would take pictures of license plates.	• Idea generated from WMATA meeting. • Prior research has found strategic use of surveillance cameras effective in crime prevention (see Welsh and Farrington 2003, 2004).	• Cost in buying cameras and recording equipment. • Timing: Installation likely to take longer than desirable.	• Cameras should be placed at exits and accompanied by prominent signs saying, "In the interest of protecting Metro users' vehicles, our security cameras are recording your license plate # and time of exit from this facility."
Increase the number of parking attendants.	• WMATA members initially saw this as a "cheap" alternative to employing various technological ideas.	• Stations with multiple facilities & "floating attendants" would require some type of training on how to view crime prevention as part of their jobs. • Cost: budget for parking attendants has already been exceeded for this fiscal year and further changes may not be well received. • Likely would require a major increase in staff to have an impact.	• Currently attendants are only on duty during peak hours of operation, approximately 5 a.m. to 2 p.m. or 10 a.m. to 10 p.m.
Redeploy Metro Transit Police light duty staff and make their presence visible.	• Extremely easy to implement because of a readily available force of people to utilize. • Would likely not require any Board approvals because Chief controls their work.	• Impact likely to be small with current available force. • Would require measurable increase in number of officers to have an impact.	• What if these staff were used to enhance current attendant force in some way? Would this reduce the constraints of hiring new attendants?
Require use of SmarTrip cards 24/7.	• Only minor technological changes would be required to extend to 24/7 operation.	• May have little impact on crime, since not much car crime is occurring on weekends and off hours. • Increased cost: Attendants would be needed at all hours.	• Currently SmarTrip is in use only on weekdays during peak hours of operation.
Increase fencing around parking facility perimeters.	• Likely to be relatively inexpensive compared to other interventions.	• Most fences are currently sufficient. • Coordination would be required to implement. • Implementation may take time.	
Install signs asking users to report suspicious behavior and to lock up their valuables.	• Simple and easy. • Relatively inexpensive. • Could be implemented quickly.	• Not likely to have a significant or long-term impact.	
Launch a public awareness campaign about crime prevention measures customers should take.	• Simple and easy. • Could be implemented quickly. • Relatively inexpensive.	• Prior research indicates that public awareness campaigns have little or no long-term impact.	

The theory behind the effectiveness of this proposed intervention was that the cameras and accompanying signage would enhance the perception of formal surveillance, increasing the perceived risk of apprehension and thereby deterring thieves from committing crime. In addition, the camera images could provide information to MTP (e.g., exact times of vehicles thefts) to inform patrolling practices and future crime prevention efforts, to aid in MTP's investigations, and to support the prosecution of known offenders. However, it is important to emphasize that prior research has found *surveillance* cameras to be effective crime control tools, particularly if they are monitored by staff (La Vigne et al. 2011). The cameras proposed for implementation in this project were more akin to red-light cameras: still, digital cameras for which movement triggers the capturing of images. Both resource and time constraints rendered the use of more sophisticated Closed-Circuit Television (CCTV) cameras infeasible. Moreover, as described below, resource constraints also led to the decision to install both live and dummy cameras at parking facility exits, further diluting the strength of the intervention.

Implementation of Car-Crime Reduction Strategy

UI staff researched a variety of camera system options and obtained quotes on camera hardware and installation costs from local vendors. The MTP Chief presented the plan to the Interim General Manager of WMATA in early July 2006 and received approval to move forward. Once the car-crime reduction strategy was identified to be digital cameras at the exits of exactly half of the parking facilities, the next steps were to determine which commuter parking facilities would be assigned to the treatment group versus the control group and then to develop a timetable for deployment of the cameras and signs in each location. The method of assigning the pairs is discussed below in more detail, followed by implementation details.

Random Assignment

When contemplating random assignment methods, the study team noted that while randomization provides theoretical equivalence, natural variation that will occur by chance, particularly in this instance due to the relatively small N. To minimize such variation between the groups, facilities were "blocked"[23] on certain characteristics/clusters of characteristics to maximize the equivalence of the groups. Blocking is a time-honored technique used with

[23] "Blocking" is a term used to describe the matching of groups with similar scores on a particular variable or variables, so that treatment and control groups each contain units with similar characteristics on the blocking variable(s).

randomized experiments because it helps to reduce heterogeneity that would otherwise obscure systematic covariation between treatment and outcome (Shadish, Cook, and Campbell 2002). The research team's analyses of historical crime data in and around Metro's parking facilities, along with site observation data, enabled the identification of appropriate factors on which to block. Because a degree of freedom is lost for each restriction on randomization, the team only blocked on factors that relate directly to the outcome of interest, car crime.

After consulting with both in-house and external Randomized Control Trial (RCT) experts, a matched pairs design was employed. Although some Metro stations have multiple parking facilities (see Figure 3.1), the research team chose to treat each surface lot and garage as a separate candidate for treatment/control. This creates a "nesting" of parking facilities in stations, which violates the principle of independence in a controlled experimental design. However, if single Metro stations (N=35) were chosen as the level of analysis, any benefits of eliminating the nesting would be outweighed a dramatically reduced sample size (from 52 to 25). Therefore, the parking facility (not the station) was used as the level of analysis.[24]

Figure 3.1: Example of Multi-Facility Location, Shady Grove Station

Source: Created using Google- Map data.

[24] An individual facility is determined as its own entity when a vehicle had to pass through automatic gates to get from one parking lot or garage to another. In this case, separate charges would incur for such an action during fee collection hours.

Initially, all 52 independent parking facilities were anticipated for inclusion in the study (located at 35 Metro stations), allowing the random assignment of 26 facilities to the treatment and 26 facilities to control. However, it was subsequently learned that one of the facilities would be closing before the end of 2006, thus eliminating the possibility of post-treatment analysis of crime and reducing the sample size to an odd number of facilities (N=51). The research team therefore excluded another facility from the randomization process and from future post-treatment analysis; the excluded facility had a much greater capacity than the other 50 facilities, making it the obvious candidate for exclusion.

Employing the marginally reduced sample size, the research team generated a list of matched pairs based on the following characteristics (see Appendix E for Matched Pairs of Parking Facilities): surrounding area crime rate[25] (high, medium, low), lot/garage capacity, AM/PM payment policy, facility type (garage, lot, or combination facility), and Metrorail line (e.g., red, green, orange). Crime rates within the facilities (i.e., theft *of*, theft *from*, and total thefts) were not used in creating the matched pairs because historical crime rates for crimes occurring within the facilities could not be accurately calculated for the six newest facilities in the system. If crime rates within the facilities had been used in the matching process, the number of paired facilities would have dropped from 50 (25 pairs) to 44 (22 pairs). Furthermore, previous analyses had determined that crime rates within the facilities were highly correlated with surrounding area crime rates, and all facility pairs were matched on surrounding crime rates.

With randomized controlled trials, the greatest threats to validity are twofold: (1) the treatment is not implemented as planned, and/or (2) the treatment spills over into the control group (Shadish, Campbell, and Cook 2002). Thus, it was critical to ensure that the treatment was implemented as intended. To that end, the research team worked with MTP staff to monitor the

[25] To assess the level of crime in the areas directly surrounding each Metro station, the number of Part I crimes was calculated for each station for January 2004 to December 2005. Rather than applying the traditional crime rate calculation using population as a divisor, geographic area was applied as an alternative to provide a concise measure of general crime levels of the area surrounding WMATA stations and parking lots and allow for comparison across all sites. Since the focus of the study is on commuter parking lots, it would be misleading to use the surrounding population as a basis for calculating crime rates (e.g., by 1,000 inhabitants) as it is relatively safe to assume that car crime victims will not be residents of the surrounding area; therefore, the area population would not be an adequate representation of potential victimization. The crime rate was calculated by taking the total number of Part I crimes within a one half-mile radius of each station divided by Pi × 0.5 miles^2.

treatment over time in order to ensure that implementation across treatment facilities was consistent with our intent and was as uniform as possible.

Installation of Cameras and Signage

This section outlines the *estimated* costs of deploying digital cameras at the exits of 25 parking facilities and the timetable for installation of the cameras and signage. For more information on the *actual* costs associated with this crime prevention strategy, readers may refer to Chapter 5 on the cost-benefit analysis of the intervention.

In June 2006, the research team provided MTP with cost estimates for hardware purchase and installation associated with the installation of camera systems at 25 WMATA-owned parking facilities. Table 3.6 summarizes the costs of (1) installing one camera at a parking facility and (2) adding an additional camera to the system. These figures were based on hardware estimates from two vendors that had existing relationships with WMATA.

Table 3.6: Camera Cost Estimate

	Hardware (GSA)	Installation*	Total
Cost of camera system at a facility with one exit lane	$6,162	$1,724	$7,886
Cost of each additional camera	$ 704	$1,200	$1,904

*Note: Installation costs do not include conduit, as most garages do not require that cable be in conduit. One vendor suggested that, if necessary, WMATA could hire an electrician to complete this work. These estimates do not include the costs of any electrical or cable wiring nor of optional car-tag-recognition/processing software and related fees (if any) to access state DMV's car registration files. Cost estimation prepared by UI.

Based on the conservative assumption that each of the 25 facilities selected for treatment had three exit lanes, the cost per facility of installing one camera at each vehicle exit lane was estimated to be $7,886 + $1,904 + $1,904 = $11,694. Thus, a rough estimate for the cost of installing cameras at each vehicle exit lane at all 25 treatment facilities was $11,694 x 25 = $292,350. MTP pieced together funding for the purchase and installation of these cameras from existing grants and MTP discretionary funds, but could not support full implementation of three functional cameras, leading to a modified intervention consisting of a combination of one live camera and two dummy cameras per facility as a means of reducing intervention costs.

