WHY ARE OLDER CARS STOLEN?

EXAMINING MOTIVE, AVAILABILITY, LOCATION, AND SECURITY

by

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ABSTRACT

Why are older cars stolen? Examining Motive, Availability, Location, and Security

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Older cars account for a majority of all stolen cars in the United States. This phenomenon has also been reported in other Western countries. Indices from Australia and the U.K. further reveal that the risk of theft increases as cars become older. This study examines mechanisms of theft of older cars through answering its main research question: "Why are older cars more stolen than their newer counterparts?" The question is addressed from the perspective of availability, security, location, and offender motive.

This project utilizes Google Street View for two purposes: (1) to estimate the number of vehicles parked on the sampled streets in Newark; and (2) to measure land use and physical disorder at the street level. Vehicle security is measured by the presence of factory-installed electronic immobilizers. This study draws on the principle of triangulation, gathering an array of evidence from different analyses using data from different sources to investigate mechanisms of theft of older cars.

Multilevel negative binominal regression is conducted for the street-level location analyses to examine the impact of physical disorder and land use on the counts of older cars parked and those stolen on the streets. Multilevel logistic regression analyses are performed to determine the effects of predictor variables on the likelihood of cars being stolen, recovered, and stripped of their parts.

Results show that older cars are more stolen because there are more older cars available to steal. However, this pattern varies considerably across vehicles makes.

Interaction terms indicate that Honda and Toyota become more likely to be stolen as they get older, while the opposite is true for Dodge and Ford. The vast majority of older cars lack electronic immobilizers which are found to reduce the likelihood of cars being stolen. Considering the magnitude of temporary thefts that are committed by opportunistic thieves, vehicle security is the most powerful determinant of theft of older cars. Physical disorder and certain types of land use have some impact on the likelihood of older cars being stolen, but their strength of predicting such an outcome is not close to that of security, vehicle age, and makes.

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CHAPTER 1

INTRODUCTION

The number of auto thefts in the United States has been declining since 1991, but nearly 800,000 vehicles were still reported stolen in 2009 (Federal Bureau of Investigation, 2010). The National Insurance Crime Bureau (NICB) has announced that auto theft costs North Americans an estimated $7.6 billion each year (2009). Although auto theft does not directly influence drivers who don't have their car stolen, all insured motorists pay for this crime through higher insurance rates, each paying hundreds of extra dollars annually in auto insurance premiums (NICB, 2009).

Among stolen vehicles in the United States, older cars are responsible for much of the auto theft problem, constituting the majority of the nation's top 10 most stolen vehicles (NICB, 2010). This study refers to a vehicle aged over nine years old as an older vehicle. According to the NICB, which compiles its list using data from the FBI's National Crime Information Center, the top 10 most frequently stolen vehicles between 2005 and 2009 are, on average, 14 years old when they were stolen (Table1). Specifically, older Japanese cars, early 90's Honda Civics and Accords and late 80's – early 90's Toyota Camrys, have dominated the nation's top 3 most stolen vehicles over the past five years. Data from insurers confirm that pattern, showing that older Japanese cars, especially Honda, and Toyota, have accounted for the major portion of the top ten stolen vehicles (CCC Information Services, 2002).

Table 1: Top 10 Most Frequently Stolen Vehicles in the U.S., 2005-2009

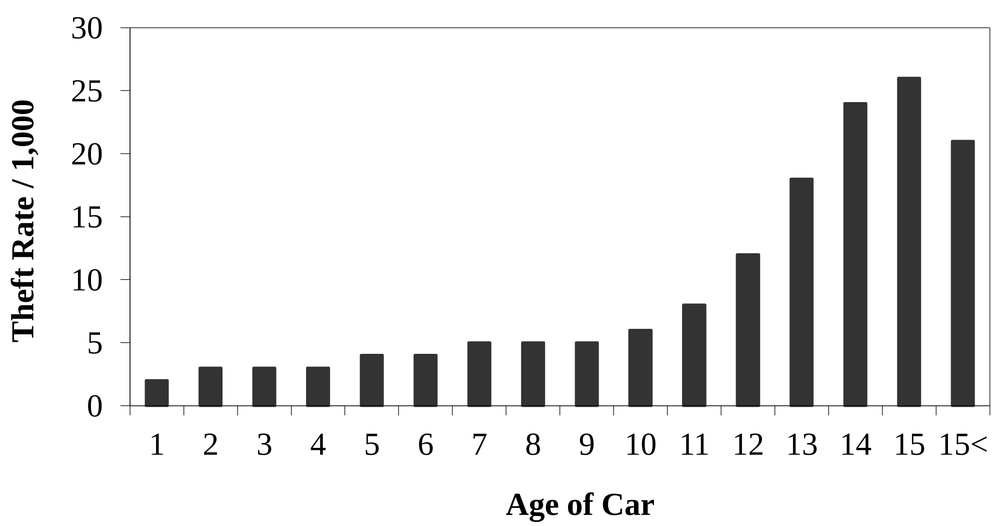
Rank	2005	2006	2007	2008	2009
1	1991 Honda Accord	1995 Honda Civic	1995 Honda Civic	1994 Honda Accord	1994 Honda Accord
2	1995 Honda Civic	1991 Honda Accord	1991 Honda Accord	1995 Honda Civic	1995 Honda Civic
3	1989 Toyota Camry	1989 Toyota Camry	1989 Toyota Camry	1989 Toyota Camry	1991 Toyota Camry
4	1994 Dodge Caravan	1997 Ford F150	1997 Ford F150	1997 Ford F150	1997 Ford F150
5	1994 Nissan Sentra	2005 Dodge Ram Pickup	1994 Chevy C/K 1500	2005 Dodge Ram Pickup	2004 Dodge Ram Pickup
6	1997 Ford F150	1994 Chevy C/K 1500	1994 Acura Integra	1994 Chevy C/K 1500	2000 Dodge Caravan
7	1990 Acura Integra	1994 Nissan Sentra	2004 Dodge Ram Pickup	1994 Nissan Sentra	1994 Chevy C/K 1500
8	1986 Toyota Pickup	1994 Dodge Caravan	1994 Nissan Sentra	1994 Acura Integra	1994 Acura Integra
9	1993 Saturn SL	1994 Saturn SL	1988 Toyota Pickup	1994 Saturn SL	2002 Ford Explorer
10	2004 Dodge Ram Pickup	1990 Acura Integra	2007 Toyota Corolla	1990 Acura Integra	2009 Toyota Corolla

Source: NICB 2006-2010

The problem of theft of older cars becomes more apparent in data from the Australian Motor Vehicle Theft Reduction Council's CARS Analyzer. It indicates that cars over 9 years old accounted for about 78 percent of cars stolen in Australia in 2008 (author's computations). Similarly, the U.K. Car Theft Index shows that older cars aged over 9 years old accounted for 75 percent of all cars stolen in the U.K. in 2005 (Home Office, 2006). These indices provide further insight into the nature of auto theft since they show theft rates for each car model.

For example, the 2006 car theft index[1] shows that the risk of theft increases with car age, peaking with cars aged 15 years (Figure1). More specifically, it reveals that the1993 Nissan Sunny GL (12 years old) had the highest risk of being stolen with theft rate of 146 per 1,000 registered, followed by the 1991 Vauxhall Astra MK2 L (108 per 1,000 registered) and the 1991 Rover Metro (99 per 1,000 registered), while the average theft rate was 7 per 1,000 registered cars. In sum, older cars are more stolen in the U.K. even after accounting for their high presence on the streets.

Figure 1: Theft Rates per 1,000 Cars Registered by Car Age in the U.K., 2005



Source: Home Office, 2006

Unlike the car theft indices from the U.K. and Australia, there is no publicly available data to determine the rate of theft per registered vehicles in the United States. However, CCC Information Services report that the year's most stolen vehicle tends to be the vehicle with the highest theft rate per registered vehicles (2006).

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[1] The 2006 car theft index is the most recent data available as of June 2011.