As shown in Figure 3.2, cameras were installed on the exterior of the attendant booths. One live camera was used in each treatment facility. The wiring ran to a DVR housed in a locked box inside the booth, which eliminated union wiring issues. The power supply was also located inside the same box. Dummy cameras were installed in the remainder of the exits within the viewsheds of live cameras to prevent tampering. Each live camera was set to run constantly and camera footage was stored on an 80 Gigabyte hard drive (storage space for 2 days of footage), which could be accessed by MTP for investigations. Images could be downloaded to a computer and were time-stamped with the date and time the photo was taken. One sign was installed per entry or exit to alert Metro users that security cameras may be recording their license plate number and time of exit from the facility.

Figure 3.2: Image of Camera Installation

Researchers conducted post-implementation site observations at each of the treatment parking facilities to confirm that cameras and signage were installed, taking photos of each camera and sign. Telephone conversations and e-mail communications with the WMATA point of contact on camera installation further confirmed that the intervention at its most basic level—installation of cameras and signage at the selected treatment facilities—was implemented with fidelity. However, researchers were unable to document the degree to which cameras were used by MTP and parking facility staff for crime control and investigative purposes. Shortly prior to camera deployment, MTP's Auto Theft Unit was disbanded due to budget cuts. Repeated outreach to MTP staff, including an in-person meeting with the newly appointed chief, yielded no concrete information on the degree to which the camera photos were used for investigative purposes and whether camera data were ever linked to license plate recognition software as originally planned. This suggests that the intervention was confined to the placement of cameras (some live, some dummy) and signage and did not involve any enhanced investigations or an increase in the identification of suspects.

Analyzing the Impact of the Intervention

Once the cameras were in place for a period of 12 months, the intervention could be evaluated from a statistical standpoint to determine if there was significant change in crime. Given that treatment and control facilities were matched prior to camera installation, pre- and post-intervention comparisons could be completed to measure whether crime was affected as a result of the cameras rather than because of natural fluctuation in crime over time, the type of facility, or crime rates in the surrounding areas. The initial analysis entailed a comparison of pre- and post-implementation means pooled across all facilities, and then run separately for both treatment and control groups, using two-tailed, independent samples t-tests on reported crime data. Researchers then introduced the matched comparison facilities into the same equation by employing DiD analyses.

The analytic plan, as outlined in the proposal, originally included panel data and autoregressive integrated moving average (ARIMA) modeling, with the time series divided into different time periods using a dummy variable to denote pre- and post-intervention months. This time series approach was anticipated to be used to examine weekly crime data occurring 12 months before and 6 months after the intervention. However, the basis for this design revolved around having sufficient power—which theoretically seemed feasible given prior research on SCP measures in parking facilities—as well as on a sufficient number of observations before and after the treatment. The relatively small sample size of 25 treatment and 25 control parking facilities was fixed; however, the anticipated effect size was large, as prior research indicated that SCP measures in parking facilities successfully reduced between 50 and 100 percent of thefts of and/or from automobiles (see Table 3.7).

Table 3.7: Summary of Surveillance and Access Control-Based Interventions

Project	Nature of Intervention	Percent Reduction in Car Crime
Dover (UK)	Combination of access control and employee surveillance	85% car thefts
Surrey University	Combination of natural and formal surveillance (CCTVs)	50% thefts from cars
Port Authority NY/NJ	Access control	100% car thefts
Newark Int'l Airport	Access control	63% car thefts
East Midlands (UK)	Combination of surveillance, access control, signage, and management practices	69-100% reduction
Portland, OR	Combination of access control and formal surveillance (bike patrols)	66-77% thefts from cars
Charlotte, NC	Combination of formal (bike patrol, CCTV) and natural surveillance (increased foot traffic), and access control	53% thefts from cars

Results of studies examining the impact of CCTVs alone were not included in this table. Information obtained from work by Mayhew and Braun (2004).

Results of a preliminary power analysis[26] assuming a 55 percent reduction in car crime indicated a power of .82, which was comfortably higher than the commonly used cut-off of .80 (Cohen 1988). Despite our original confidence in this study design, the research team was unable to aggregate car crimes down to the weekly level to provide an acceptable number of observations for ARIMA modeling. However, the volume of car-related crimes occurring across the 50 commuter parking facilities was consistent with what was anticipated, yielding enough power for a rigorous technique to be employed.

Therefore, researchers modified the straightforward approach to DiD analysis, whereby the difference in the average outcome in the treated group before and after the intervention is compared to the difference in the average outcome of the control group before and after the intervention period, by introducing the average monthly differences generated by the DiD approach into a regression model. This method provides both an estimate of the gross impact of

[26] Power was calculated using a two-sample test with a lognormal outcome based on the assumption of equal variances. Log-transformed historical car crime rates from the 33 stations that have long-term parking facilities were used to calculate the coefficient of variation. An alpha level of .05 was employed with a two-tailed test.

the intervention (i.e., the average treatment effect) and whether the treatment effect is statistically different than the control group (using a threshold of $p < .05$).

The analysis involved the construction of a time series of accumulated reported crime counts by month for each of several categories of criminal incidents (e.g., violent crime, motor vehicle theft, theft from motor vehicle) from April 2007 through March 2009 (i.e., 12 months of pre-intervention data and 12 months of post-intervention data). Several crime categories were modeled independently and aggregated to meaningful groupings, such as all car-related crime and property crime. The outcome of the DiD analysis, which compares net change in crime in the target area using a control area to subtract other changes occurring in a similar location over the same evaluation period, results in the average monthly change for the given crime category. This method assumes that these *other* changes were identical between the target and control areas. Data were pooled across all treatment facilities and similarly with control facilities to assess the overall impact of the intervention. To compare results and determine whether contamination may have occurred in locations with mixed groups, additional variations of this design were tested: for example, with only those treatment and control facilities that contained a single group (i.e., meaning whether the matched pair contained stations that had only treatment or control facilities).

Similarly, the impact analysis also addressed methodological challenges that threaten the validity and interpretation of analysis findings. First, the unit of analysis was the parking facility rather than the Metro station, and therefore, there was potential for contamination or treatment effects influencing the control group (rendering the controls unusable). Second, there was a lack of specificity in the location of car-related crimes at stations with multiple parking facilities, which resulted in the need for proportional assignment of crime to each facility and thus increased the potential for masking the results. To tackle these challenges, the researchers conducted DiD analyses using a one-mile buffer of the surrounding neighborhoods, employing the data obtained from police jurisdictions in which the stations are located in two ways: (1) crime in treatment facilities was pooled and compared to crime in the one-mile surrounding area, and (2) crime in control facilities was pooled and compared to the one-mile surrounding area. Independent samples t-tests were also used to compare pre- and post-intervention means within the same stations that contained both treatment and control facilities pooled and then the one-mile buffer area to determine the extent to which intervention may have collectively influenced all facilities within a single station as well as whether changes occurred in the immediate vicinity of the station.

Lastly, we explored the possibility of displacement of crime or diffusion of benefits—resulting from the intervention—to neighboring areas. This methodology was mirrored after the techniques discussed above, using a one-mile buffer area as the comparison area. However, this analysis is only conducted for those crime types that were significantly impacted in the treatment facilities.

Chapter 4. Impact Findings

This chapter reports on the degree to which cameras and signs installed in randomly assigned treatment parking facilities yielded their intended crime prevention impact. The research team employed a series of analyses beginning with basic pre- and post-intervention comparisons of means in the treatment and control facilities individually, employing independent samples t-tests. These analyses were followed by more rigorous comparisons of treatment to control facilities to test for significant change while controlling for fluctuations in crime that are not attributable to the intervention using DiD analysis. Finally evidence of geographic displacement or diffusion of crime to the areas immediately adjacent the treatment sites was examined using DiD analysis. Below is a description of these impact analysis findings, beginning with a brief summary of the crime trends that existed in the parking facilities prior to camera deployment.

Crime Trends in Metro Parking Facilities

In 2003, at the onset of this study, automobile-related crimes accounted for approximately half of all crime occurring on WMATA property. To give a more detailed illustration of the volume of crime that was occurring specifically in Metro's commuter parking facilities, line graphs of four major crime categories—all crime, car-related crime, property crime, and violent crime—are presented in Figures 4.1 to 4.5 below. As shown in Figure 4.1, crime peaked at the end of 2007 in both the treatment and control parking facilities, with more than 100 incidents in a single month, and then greatly declined in the months leading up to the intervention in April 2008. The average for both treatment and control groups, denoted with dotted lines, dropped following camera deployment.

Because the same parameters were used in both, Figure 4.2 can be directly compared to Figure 4.1 to examine the share of total parking facility crime that was car-related crime. Car-related crime includes motor vehicle theft, attempted motor vehicle theft, and theft from automobiles (including theft of merchandise within cars and theft of auto parts and accessories). As shown in Figure 4.2, car-related crime follows a similar pattern as total crime, with higher counts at the end of 2007 and the beginning of 2009. Over the three years included in the evaluation period, car-related crime accounted for more than 40 percent of total monthly crime occurring in Metro's commuter parking facilities. In both treatment and control facilities, the average monthly car-related crime increased following the intervention.