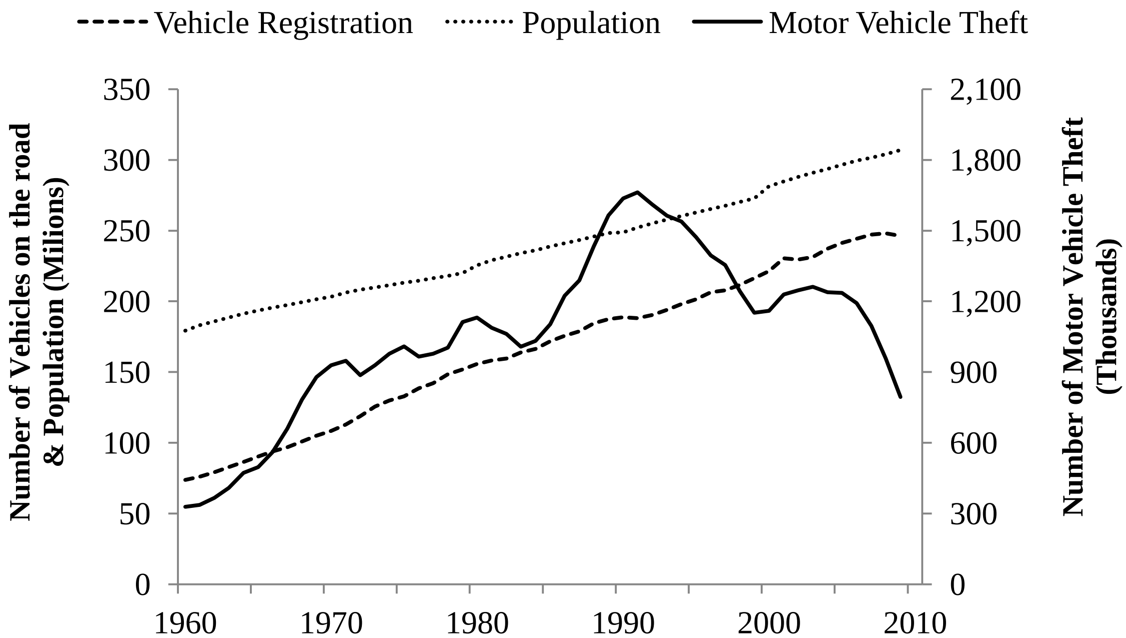
From less comprehensive data, it is evident that older cars are at the core of auto theft. The purpose of this study is to investigate why older cars are more often stolen than newer counterparts and what makes them vulnerable to theft. Before getting down to details, this study starts with describing the problem of auto theft in general.

The Role of Automobiles in Society

Despite some notable exceptions (e.g., Clarke and Harris, 1992a,b; Maxfield and Clarke, 2004; Maxfield and Clarke, 2009), auto theft still falls far short of a well-researched topic when considering the cultural importance of automobiles to North Americans as well as the prevalence and cost of auto theft (Cherbonneau and Wright, 2009). In an automobile-dominated society, streets are the veins of communities, especially in suburbs, while automobiles are like red blood. Both automobiles and streets have formed the organ of modern North American growth where streets usually precede the construction of homes and businesses.

Indeed, people in the U.S. spend more money on their vehicles than on food each year, and spend more money to maintain their vehicles than to pay for utilities and housekeeping supplies, apparel, healthcare, or education (Bureau of Labor Statistics, 2009). The American Community Survey estimates that 86 percent of workers aged 16 years old and older drive motor vehicles to work (U.S Census Bureau, 2009). Between 1960 and 2009, the number of vehicles registered in the U.S. increased by 233 percent, from about 74 million to 246 million (Federal Highway Administration, 2010), where the growth of vehicles on the road has outpaced by far the growth of population which increased 71 percent between the same periods (Figure 2).

Figure 2: Trends in Vehicle Fleet, Population and MVT in the U.S., 1960-2009



Sources: Federal Highway Statistics, 1961-2010; Bureau of Justice Statistics, 2010

The Prevalence of Auto Theft

In an environment where automobiles dominate our society, the prevalence and cost of auto theft are major concerns for members of society as well as victims. According to the UCR, in 2009 there were 794,616 auto thefts - 259 thefts per 100,000 residents - reported to the police, in which 72 percent of the stolen vehicles were cars (FBI, 2010). Between 1960 and 2009, the number of auto thefts increased by 142 percent although it has dropped dramatically since 1991 (Figure 1). In 2009, auto theft accounted for about 7 percent of all index crimes and about 9 percent of property crimes. In addition, when including theft of vehicle parts and accessories and theft from vehicles, vehicle-related crimes were responsible for 24 percent of all index crimes and 30 percent of property crimes (FBI, 2010).

The Cost of Auto Theft

Despite its declining rate, auto theft accounts for the highest losses among property crime excluding arson. The Uniform Crime Report estimated the value of motor vehicles stolen in 2009 at $5.2 billion which constituted 39 percent of total losses resulting from property crime. The average value of motor vehicles stolen in 2009 was $6,505, while the average losses resulted from larceny-theft and burglary were $864 and $2,096, respectively. Since 57 percent of the value of stolen vehicles were recovered, the net theft loss in 2009 would be about $2.2 billion, or $2,800 per incident (FBI, 2010), though this estimate is only based on the stolen vehicles which were not recovered.

As the figures from the National Crime Victimization suggests, some stolen vehicles are recovered with damage or missing parts. When the value of vehicle damage or property taken in the crime was taken into consideration, the average loss per incident was estimated to be $4,400 over 10 years ago (Rhodes et al., 1997). In addition, a study conducted in Australia has shown that the average loss for auto theft[2] is $5,050 (Rollings 2008), which is similar to the UK estimate of $4,950 (Dubourg et al., 2005).

Besides the direct economic losses associated with the value of the vehicle itself, victims may lose time from work or earnings. They also often have to, rent a temporary replacement vehicle or pay public transportation fees, and they also may suffer from emotional distress (Curtin et al., 2005; Clarke and Harris, 1992a; Field, 1993). According to the work of Klaus (1994) based on the Nation Crime Victimization Survey, the average loss per crime in 1992 was $524 for all crimes, $834 for burglary, and $3,990

[2] The calculation was base on value of property stolen plus value of property damaged minus property recovered.

for auto theft, after giving consideration to all forms of economic loss, medical expenses, and time lost from work because of the crime.

Furthermore, other costs of auto theft include, for example, an increase in insurance premiums, dollars spent protecting vehicles by car owners, accidents caused by joyriders or incurred in attempting to escape from a police pursuit, and the cost of criminal justice system (Clarke and Harris, 1992a; Curtin et al., 2005; Field, 1993). According to Field, the total social costs of auto theft for the United States in 1985 were estimated around $5 billion. The costs of victimization and theft prevention measures accounted for 27% of the total social costs while the criminal justice system costs associated with apprehension, prosecution, and punishment constituted 18%. The remaining 55% came from insurance premiums (Field, 1993).

Because the majority of auto theft involves older cars aged 10 years and older, much of the costs mentioned earlier would be attributed to these cars. Of course, since the value/price of older cars in general is lower than that of newer cars, the average monetary losses for theft of older cars may be substantially lower. However, the criminal justice system still suffers from the large number of auto thefts involving older cars when its limited resources are diverted to deal with individual cases (Drugs and Crime Prevention Committee, 2002). Also, theft of older cars especially produces hardship for low income residents who are likely to be an owner of those cars and whose cars are often not insured for the theft losses.

Overview of this Study

As describes in this chapter, older cars are at the core of auto theft that costs North Americans billions of dollars each year. They constitute the major portion of the nation's top ten stolen vehicles (NICB, 2010). Older cars are, in general, stolen more often than their newer counterparts even after taking into account their high presence on the road (Home Office, 2006). Auto theft research in the U.S. is limited compared to other Western countries (Maxfield and Clarke, 2004), but this is even more true for research on theft of older cars. No empirical research known to the author has investigated mechanisms of theft of older cars despite the evidence that they are at most risk of theft.