Figure 4.1: Trend in All Crime, 2007-2009

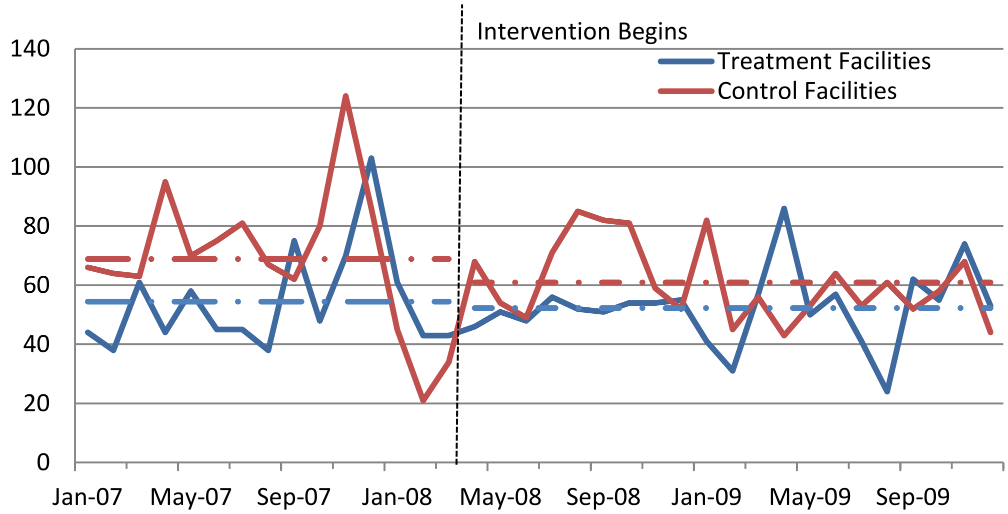


Figure 4.2: Trend in Car-Related Crime, 2007-2009

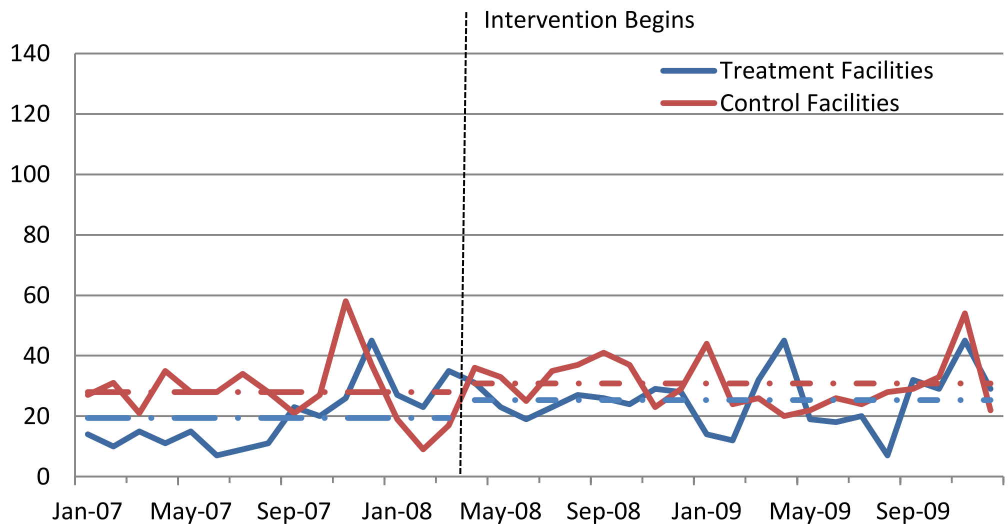
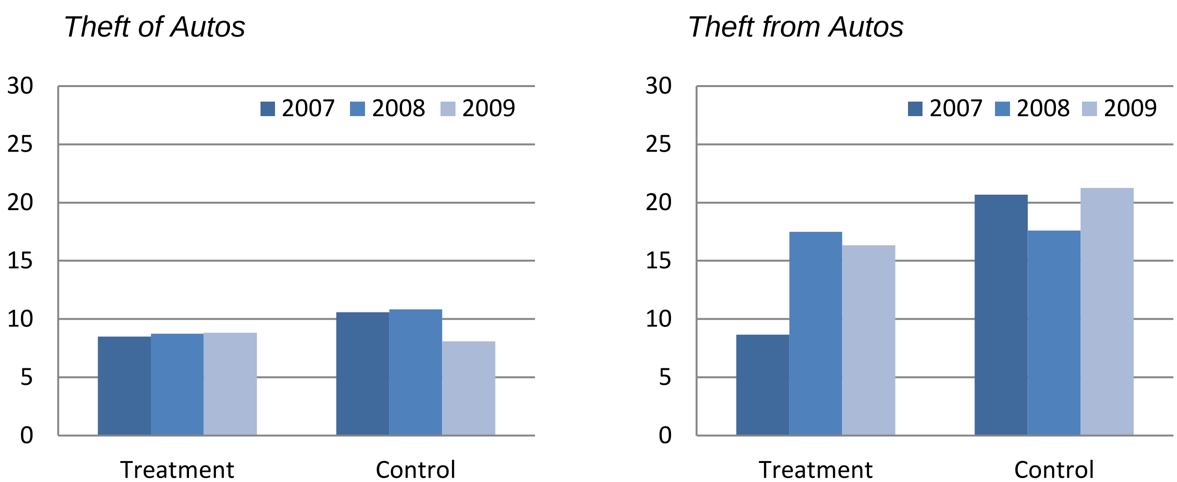


Figure 4.3 displays both thefts *of* and *from* autos to illustrate the change over time and variations between the two crime groupings. The number of thefts *of* autos remained stable in the treatment group, averaging eight thefts per month across the three years presented. In the control

facilities, however, the monthly average dropped from approximately 10 thefts *of* autos in 2007 and 2008 to levels similar to the treatment group in 2009. The monthly volume of theft *from* autos was higher than that for theft *of* autos. In the treatment facilities, the monthly average for thefts *from* autos (including both thefts of items within vehicles and thefts of car parts) was initially similar to that of motor vehicle theft, but more than doubled that average in 2008 and 2009. The control facilities had consistently higher volumes of thefts *from* autos, averaging slightly over 20 each month.

Figure 4.3: Average Monthly Car-Related Crime, 2007-2009



When all property crime was aggregated together (see Figure 4.4), it followed a similar trend to that for total crime. Following the intervention, property crime leveled off—at just under 40 incidents per month—and then rose back up to pre-intervention levels. The average monthly total for violent crime (see Figure 4.5) declined by 60 percent following camera deployment and remained low during the entire 12-month post-intervention period. However, both treatment and control groups followed this same trend, and the treatment group's monthly violent crime counts remained higher, on average, than the control group's over time.

Figure 4.4: Trend in Property Crime, 2007-2009

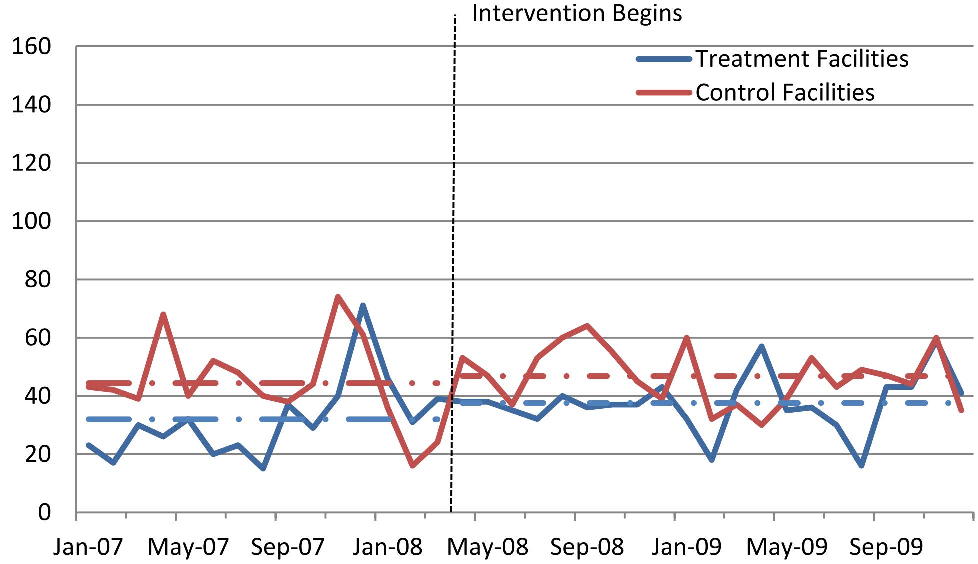
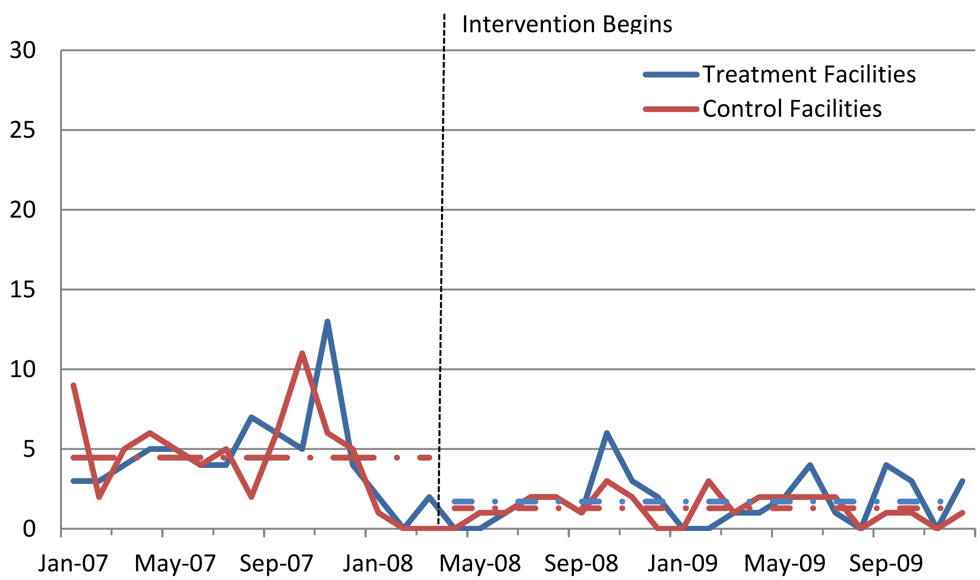


Figure 4.5: Trend in Violent Crime, 2007-2009



Note: The parameters for this figure do not match Figure 4.4 or those discussed above, thus they cannot be directly compared. The number of violent crimes was quite small and the axis was limited to account for this difference.