This study examines mechanisms of theft of older cars through answering its general research question: "Why are older cars more stolen than their newer counterparts?" This question is addressed from perspectives of target availability, security, location, and offender motive. Chapter 2 describes the theories of crime in which this study is grounded. These include routine activity, rational choice, crime pattern, and broken windows. Chapter 3 discusses offender motive, as well as the risk and protective factors for auto theft, including target availability, vehicle security, and locations of theft. Chapter 4 presents the specific research questions and justification for these questions. Chapter 5 describes the research methodology utilized in this study – sampling, data sources, measurements, and analytic technique – along with the working hypotheses to be tested. Chapter 6 reports the findings of the analyses. Chapter 7 summarizes the findings, answers the overall research question, and provides the implications for future research.

CHAPTER 2

THEORETICAL FOUNDATIONS

When considering why certain vehicles are more likely to be stolen than others or what makes them so vulnerable to theft, traditional theories which focus on the factors that influence a person to engage in criminal activities are not able to address such questions. Most criminological theories have been concerned with explaining what motivates people to commit crime, offering biological, psychological, sociological, and other reasons, but ignored other elements of a criminal event (Paulsen and Robinson, 2009). According to Brantingham and Brantingham, the criminal event is “an opportune cross-product of law, offender motivation, and target characteristic arrayed on an environmental backcloth at a particular point in space-time” (1993:259). That is, in order for a crime to take place, an offender must come in contact with a target in a place and in time, and above all, there must be a law which makes a certain act or behavior illegal.

Like Brantingham and Brantingham, environmental criminologists have long emphasized the importance of crime opportunities, contending that criminality cannot be translated into a criminal act without opportunities to act on such motives. That is, “no crime can occur without the physical opportunities to carry it out” (Felson and Clarke, 1998:1). For example, a thief would not be able to steal a car if there were no cars. The thief would be unlikely to steal a car which is secured inside an owner’s garage and immobilized by heavy iron wheel locks and other anti-theft devices. On the other hand, the thief may find it easy to steal a car left running and unattended on the street where nobody is around. Consequently, those scholars have looked into the factors or conditions favoring the occurrence of a criminal event, rather than the development of a criminal disposition. Jeffery (1977) stressed that shifting the focus to the criminal event from the offender's criminality is more promising when the object of analysis is crime rather than criminality and when the policy objective is to control crime rather than the offender.

There are four key approaches that help to explain what makes vehicles vulnerable to theft. These are the routine activity approach, rational choice perspective, crime pattern theory, and broken window thesis.

Routine Activity Approach

The routine activity approach[3] adds another element, a guardian who protects a target, to the interaction between an offender and a target that was mentioned earlier. It posits that a crime occurs when a motivated offender and a suitable target meet at a suitable place and time in absence of a capable guardian to prevent the crime (Cohen and Felson, 1979). Felson (2002) noted that the typical and the most important guardians are not formal authority, such as police or security personnel, but are ordinary citizens going about their daily life, such as owners of property, family members, friends or neighbors. This is supported by the concept of natural surveillance portrayed in the works of Jacobs (1961) and Newman (1972) in which they argued that the proximity and visibility of bystanders can discourage offenders. Additionally, Felson suggests that a guardian includes security devices, not just human actors. In short, cars will be susceptible to theft when they are left unattended or unguarded.

[3] Cohen and Felson referred routine activities as "any recurrent and prevalent activities which provide for basic population and individual needs … including formalized work, leisure, social interaction, learning … which occur at home, in jobs away from home, and in other activities away from home" (1979, p.593).

In the updated routine activity approach, Felson (1995) adds two more elements which are an intimate handler and a place manager. While a guardian protects a target, a handler supervises a potential offender (e.g., parents, teachers, friends and employers) and a place manager controls or monitors a specific location (e.g., landlords, janitors, security officers, bus drivers and bar owners). Accordingly, crime is least likely to occur when targets are controlled by guardians, offenders by handlers, and places by managers. In other words, for an offender to commit a crime successfully, he needs to be away from his handlers and find a target unprotected by guardians in a place free from intrusive managers (Osgood and Anderson, 2004).

The routine activity approach predominantly concerns itself with the availability and vulnerability of a target. Originally, Cohen and Felson (1979) developed this approach to explain changes in crime rates over time in the United States. For example, they pointed out that the increase in burglary rates in the U.S. between 1960 and 1975 was linked to an increase in target suitability and a decrease in guardian presence. During that period, the ownership of electronic products such as TVs, VCRs and audio systems increased dramatically, and the weight of those products became lighter, while conditions that foster criminality, such as unemployment and economic inequality, declined. This means that those products became widely available to not only the general public, but offenders, and that their features such as volume and weight made it easier for offenders to steal, carry, and conceal. In the meantime, with more women in the workplace, homes were increasingly left unattended during the day, and consequently became more vulnerable to burglary. Most important, the routine activity approach has posited that changes in the availability of targets and in the absence of capable guardians can explain changes in the crime rates without any changes in the offender population, specifically criminality (Cohen and Felson, 1979).

Cohen and Felson (1979) suggest that a target of crime, which can be either a person or a property, becomes especially suitable or attractive to offenders when it meets four features: *Value*, *Inertia*, *Visibility*, and *Access* (VIVA). *Value* refers to the material or symbolic desirability of a target for offenders. *Inertia* refers to the portability or mobility of a target. *Visibility* refers to how easily offenders spot a target, while *access* means how easily offenders can access to a target. In sum, thieves will be interested in cars that they value for whatever reason, that can be easily broken into and drove off, and that are parked in such a way that thieves can spot and get to their targets easily.

Rational Choice Perspective

While the routine activities approach concerns itself with the vulnerability and availability of a target, the rational choice perspective focuses on an offender's subjective evaluation of crime opportunity (Cornish and Clarke, 1986). In other words, it explains the thinking process of offenders or why they choose one target rather and another.

Rational choice perspective suggests that offenders take account of perceived risks, perceived efforts, and anticipated rewards in their commission of crime. They will engage in crime if anticipated rewards outweigh perceived risks and efforts (Cornish and Clarke, 1986). Consistent with the routine activity approach, the rational choice perspective contends that much offending is opportunity driven and that the suitability of opportunity is central for the offender to make a decision to engage in a particular crime (Cornish and Clarke, 1986; Felson and Clarke, 1998).

According to the rational choice perspective, offenders will go through the two-stage decision-making process when they choose to commit crime. The first stage is a long-term and multi-level process where offenders decide whether or not to become involved in crime. They assess their personal goals and needs, moral attitude towards criminality, and available non-criminal alternatives, all of which varies across individual offenders. The second stage is short-term and situational, in which offenders assess the situation surrounding a crime target for value of a target, the difficulty of getting at it, and the likelihood of being seen or caught (Cornish and Clarke, 1986).

The rational choice perspective emphasizes the latter -- the specific decision-making to engage in crime at the point of commission. In other words, the decision models of rational choice have a micro, individual-level focus, as opposed the routine activity approach which is oriented to the macro, population level (Clarke and Felson, 1993). Accordingly, the offender's decision making is mostly based on evident and immediate costs and benefits of crime, rather than those that are more remote. Previous research has shown that auto thieves generally do not plan or think about the consequences of their behavior, including risks of punishment facing them if caught. They often believe that the chances of being caught are small or they may not even think about it. Rather, they are more concerned with the ease and the attractiveness of stealing a car (Dhami, 2008; Light et al., 1993; Slobodian and Brown, 2001).

As can be read in the above case, the offender's crime commission choice is subjective rather than objective, and it rarely takes into account a full picture of all the various costs and benefits of the crime. The rational choice perspective notes that offender decisions are sometimes based on imperfect information or perception and are sometimes quick decisions that are not thought through (Cornish and Clarke, 1986). For example, an offender sometimes commits crime in a similar way that a person picks up a cookie within 5 seconds after it falls to a ground and eats it (Felson and Clarke, 1998). This is especially the case when the decisions are impaired by alcohol or drug. In fact, about a third of 100 auto thieves in a study conducted by Light and his colleagues (1993) admitted using drugs before stealing cars and then continuing while driving them around. Consequently, such offenders tended to neglect risks involved in the offence.