The above summary of the volume and type of crime in both the treatment and control facilities was designed to be purely descriptive and exploratory and does not account for crime trends in the geographic areas that WMATA serves. Below is a more rigorous analysis of whether the changes in crime discussed above were statistically significant and how changes in the treatment facilities compared to those in control facilities.

Analysis of Camera Deployment

Researchers employed a two-tiered impact analysis, beginning with comparisons of pre- and post-intervention crime means using two-tailed, independent samples t-tests for selected crime types and categories to determine if changes occurred following camera implementation in April 2008. The second tier of the process employed DiD analysis to test again for significant change, this time in relationship to the comparison area. As previously discussed, each treatment facility was matched with a comparison area to create two groups that were similar on a variety of measures prior to the intervention. DiD—using reported crime, pooled across each experimental group—was employed to compare net change in crime in treatment areas using matched control areas to subtract other changes occurring in a similar location over the same evaluation period. This method assumes that other factors influencing fluctuations in crime are identical between the treatment and control areas.

Table 4.1: Changes in Car-Related Crime by Type and Location*

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Car-Related Crime	Treatment	21.00	24.00	+3.00	-0.80	
	Comparison	28.42	32.50	+4.08	-1.00	-1.08
Auto Theft (including attempted)	Treatment	8.25	8.58	+0.33	-0.22	
	Comparison	9.83	12.92	+3.08	-1.28	-2.75
Auto Theft (excluding attempted)	Treatment	4.58	4.58	0.00	0.00	
	Comparison	5.83	8.00	+2.17	-1.90	-2.17
Attempted Auto Theft	Treatment	3.67	4.00	+0.33	-0.35	
	Comparison	4.00	4.92	+0.92	-0.46	-0.58
Theft from Auto	Treatment	12.75	15.42	+2.67	-0.78	
	Comparison	18.58	19.58	+1.00	-0.37	1.67

*Camera installation began in early April 2008; therefore, the intervention point was determined to be April 2008.
†Significant at $p < .05$.

Overall, the results of the t-tests showed no indication that the cameras had an impact on car-related crime (see Table 4.1) in either direction (i.e., crime in the treatment group neither increased nor decreased in relation to crime in the control group). All car crimes either remained the same or increased following camera implementation. Violent crime was the only category that significantly changed (see Table 4.2), with the average number of violent offenses declining by more than three incidents post-intervention.

Table 4.2: Changes in Crime by Category and Location

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Crime	Treatment	56.08	49.67	-6.42	1.10	
	Comparison	70.00	65.33	-4.67	0.52	-1.75
Property Crime	Treatment	34.08	35.67	+1.58	-0.34	
	Comparison	45.08	48.50	+3.42	-0.59	-1.83
Larceny-theft	Treatment	23.42	24.67	+1.25	-0.36	
	Comparison	30.50	32.75	+2.25	-0.52	-1.00
Violent Crime	Treatment	4.75	1.50	-3.25	3.08†	
	Comparison	4.25	1.33	-2.92	3.05†	-0.33

†Significant at $p < .05$.

The DiD results mirrored the t-test findings, with no significant change once the control facilities were introduced. As shown in Table 4.2, violent crime was no longer significant. All crime—which combines Part I and II offenses reported by MTP—had reduced by more than 11 percent in the treatment facilities compared to a 7 percent reduction in the control facilities. Although this crime reduction appears promising, it was not large enough to reach statistical significance.

Addressing Methodological Challenges

As referenced in detail in the previous chapter, this evaluation was plagued by two methodological challenges that threaten the validity and interpretation of analysis findings: (1) the unit of analysis was the parking facility rather than the Metro station; and (2) there was a lack of specificity in the location of car-related crimes at stations with multiple parking facilities. The first challenge created six instances in which both treatment and control facilities are located within the same station, rendering control stations vulnerable to contamination and/or diffusion of benefits. While cameras installed in treatment facilities cannot very well "contaminate" neighboring control facilities, a diffusion of benefits may occur if potential offenders perceive that security on WMATA property generally. The second challenge, lack of specificity in the location of crime incidents within multi-facility stations, necessitated the proportional assignment of crime events to treatment and control facilities based on historical data, and thus diluted an intervention impact that might exist in these facilities. Together, the research team's response to these challenges resulted in a reduction in statistical power, increasing the likelihood of making a type II error (accepting the null hypothesis when it is false). This section explores alternative analyses to determine whether internal threats to validity affected the impact analysis results.

In order to identify any contamination or spillover effects from treatment to control facilities located at the same Metro stations, researchers compared changes in crime for those treatment and control facilities within the six stations that fit this criterion: Branch Avenue, College Park, Huntington, Shady Grove, Twinbrook, and Vienna. First, treatment and control facilities were analyzed separately within each of the stations. Independent samples t-tests were used to determine if there was a shift in the mean following camera deployment for each of the experimental groups. If contamination occurred it would be expected that a reduction in the treatment facility would be mirrored by a similar reduction in the control facilities. Analysis results indicated a significant change in the treatment facilities at the Shady Grove station for all car-related crime. However, the crime rate in control facilities at the same station only slightly increased. Therefore, contamination of the control facilities—where the treatment effect influenced the control group—does not appear to have occurred based on these limited findings. Indeed, when each crime type was assessed individually, there were no longer any statistically significant changes. For more details on the outcomes for these stations, refer to Tables F-1 to F-6 in Appendix F.

Despite the absence of evidence of contamination or diffusion, researchers nonetheless sought to identify an alternative proxy for a control area that would be immune from any spillover effects caused by the close juxtaposition of treatment and control facilities at the same station. To do so, reported crime data from the surrounding jurisdictions were employed to compare the change within the stations to crime nearby. The immediate vicinity of each Metro station was primarily residential, but this provided the closest comparison to how crime within the station's parking facilities on a whole related to crime patterns in the overall area. For this method, crime data in all the parking facilities within each of the multi-facility stations—the same six stations used above—were pooled across treatment and control facilities. Then pre- and post-intervention means for these stations were compared to pre- and post-intervention means for the one-mile areas surrounding the stations, employing independent samples t-tests and DiD analyses. This analysis yielded only one statistically significant finding: car crimes across both treatment and control facilities at the Shady Grove station increased significantly between pre- and post-intervention periods (driven largely by motor vehicle theft). However, when the one-mile buffer was introduced as the control in the DiD analysis, the significant increase became a significant decrease because motor vehicle theft rose quite a bit in the one-mile area (thus resulting in a minimal increase at the station and a significant one). This provides slight but not convincing evidence that cameras in the Shady Grove station insulated the area from a large spike in auto theft that was experienced in the surrounding area. As shown in Tables F-7 to F-12 in Appendix F, there were no other statistical changes identified in the other five stations and their surrounding jurisdictions.

To address any threats to internal validity stemming from the proportional assignment of crime events that was required for facilities located in four of the stations that lacked facility-specific information (see the *Research Design and Methods* chapter for more details), the same impact analyses conducted in the *Analysis of Camera Deployment* section were also run without those facilities that required proportional assignment. The results indicated that the proportional assignment did not influence the outcome, with the t-tests and DiD analyses producing no statistically significant differences between the treatment and control facilities for any of the crime types included in this evaluation.

Geographic Displacement

Identifying crime declines in the treatment area without employing measures to detect displacement may generate misleading findings about the overall impact of the intervention. Given the absence of a reduction of car-related crime in the treatment facilities, tests for displacement are not typically appropriate. Indeed, as the previous analysis comparing crime changes in multi-facility stations to crime changes in the surrounding area indicates, cameras were not effective in the parking facilities nor did they influence crime in the surrounding areas, either positively or negatively. The one exception is the slight increase in car crimes in the one-mile area surrounding the Shady Grove station, but that was not accompanied by a decrease in car crimes at the station itself. The next section presents the costs associated with the installation of the cameras and the level of crime reduction impact that would be necessary to render the intervention cost-effective.