Although these impulsive decisions made by offenders may be viewed by most people as bad decisions, they may be rational when offenders make them (Farrell and Pease, 2006). This is what Clarke suggests the “limited” or “bounded” nature of rationality, where it is often limited by the amount of time and effort that offenders can give to the decision and the quality of information available to them. Such decisions do not necessarily appear rational, but they are still based on a process of weighing the various perceived costs and benefits involved, although it is a rough calculation (Felson and Clarke, 1998). In sum, as Taylor and Harrell (1996) also state, offenders often behave in a rational fashion that they prefer to commit crimes which require little effort, but provide high rewards and pose low risks.

The rational choice perspective also emphasizes the crime-specific focus, the need for analyzing highly specific categories of crime to understand offenders’ crime commission choices. This is not only because different crimes serve different purposes, but also because the situational context of decision making and information utilized will vary greatly among crimes (Cornish and Clarke, 1987). Taking auto theft as an example, offenders steal cars for different purposes, such as stealing cars for excitement, transportation, chopping for spare parts, resale, export, and insurance fraud (Clarke and Harris, 1992a). Accordingly, they steal different types of cars that can satisfy differential needs of individual thieves (Clarke and Harris, 1992b). For example, auto thieves who steal a car for its replacement parts may target an older car whose parts are valuable on the market, while those who steal a car for resale may choose a relatively newer luxury car that has a high resale value despite its higher level of security. Those who steal cars simply because they need a ride may pick a car which is readily available and easy to steal. Still joyriders may steal a car which has a high horse power and good acceleration. As is obvious from the above, different factors would be more or less important in different types of auto theft.

Cornish and Clarke (1987) referred to such factors that affect offender's calculations of risks and rewards of committing a crime as the rational choice concept of *choice structuring properties*. Specifically, choice structuring properties are "the properties of specific offenses - such as type and amount of rewards, perceived risk, skill needed and so on - which are perceived by the offender as being especially salient to his or her goals, motives, experience, expertise, and preferences" (p.935). For example, the weight and portability of valuable items described in the work of Cohen and Felson (1979) constitute an important choice-structuring property of targets for the theft.

Crime Pattern Theory

Deriving from the ideas of the routine activity approach and the rational choice perspective, Brantingham and Brantingham (1993) developed crime pattern theory which emphasizes the geographical distribution of crime. It offers an explanation as to why crime clusters at particular locations. According to the theory, crime is highly patterned by daily behavior. Offenders search for targets around nodes - locations where they travel to and from, such as home, school, working place, and shopping mall - and paths that they take.

Brantingham and Brantingham (1995) call the nodes that attract many place users for non-criminal reasons as crime generators. Crime generators include, but not limited to, shopping malls, apartments, entertainment districts, sport stadiums, and train stations. Crime tends to concentrate at these locations because a large number of people and targets converge, with some of these place users being motivated enough to exploit crime opportunities presented. A crime generator becomes a crime attractor when it begins to attract offenders who have an intent to commit particular types of crime at the location. For example, a person notices that every time he visited a shopping mall there were many cars left unattended and unlocked in its parking lots for a long period of time. The person steals a car one day and tells his friends about his successful offense. Consequently, new thieves began to come to the mall's parking lots to take advantage of such criminal opportunity.

Another key element in crime pattern theory is edges. The edges distinguish one part of area from another. For example, edges include the boundary which separate residential areas from commercial districts. Major streets, railroads, and rivers may play a role as edges. Brantingham and Brantingham (1981) point out that burglary rates, for example, decline rapidly as areas become more homogeneous, while the rates become high on edges of neighborhoods. This is because outsiders are easily spotted and watched by residents inside the neighborhood where residents have formed some kinds of territoriality, keeping eyes on their own property, whereas outsiders are often ignored around edges. Though, it should be considered that there is a likelihood of insiders committing crime in their own neighborhoods (Mawby, 1977).

Brantingham and Brantingham (1995) stress that crime often does not involve premeditation but offenders tend to exploit easy opportunities they come across while engaging in legitimate activities. A study that interviewed 60 burglars has shown that the potential vulnerability of targets was determined during a trip that was noncriminal in nature. It shows that more than 75% of the burglaries have involved offenders taking advantage of opportunities that were discovered during their noncriminal routine activities (Costello and Wiles, 2000). In addition, Wiles and Costello (2000) found that offenders tend not to travel far from their home to commit crimes, but they are likely to offend near their home.