Chapter 5. Cost-Effectiveness Analysis

The final step in determining the effectiveness of the camera and signage intervention involved evaluating the costs associated with camera implementation against the benefits of the cameras. The benefit in this case would be the monetary value associated with the prevention of crime attributed to the intervention, both in terms of direct and indirect criminal justice and victim costs. As previously discussed, cameras are relatively costly to implement and maintain. The research team assisted with negotiating funds to cover the labor hours and hardware needed for such a camera system, as well as providing support under the current grant. Initially the rough estimate for the cost of installing live cameras in all 25 of the treatment facilities—with one per vehicle exit—totaled $292,350. This estimate was based on a per facility cost of $11,694, including both hardware and software installation fees and assuming an average of three exits per facility.[27]

Site observations confirmed that there were a total of 75 exit lanes in the 25 facilities selected for treatment. Since one facility already had existing cameras, researchers calculated a rough purchase and installation cost estimate for the remaining 24 facilities.[28] Because the estimated cost of installing live cameras at each exit lane was prohibitive, the decision was made to use dummy cameras as a cost-saving measure; one live camera and two dummy cameras were used at each of these 24 facilities. The estimated cost of installing a camera system with one live camera at each of these facilities was $189,264. The estimated cost of purchasing 45 additional dummy cameras to be installed at each exit lane without a live camera was $2,250, with a per dummy camera cost of $50. Thus, the total estimated cost of installing one live camera and two dummy cameras at 24 facilities was $199,450.

As shown in Table 5.1, the costs of the intervention were broken into four categories: equipment and infrastructure, maintenance, external services, and internal labor. The equipment and infrastructure costs ($40,387) included the cameras (which had vandal-proof, weatherproof

[27] The use of dummy cameras was employed as a cost-saving measure.
[28] One of the facilities selected for treatment, the Shady Grove North garage, already had cameras installed at each of its six exit lanes. At the time, it was the only facility within the Metro system that had cameras installed there. Our cost estimate assumed that no additional cameras would be installed in these lanes but that camera signage would be erected there.

domes) and the infrastructure (including video cable and power supply) to support them. A DVR, equipped with an 80 gigabyte hard drive and stored in a tamperproof lock box, was used to record footage. The installation of the cameras, power, and signal lines (which included conduit) from external vendors cost $27,962. The WMATA project manager was involved with purchasing the equipment and assisting with installation of the cameras. Detailed records of the number of labor hours spent on implementation were kept throughout the project period. The overtime internal labor costs for the project manager were fully loaded (i.e., they included benefits) and totaled $9,230. Maintenance was not reported over the project period. Overall, these expenses came to a total intervention cost of $77,579, significantly less than the estimated costs of $199,450. Costs were reduced because the WMATA project manager was able to work with an existing vendor to negotiate a lower cost for the hardware and identified an MTP staff person with technical expertise to do the installation rather than using an outside vendor.

Table 5.1: Costs of Intervention

Type of Cost		Cost ($)
Equipment and Infrastructure	*Cameras with vandal-proof, weatherproof dome; DVR and lock box; 80 GB hard drive; power supply; video cable; and shipping fees*	$40,387
Maintenance	*No maintenance performed*	$0
External Services	*Installation of cameras, power, and signal lines (including conduit)*	$27,962
Internal Labor	*Overtime worked by WMATA's project manager to oversee and assist with installation*	$9,230
Total		**$77,579**

Note: Costs incurred from inception in April 2008. Costs compiled by Urban Institute staff based on receipts provided by WMATA.

Given the fact that there were no impacts on car-related crime identified in the treatment facilities, there were no net benefits of the cameras. However, it is useful to determine what degree of crime reduction would enable the camera system to "pay for itself." Considering potential societal savings (both justice system costs and costs of victimization) associated with motor vehicle theft, the camera system would have to be associated with a reduction of just 12 auto thefts in order to be cost-effective (based on the FBI's 2009 estimate of the average cost per motor vehicle theft of $6,505). In other words, if two motor vehicle thefts were prevented per month across all commuter parking facilities, it would take six months before a savings would occur (12 × $6,505 = $78,060). This calculation does not include anticipated savings from the prevention of *attempted* auto thefts, which often result in vehicle damage, nor does it include expected reductions in thefts *from* cars and increased revenues from greater customer perceptions of safety, which are likely to increase parking facility usage.

Chapter 6. Summary and Implications

This project set out to test the application of SCP to identify and evaluate a measure designed to prevent car-related crimes in commuter parking facilities. The intervention implemented—installation of digital cameras and accompanying signage at the exits of treatment facilities—was selected based on a thorough assessment of the characteristics of Metro's parking facilities that created opportunities for crime. Site observations of Metro's parking facilities identified a lack of formal surveillance as a key vulnerability, and cameras were theorized to increase the perceptions of potential offenders that they were at greater risk of apprehension due to the cameras. Consistent with this theory, cameras were accompanied by prominent signs advertising their presence. It is important to emphasize that these cameras were not actually surveillance cameras since these cameras only had the ability to capture images as cars exited facilities. Moreover, due to budget limitations, only one-third of the cameras were live, rendering the intervention of limited use for investigative purposes. Nonetheless, the theory that the cameras (whether live or dummy), together with signage, increased *perceptions* of formal surveillance was deemed worthy of testing. Applying a rigorous random assignment design, researchers aimed to isolate the impact of this intervention on car-related crime.

The impact analysis results from this project, however, yielded no significant findings. Both car crime specifically and crimes in general in the treatment facilities did not differ statistically from those in the control facilities. Employing multiple levels and types of analyses and controls, including using crime in the one-mile area surrounding Metro stations as both an additional control and a location of potential displacement or diffusion, researchers found no intervention effects whatsoever.

It bears noting that the integrity of the RCT employed for this project had inherent threats to internal validity that may relate to the lack of an intervention impact. The original research design had always been centered on the use of individual parking facilities rather than stations as the unit of analysis, but during the course of the evaluation researchers discovered that specificity in the location of crime events was lacking for a subset of facilities located in multi-facility stations. While corrective measures were taken, these threats to validity dilute the confidence with which researchers concluded that the intervention had no impact. However, additional statistical tests to determine if the lack of location specificity and proximity of treatment to control facilities in a subset of stations had an impact on analysis results indicated that these threats to validity had no bearing on intervention effectiveness.

Both theory and prior research support this study's findings that the cameras had no discernable impact on crime. While prominently advertised through signage, the cameras were not integrated into law enforcement patrol or investigative activities. The absence of a close-circuit component to the cameras precluded staff from viewing them from a central location to intervene on the scene during crimes in progress. Moreover, while a portion of the cameras had the ability to record and thus presented the possibility of aiding in investigations, camera footage had to be downloaded manually from each individual camera location and officers may have had difficulty determining which cameras were live versus dummy. This level of effort likely resulted in minimal use of camera footage.

Recent research on the use of public surveillance cameras in high-crime areas supports the lack of impact found in this evaluation, finding that cameras are most likely to have an impact when they are highly concentrated, actively monitored, and well integrated into law enforcement crime control and investigative activities (La Vigne et al, 2011). These are critical factors that both current and future investors in camera systems should consider when implementing or expanding camera systems. It is equally important for law enforcement agencies to understand that technology is only as good as the manner in which it is employed. If it is employed minimally or is not well integrated into other policing functions, it is unlikely to yield a significant impact on crime. On a positive note, camera systems such as those implemented by MTP need not have a large impact on crime in order to be cost-effective, suggesting that an enhanced version of this type of intervention—cameras with surveillance capabilities—merits consideration by entities aiming to prevent car crimes in parking facilities.

Appendix A. References

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Appendix B. Site Observation Instrument

Facility Number	
Description	
Type Of Facility	**Signage**
Number Of Spaces	Directions Clearly Marked
Metered Spaces	Signs Easy To Read
Payment Policy	Signs Obstruct Natural Surveillance
Daily Parking Fee	Signs For Locking Up Valuables
	Signs For Other Habits
Observer Initials	Numbers/Letters To Remind Where Parked
Date	
Time	**Security Features**
	CCTV
Station Features	Number Of Visible Cameras
Bus Bay(S)	Panic Buttons
Kiss And Ride	Intercoms
Bike Rack(S)	Emergency Phones
Bike Rack Locations	Uniformed Security
	Security Present At All Times
Facility Surroundings	Mirrors
Residential	
Commercial	**Immediate Surroundings**
Industrial	Grass Or Flat Land
Other	Woods Or Trees
	City/Concrete
Another Facility Adjacent	Other
Another Facility Nonadjacent	
Metered Spaces Adjacent	Highest Obstruction By Hedges
Metered Spaces Nonadjacent	Lowest Obstruction By Hedges

Direct Highway Access

Indirect Highway Access

Shopping Area Or Mall

Gas Station Or Conv. Store

School

Attendant Booth

Number Of Attendants On Duty

View Of Facility From Attendant Booth

Visibility Into Booth

All Pedestrian Enter/Exits Visible From Booth

All Vehicle Enter/Exits Visible From Booth

Entrances / Exits

Number Of Vehicle Entrances/Exits

Automatic Gates At Each Entrance

Automatic Gates At Each Exit

Entrances And Exits Are Together

Separate Pedestrian Entrances/Exits

Number Of Pedestrian Entrances/Exits

Physical Environment

Facility Is Clean

Facility Is Well Maintained

Trash Cans

Litter

Graffiti

Evidence Of Deterioration

Construction

Lot Only

Fence Around Perimeter

Fence Height

Fence Blocks Vision

Garage Only

Number Of Elevators

Number Of Stairwells

Elevators Along Perimeter

Stairwells Along Perimeter

Elevators Permit Surveillance From Outside

Stairwells Permit Surveillance From Outside

Glass-Backed Elevators (Look Out)

Glass Backed Or Open Stairs (Look Out)

Elevator Lobbies Open To Garage

Ceiling/Clearance Height

Lowest Light Measurement

Overall Lighting

General Information

Number Of Levels

Current Utilization

Dead-ends In Facility

Facility Visible From

Bus Stop

Metro Exit/Entrance

Other

Appendix C. Detailed Summary of Site Observations

This section includes more detailed information from the site observations conducted at 35 Metro stations. The information is categorized according to topical areas specified in the site observation instrument presented in Appendix B.

Access Control. All of Metro's parking facilities had automatic gates at the entrances and exits, and all of the facilities required drivers to use a SmarTrip card to pay for daily parking fees. SmarTrip cards are electronic payment cards used by Metro to collect fares for parking and trains. As of June 2005, commuters were required to use SmarTrip cards to pay for parking in Metro-owned facilities.

In the majority of facilities (90 percent), payment was collected upon exit. In the remaining 10 percent of facilities, payment was collected upon entrance. The daily fees charged for parking at the facilities ranged from $2.50 to $4.00.

Entrances and Exits. More than three-fourths of the facilities (77 percent) had vehicle entrances and exits that were immediately adjacent to each other, while the remaining 23 percent of facilities had at least one vehicle entrance or exit located some distance from the other entrances and exits. More than half of the facilities (54 percent) had only one vehicle entrance and exit, while 31 percent of the facilities had two vehicle entrances and exits, and 15 percent of the facilities had three or more vehicle entrances and exits.

All of the facilities had formal pedestrian entrances and exits that were separate from the vehicle entrances, although it should be noted that in most facilities pedestrians can also enter and exit through the vehicle entrances and through informal passageways. Of these facilities, 12 percent had only one pedestrian entrance, 27 percent had two pedestrian entrances, 31 percent had three pedestrian entrances, and 15 percent had four or more pedestrian entrances. In general, the number of pedestrian exits was correlated with facility size.

Facility Surroundings. The majority (71 percent) of Metro's parking facilities were adjacent to residential areas. Less than half (44 percent) bordered commercial areas, and fewer than one in six (15 percent) were adjacent to industrial areas. More than 70 percent of the facilities had direct or indirect highway access, and 40 percent were immediately adjacent to other WMATA-owned parking facilities. Approximately one-fifth (21 percent) of the facilities were located in view of shopping areas, while a far lower share of the facilities were located in view of gas stations or convenience stores (8 percent and 5 percent, respectively).

Employee Surveillance. At 31 of the facilities visited (60 percent), there was at least one parking attendant on duty during the time of the visit. In some cases, the attendants were stationed inside the attendant booths at the entrances and exits of the facility, while in other cases the attendants were patrolling the facilities on foot. All 52 of the WMATA-owned parking facilities had attendant booths, but the views from and into these booths varied considerably among the facilities.

Attendant Booths. In three of the facilities visited (6 percent), none of the parking spaces in the facilities were visible from the attendant booth(s). In 18 of the facilities (35 percent), a small share of the spaces were visible from the booth(s); in the remaining 31 facilities (60 percent), around half of the spaces were visible. None of the 52 facilities visited had attendant booths from which most or all of the parking spaces in the facility were visible. Interestingly, while approximately two-thirds of the facilities (67 percent) had booths with a complete view of all vehicle entrances and exits, only three of the parking facilities (6 percent) had booths with a complete view of all pedestrian entrances and exits.

Visibility into the attendant booths was similarly varied among the facilities. In 40 percent of the facilities, the interior of the attendant booth(s) was completely or mostly visible from the outside, in 29 percent the interior was partly visible, and in 31 percent the interior was barely or not at all visible. Some of the booths had dark or tinted glass that obstructed view into the booths, while others had posters obstructing view. These obstructions to booth visibility make it more difficult for commuters to know whether an attendant is inside if someone should need assistance, especially in reporting a crime in progress. Similarly, posters and dark glass can also obstruct an attendant's view of the parking facility.

Facility Maintenance. Overall, the Metro parking facilities were in good physical condition and were generally well maintained. At the time of the visits, the vast majority of the facilities were clean (94 percent), had little or no litter (96 percent), were free from graffiti (90 percent), and displayed little or no evidence of deterioration (90 percent).[29] Less than half (42 percent) of the facilities provided trash cans for customer use. Of the 52 facilities, 8 (15 percent) were undergoing some form of construction at the time of the visits.

Signage. In general, the style and content of signs in WMATA-owned parking facilities varied by facility type. Though signs in all types of facilities were easy to read (98 percent) and did not obstruct natural surveillance (98 percent), definite differences existed between the signage in parking garages and the signage in parking lots. While 80 percent of the parking garages had numbers or letters posted to remind customers where they had parked (e.g., B1), only one-third of lots had comparable marking schemes. Moreover, 80 percent of garages had signs reminding customers to lock up their valuables, yet none of the 32 parking lots had such reminders. Sixty percent of garages also had signs banning certain behaviors, such as smoking or skateboarding, while none of the lots had similar signs. The signage characteristics of the combination facilities, which contained garages within parking lots, mirrored those of the regular parking garages.

Security Features. Only 7 of the 52 WMATA-owned parking facilities had Closed Circuit Television (CCTV) at the time of our visits. Among the facilities that had CCTV, the number of visible cameras ranged from 1 to 11, and the median number was 3. Twelve of the 52 facilities had panic buttons (23 percent), and 13 had intercoms or emergency phones (25 percent). Almost all of the facilities with CCTV, panic buttons, and intercoms or emergency phones were multi-level garages. None of the facilities had a uniformed security guard at the time of our visit, and none had mirrors to improve visibility.

Lot Characteristics. The observation instrument contained a list of questions that pertained only to parking lots. Among the lot-specific questions, the most varied results related to fencing. One-third of the lots were completely fenced in (no openings other than pedestrian and vehicle entrance and exits), over 60 percent of the lots had partial fencing, and the remaining 6 percent of lots had no fencing at all. The fences ranged in height from three feet to nine feet, with an average height of five feet. In the large majority of lots (89 percent), the fences did not

[29] These figures were impressive given that the dates and times of the site visits were unannounced, leaving no opportunity for WMATA staff to make changes to the physical appearance of the facilities in anticipation of the visits.

block vision into or out of the facility at all; in the minority of lots (11 percent), vision into and out of the facility was completely or partially blocked by fencing.

Garage Characteristics. WMATA-owned garages ranged in size from two to eight levels, with a median size of five levels. The ceiling height of the garages ranged from 6 to 10 feet, with an average ceiling height between seven and eight feet. The lighting quality of the Metro garages was also quite varied: 20 percent of the garages had substantial natural light throughout the facility, 60 percent had areas with little natural light, and the remaining 20 percent had areas with no natural light at all. Since the site visits were conducted during daylight hours (coinciding with the peak hours of crime commission in the facilities), the survey instrument did not include measures for artificial lighting.

The greatest variations in garage characteristics involved elevators and stairwells. Elevators were present in over three-fourths of the parking garages, and the median number of elevators per garage was slightly less than two. In all but one of the 18 facilities with elevators, the elevators were located on the perimeter of the facility; over four-fifths (81 percent) permitted surveillance from the outside in, and an even higher percentage (88 percent) had glass backs that permitted surveillance from the inside out. In all but one of the facilities with elevators, the elevator waiting areas were open to the rest of the garage, permitting surveillance from the waiting areas to the parking areas and vice versa.

Similarly, the number of stairwells in the garages was also varied, ranging from two to seven stairwells, with an average of just over four stairwells per garage. All but one of the 20 facilities with stairwells had stairwells located along the perimeter of the facility, 80 percent of which permitted surveillance from the outside in and 85 percent of which permitted surveillance from the inside out.

Other Surveillance. At many of the Metro stations with parking facilities, the lots and garages were partially or completely visible from other WMATA-owned property at the station. Thirty of the facilities visited (57 percent) were at least partially visible from the bus bays at their respective stations, and 21 of the facilities (39 percent) were at least partially visible from an entrance or exit to the Metro station.

All 52 facilities were at least partially surrounded by hedges or other landscaping, some of which obstructed the views into and out of the facilities. Slightly less than one-third of the facilities (29 percent) were not at all obstructed by hedges, slightly more than one-third were barely or partially obstructed by hedges (38 percent), and the remaining one-third of facilities (33 percent) were substantially or completely blocked from view from outside view by hedges.

Appendix D. Adaptation of Clarke's (1997) Opportunity Reducing Techniques Matrix

Increasing the Effort	Increasing the Risks	Other
1. <u>Access Control</u> Number of pedestrian entrances Number of vehicle entrances Fencing: complete/partial Fence height Number of Stairs/Elevators AM/PM	3. <u>Formal Surveillance</u> Police patrols Security guards Number of attendants Visibility from booth (facility exits) Visibility into booth CCTV: yes/no Number of visible cameras Emergency phones Intercoms	6. <u>Target Removal</u> Signs to lock up valuables 7. <u>Land Use</u> Residential Commercial Industrial
2. <u>Controlling Facilitators</u> Highway access Shopping areas Gas stations Schools	4. <u>Natural Surveillance</u> Visibility from bus bays Visibility from metro exit Stairs/Elevators on perimeter Stairs/Elevators look out Stairs/Elevators look in Overall lighting Lowest light measurement Ceiling height Fence blocks vision Obstruction by hedges Surroundings (grass, trees, city)	8. <u>Current Utilization</u> 9. <u>Facility Type</u>
	5. <u>Perception of Surveillance (Disorder)</u> Graffiti Litter Cleanliness Maintenance Deterioration Trash cans Signs for other habits	

Appendix E. Matched Pairs of Parking Facilities

Pairing No.	Treatment Facility	Control Facility	Matched Dimensions
1	Facility Type: GARAGE Total Thefts: 76 Crime Rate: HIGH-700 Capacity: 1980 Line: SE GREEN	Facility Type: GARAGE Total Thefts: 103 Crime Rate: HIGH-932 Capacity: 1890 Line: SE GREEN	MATCHED ON ALL 5 DIMENSIONS
2	Facility Type: GARAGE Total Thefts: 51 Crime Rate: HIGH-768 Capacity: 1068 Line: NE GREEN	Facility Type: GARAGE Total Thefts: 27 Crime Rate: HIGH-987 Capacity: 808 Line: SE GREEN	Not matched on: Line
3	Facility Type: GARAGE Total Thefts: 21 Crime Rate: LOW-271 Capacity: 1340 Line: NE GREEN	Facility Type: GAR-MIX Total Thefts: 28 Crime Rate: LOW-257 Capacity: 1781 Line: NE RED	Not matched on: Line
4	Facility Type: GARAGE Total Thefts: N/A-NEW Crime Rate: MID-461 Capacity: 2200 Line: E BLUE	Facility Type: GARAGE Total Thefts: N/A-NEW Crime Rate: MID-540 Capacity: 1747 Line: E ORANGE	Not matched on: Line
5	Facility Type: GAR-MIX Total Thefts: 14 Crime Rate: LOW-204 Capacity: 1310 Line: NW RED	Facility Type: GARAGE Total Thefts: N/A-NEW Crime Rate: MID-323 Capacity: 1270 Line: NW RED	Not matched on: Facility Type
6	Facility Type: LOT Total Thefts: 39 Crime Rate: HIGH-1016 Capacity: 333 Line: E ORANGE (AM LOT)	Facility Type: LOT Total Thefts: 21 Crime Rate: HIGH-1319 Capacity: 340 Line: NE RED (AM LOT)	Not matched on: Line
7	Facility Type: LOT Total Thefts: 15 Crime Rate: HIGH-1001 Capacity: 368 Line: SE GREEN	Facility Type: GARAGE Total Thefts: 63 Crime Rate: HIGH-782 Capacity: 268 Line: E BLUE	Not matched on: Facility Type Line
8	Facility Type: LOT Total Thefts: 41 Crime Rate: HIGH-873 Capacity: 372 Line: E BLUE (AM LOT)	Facility Type: LOT Total Thefts: 68 Crime Rate: HIGH-895 Capacity: 194 Line: E ORANGE (AM LOT)	Not matched on: Line
9	Facility Type: LOT Total Thefts: 12 Crime Rate: MID-642 Capacity: 1185 Line: E ORANGE	Facility Type: LOT Total Thefts: 28 Crime Rate: MID-540 Capacity: 825 Line: E ORANGE	MATCHED ON ALL 5 DIMENSIONS

Pairing No.	Treatment Facility	Control Facility	Matched Dimensions
10	Facility Type: LOT Total Thefts: 11 Crime Rate: MID-642 Capacity: 681 Line: E ORANGE	Facility Type: LOT Total Thefts: 24 Crime Rate: MID-540 Capacity: 590 Line: E ORANGE	MATCHED ON ALL 5 DIMENSIONS
11	Facility Type: LOT Total Thefts: 26 Crime Rate: MID-303 Capacity: 453 Line: NE GREEN	Facility Type: LOT Total Thefts: 21 Crime Rate: LOW-271 Capacity: 530 Line: NE GREEN	MATCHED ON ALL 5 DIMENSIONS
12	Facility Type: LOT Total Thefts: 13 Crime Rate: LOW-199 Capacity: 524 Line: NW RED	Facility Type: LOT Total Thefts: 11 Crime Rate: LOW-144 Capacity: 596 Line: NE RED	Not matched on: Line
13	Facility Type: LOT Total Thefts: 8 Crime Rate: LOW-244 Capacity: 847 Line: NW RED	Facility Type: LOT Total Thefts: 14 Crime Rate: LOW-204 Capacity: 922 Line: NW RED	MATCHED ON ALL 5 DIMENSIONS
14	Facility Type: LOT Total Thefts: 8 Crime Rate: LOW-85 Capacity: 361 Line: S BLUE	Facility Type: LOT Total Thefts: 4 Crime Rate: LOW-244 Capacity: 250 Line: NW RED	Not matched on: Line
15	Facility Type: LOT Total Thefts: 12 Crime Rate: LOW-191 Capacity: 731 Line: SE GREEN	Facility Type: LOT Total Thefts: 10 Crime Rate: LOW-222 Capacity: 500 Line: E ORANGE	Not matched on: Line
16	Facility Type: LOT Total Thefts: 19 Crime Rate: LOW-191 Capacity: 1241 Line: SE GREEN	Facility Type: LOT Total Thefts: 18 Crime Rate: LOW-191 Capacity: 1100 Line: SE GREEN	MATCHED ON ALL 5 DIMENSIONS
17	Facility Type: LOT Total Thefts: 18 Crime Rate: LOW-56 Capacity: 515 Line: W ORANGE	Facility Type: LOT Total Thefts: 12 Crime Rate: LOW-107 Capacity: 422 Line: W ORANGE	MATCHED ON ALL 5 DIMENSIONS
18	Facility Type: LOT Total Thefts: 11 Crime Rate: LOW-56 Capacity: 680 Line: W ORANGE	Facility Type: LOT Total Thefts: 13 Crime Rate: LOW-56 Capacity: 615 Line: W ORANGE	MATCHED ON ALL 5 DIMENSIONS

Pairing No.	Treatment Facility	Control Facility	Matched Dimensions
19	Facility Type: LOT Total Thefts: 12 Crime Rate: LOW-210 Capacity: 924 Line: S YELLOW	Facility Type: LOT Total Thefts: 6 Crime Rate: LOW-182 Capacity: 1319 Line: W ORANGE	Not matched on: Line
20	Facility Type: GAR-MIX Total Thefts: 15 Crime Rate: LOW-204 Capacity: 3235 Line: NW RED	Facility Type: LOT Total Thefts: 77 Crime Rate: LOW-116 Capacity: 3399 Line: NE GREEN	Not matched on: Facility Type Line
21	Facility Type: GARAGE Total Thefts: 14 Crime Rate: LOW-210 Capacity: 1281 Line: S YELLOW	Facility Type: GARAGE Total Thefts: 6 Crime Rate: LOW-210 Capacity: 885 Line: S YELLOW	Not matched on: *Capacity*- OK
22	Facility Type: GARAGE Total Thefts: N/A-NEW Crime Rate: LOW-148 Capacity: 2009 Line: W ORANGE	Facility Type: GAR-MIX Total Thefts: 9 Crime Rate: LOW-94 Capacity: 1894 Line: NW RED	Not matched on: Facility Type Line
23	Facility Type: GARAGE Total Thefts: 12 Crime Rate: LOW-56 Capacity: 1865 Line: W ORANGE	Facility Type: GARAGE Total Thefts: 18 Crime Rate: LOW-56 Capacity: 2174 Line: W ORANGE	MATCHED ON ALL 5 DIMENSIONS
24	Facility Type: GARAGE Total Thefts: 23 Crime Rate: MID-539 Capacity: 977 Line: NE RED (AM LOT)	Facility Type: LOT Total Thefts: N/A-NEW Crime Rate: MID-368 Capacity: 608 Line: E BLUE	Not matched on: AM/PM Payment Facility Type Line
25	Facility Type: LOT Total Thefts: 26 Crime Rate: MID-421 Capacity: 408 Line: RED/GREEN (AM LOT)	Facility Type: LOT Total Thefts: 12 Crime Rate: MID-540 Capacity: 351 Line: E ORANGE	Not matched on: AM/PM Payment Facility Type Line

Appendix F. Detailed Summary of Findings

Table F-1: Changes in Car-Related Crime, Branch Avenue Station

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Car-Related Crime	Treatment	1.08	1.42	+0.33	-0.61	
	Comparison	1.75	1.50	-0.25	0.29	+0.58
Auto Theft (w/ Att.)	Treatment	0.42	1.00	+0.58	-1.29	
	Comparison	0.67	0.75	+0.08	-0.21	+0.50
Auto Theft (w/o Att.)	Treatment	0.17	0.50	+0.33	-1.48	
	Comparison	0.25	0.50	+0.25	-0.94	+0.08
Attempted Auto Theft	Treatment	0.25	0.50	+0.25	-0.86	
	Comparison	0.42	0.25	-0.17	0.53	+0.42
Theft from Auto	Treatment	0.67	0.42	-0.25	0.73	
	Comparison	1.08	0.75	-0.33	0.42	+0.08

†Significant at $p < .05$.

Table F-2: Changes in Car-Related Crime, College Park Station

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Car-Related Crime	Treatment	1.42	1.42	0.00	---	
	Comparison	1.42	2.00	+0.58	-0.78	-0.58
Auto Theft (w/ Att.)	Treatment	0.00	0.08	+0.08	-1.00	
	Comparison	0.33	0.25	-0.08	0.36	+0.17
Auto Theft (w/o Att.)	Treatment	0.00	0.08	+0.08	-1.00	
	Comparison	0.25	0.08	-0.17	1.08	+0.25
Attempted Auto Theft	Treatment	0.00	0.00	0.00	---	
	Comparison	0.08	0.17	+0.08	-0.60	-0.08
Theft from Auto	Treatment	1.42	1.33	-0.08	0.11	
	Comparison	1.08	1.75	+0.67	-1.03	-0.75

†Significant at $p < .05$.

Table F-3: Changes in Car-Related Crime, Huntington Station

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Car-Related Crime	Treatment	0.00	0.17	+0.17	-1.48	
	Comparison	0.08	0.50	+0.42	-1.39	-0.25
Auto Theft (w/ Att.)	Treatment	0.00	0.00	0.00	---	
	Comparison	0.00	0.08	+0.08	-1.00	-0.08
Auto Theft (w/o Att.)	Treatment	0.00	0.00	0.00	---	
	Comparison	0.00	0.08	+0.08	-1.00	-0.83
Attempted Auto Theft	Treatment	0.00	0.00	0.00	---	
	Comparison	0.00	0.00	0.00	---	---
Theft from Auto	Treatment	0.00	0.17	+0.17	-1.48	
	Comparison	0.08	0.42	+0.33	-1.11	-0.17

†Significant at $p < .05$.

Table F-4: Changes in Car-Related Crime, Shady Grove Station

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Car-Related Crime	Treatment	0.25	2.17	+1.92	-2.14†	
	Comparison	0.17	0.25	+0.08	-0.34	+1.83
Auto Theft (w/ Att.)	Treatment	0.08	0.42	+0.33	-1.59	
	Comparison	0.00	0.08	+0.08	-1.00	+0.25
Auto Theft (w/o Att.)	Treatment	0.08	0.42	+0.33	-1.59	
	Comparison	0.00	0.08	+0.08	-1.00	+0.25
Attempted Auto Theft	Treatment	0.00	0.00	0.00	---	
	Comparison	0.00	0.00	0.00	---	---
Theft from Auto	Treatment	0.17	1.75	+1.58	-2.06	
	Comparison	0.17	0.17	0.00	---	+1.58

†Significant at $p < .05$.

Table F-5: Changes in Car-Related Crime, Twinbrook Station

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Car-Related Crime	Treatment	0.00	0.25	+0.25	-1.91	
	Comparison	0.00	0.08	+0.08	-1.00	+0.17
Auto Theft (w/ Att.)	Treatment	0.00	0.08	+0.08	-1.00	
	Comparison	0.00	0.00	0.00	---	+0.08
Auto Theft (w/o Att.)	Treatment	0.00	0.08	+0.08	-1.00	
	Comparison	0.00	0.00	0.00	---	+0.08
Attempted Auto Theft	Treatment	0.00	0.00	0.00	---	
	Comparison	0.00	0.00	0.00	---	---
Theft from Auto	Treatment	0.00	0.17	+0.17	-1.48	
	Comparison	0.00	0.08	+0.08	-1.00	+0.08

†Significant at $p < .05$.

Table F-6: Changes in Car-Related Crime, Vienna Station

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Car-Related Crime	Treatment	2.42	0.67	-1.75	1.34	
	Comparison	1.50	0.83	-0.67	0.98	-1.08
Auto Theft (w/ Att.)	Treatment	0.50	0.33	-0.17	0.80	
	Comparison	0.42	0.33	-0.08	0.31	-0.08
Auto Theft (w/o Att.)	Treatment	0.42	0.25	-0.17	0.84	
	Comparison	0.25	0.33	+0.08	-0.32	-0.25
Attempted Auto Theft	Treatment	0.08	0.08	0.00	---	
	Comparison	0.17	0.00	-0.17	1.48	+0.17
Theft from Auto	Treatment	1.92	0.33	-1.58	1.27	
	Comparison	1.08	0.50	-0.58	1.06	-1.00

†Significant at $p < .05$.

Table F-7: Changes in Car-Related Crime, Branch Avenue Station and 1-Mile Buffer

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Car-Related Crime	Metro Parking	2.83	2.92	+0.08	-0.09	
	1-Mile Buffer	2.83	3.17	+0.33	-0.11	-0.25
Auto Theft (w/ Att.)	Metro Parking	1.08	1.75	+0.67	-0.98	
	1-Mile Buffer	1.42	2.00	+0.58	-0.30	+0.08
Auto Theft (w/o Att.)	Metro Parking	0.42	1.00	+0.58	-1.86	
	1-Mile Buffer	1.25	1.83	+0.58	-0.33	---
Attempted Auto Theft	Metro Parking	0.67	0.75	+0.08	-0.15	
	1-Mile Buffer	0.17	0.17	0.00	---	+0.08
Theft from Auto	Metro Parking	1.75	1.17	-0.58	0.75	
	1-Mile Buffer	1.42	1.17	-0.25	0.22	-0.33

†Significant at $p < .05$.

Table F-8: Changes in Car-Related Crime, College Park Station and 1-Mile Buffer

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Car-Related Crime	Metro Parking	2.83	3.42	+0.58	-0.55	
	1-Mile Buffer	1.50	1.92	+0.42	-0.27	+0.17
Auto Theft (w/ Att.)	Metro Parking	0.33	0.33	0.00	---	
	1-Mile Buffer	0.25	0.33	0.08	-0.23	-0.08
Auto Theft (w/o Att.)	Metro Parking	0.25	0.17	-0.08	0.48	
	1-Mile Buffer	0.25	0.25	0.00	---	-0.08
Attempted Auto Theft	Metro Parking	0.08	0.17	+0.08	-0.60	
	1-Mile Buffer	0.00	0.08	+0.08	-1.00	---
Theft from Auto	Metro Parking	2.50	3.08	+0.58	-0.57	
	1-Mile Buffer	1.25	1.58	+0.33	-0.26	+0.25

†Significant at $p < .05$.

Table F-9: Changes in Car-Related Crime, Huntington Station and 1-Mile Buffer

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Car-Related Crime	Metro Parking	0.08	0.67	+0.58	-1.60	
	1-Mile Buffer	3.42	3.17	-0.25	0.21	+0.83
Auto Theft (w/ Att.)	Metro Parking	0.00	0.08	+0.08	-1.00	
	1-Mile Buffer	0.33	0.25	-0.08	0.32	+0.17
Auto Theft (w/o Att.)	Metro Parking	0.00	0.08	+0.08	-1.00	
	1-Mile Buffer	0.00	0.00	0.00	---	+0.08
Attempted Auto Theft	Metro Parking	0.00	0.00	0.00	---	
	1-Mile Buffer	0.00	0.00	0.00	---	---
Theft from Auto	Metro Parking	0.08	0.58	+0.50	-1.36	
	1-Mile Buffer	3.42	6.17	+2.75	0.21	+0.75

†Significant at $p < .05$.

Table F-10: Changes in Car-Related Crime, Shady Grove Station and 1-Mile Buffer

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Car-Related Crime	Metro Parking	0.42	2.42	+2.00	-2.19†	
	1-Mile Buffer	0.75	2.92	+2.17	-3.18†	-0.17
Auto Theft (w/ Att.)	Metro Parking	0.08	0.50	+0.42	-1.97	
	1-Mile Buffer	1.42	4.26	+2.84	-3.18†	-1.75†
Auto Theft (w/o Att.)	Metro Parking	0.08	0.50	+0.42	-1.97	
	1-Mile Buffer	0.75	4.23	+3.48	-3.18†	-1.75†
Attempted Auto Theft	Metro Parking	0.00	0.00	0.00	---	
	1-Mile Buffer	0.00	0.00	0.00	---	---
Theft from Auto	Metro Parking	0.33	1.92	+1.59	-1.97	
	1-Mile Buffer	0.00	0.00	0.00	---	1.58

†Significant at $p < .05$.

Table F-11: Changes in Car-Related Crime, Twinbrook Station and 1-Mile Buffer

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Car-Related Crime	Metro Parking	0.00	0.33	+0.33	-1.77	
	1-Mile Buffer	1.50	2.67	+1.17	-1.50	-0.83
Auto Theft (w/ Att.)	Metro Parking	0.00	0.08	+0.08	-1.00	
	1-Mile Buffer	1.50	2.67	+1.17	-1.50	-1.08
Auto Theft (w/o Att.)	Metro Parking	0.00	0.08	+0.08	-1.00	
	1-Mile Buffer	1.50	2.67	+1.17	-1.50	-1.08
Attempted Auto Theft	Metro Parking	0.00	0.00	0.00	---	
	1-Mile Buffer	0.00	0.00	0.00	---	---
Theft from Auto	Metro Parking	0.00	0.25	+0.25	-1.39	
	1-Mile Buffer	0.00	0.00	0.00	---	0.25

†Significant at $p < .05$.

Table F-12: Changes in Car-Related Crime, Vienna Station and 1-Mile Buffer

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Car-Related Crime	Metro Parking	3.92	1.50	-2.42	1.67	
	1-Mile Buffer	0.33	0.42	+0.08	-0.35	-2.50
Auto Theft (w/ Att.)	Metro Parking	0.92	0.67	-0.25	0.65	
	1-Mile Buffer	0.33	0.42	+0.08	-0.35	-0.33
Auto Theft (w/o Att.)	Metro Parking	0.67	0.58	-0.08	0.23	
	1-Mile Buffer	0.33	0.42	+0.08	-0.35	-0.17
Attempted Auto Theft	Metro Parking	0.25	0.08	-0.17	0.84	
	1-Mile Buffer	0.00	0.00	0.00	---	-0.17
Theft from Auto	Metro Parking	3.00	0.83	-2.17	1.58	
	1-Mile Buffer	0.00	0.00	0.00	----	-2.17

†Significant at $p < .05$.