The tendency of offenders committing crime close to their home has been supported by Ratcliffe (2006). He suggests that temporal constraints on criminal behavior in space limit the offender's crime-search behavior during his/her noncriminal trip. For example, suppose that an offender has two spare hours to travel from home to look for a criminal opportunity, such as the theft of a portable GPS navigator from a car that takes 20 minutes to complete the offense, and to return home. In this case, there are two main temporal constraints, the need to return to home within two hours and the time require completing the offense. Thus, the offender has one hour and 40 minutes (100 minutes) to search for the target. Given the need to travel to and from the target, cars within 50 minutes away from the offender's home will be at risk. Particularly, cars parked nearby the offender's home will be at risk of most of the two-hour time period, while a location 40 minutes away will be at risk for only a 20-minute time period. This illustrates the idea of time acting as a constraint and provides a temporal rational for findings showing that crime tends to cluster around an offender's home and that the probability of crime occurring decreases as distance from the offender's home increases.

In addition to crime generators and crime attractors, Clarke and Eck (2005) have introduced another kind of crime hotspots, crime enablers. Crime enablers are places or areas where there are no controllers who intervene to prevent crime. For example, increased crime in an area results in the number of place users to drop. This reduces not only the level of guardianship (place users), but also place management due to a decline in the resources of the businesses. Although the area becomes less attractive to the users (targets), those few targets using the area will have high risks of being victimized.

Broken Window Theory

The process of how a place or area evolves into a crime enabler is somewhat similar to the process of "how neighborhoods might decay into disorder and even crime if no one attends faithfully to their maintenance," portrayed in the broken window theory (Kelling and Coles, 1996: xv). Broken window theory posits that disorder and crime are closely linked in a developmental sequence. Untended disorder leads to an increase in fear of crime, which in turn causes neighborhood residents to withdraw from using public spaces and maintaining mutual support with fellow residents. Such an area then becomes vulnerable to criminal invasion (Wagers et al, 2008; Wilson and Kelling, 1982). In other words, disorder left untended in an area conveys to would-be offenders that nobody cares about the area, and thus the chances of being interfered with or caught is low. This consequently invites more crime opportunities. More instructive, broken window theory suggests that such phenomenon is just as true in a stable neighborhood as in a crime-prone neighborhood (Wilson and Kelling, 1982).

Disorder or incivilities, what Skogan and Maxfield (1981) called signs of crime, include abandoned buildings with broken windows, litter in streets, vacant lots filled with trash, graffiti on buildings and walls, public drinking, and groups of people hanging out on streets. Existing empirical research has consistently shown that area with disorders have high levels of fear of crime (Lewis and Maxfield, 1980; Skogan, 1990; Xu et al., 2005) as well as dissatisfaction with one's neighborhood (Robinson et al., 2003). Also, existing studies have reported that higher levels of disorder are associated with higher levels of crime (Doran and Lees, 2005: Perkins et al., 1993; Skogan, 1990), including burglary (Robinson, 1999), robbery (Sampson and Raudenbush, 1999) and auto theft (Sallybanks and Brown, 1999).

Summary

The four theories discussed above converge to frame this study. Table 2 summarizes the key statements from those theories, linking their propositions to the context of auto theft and explaining the elements or factors that would make vehicles vulnerable to theft. They suggest that there are a number of factors that can contribute to the vulnerability of vehicles to theft. Some of the factors may be associated with the characteristics of vehicles themselves, such as availability, security and value, while other factors may be related to environmental conditions of where vehicles are parked. More important, as rational choice theory suggests, different factors become more or less important for different types of auto theft. For each type, thieves may consider such factors as vehicle availability, security, value, and location of auto theft differently when stealing vehicles. The next chapter discusses the factors that have been shown to be related with the vulnerability of vehicles to theft in detail.

Table 2: Theories of Crime Applied to Auto Theft

Theories	Vehicle will be vulnerable to theft, if...
Routine Activity	• Having lower levels of guardianship. • Having greater symbolic or monetary value to offenders. • Being more available (exposed and accessible) to offenders. *Caveat:* • Crime occurs when a motivated offender and a suitable target meet at a suitable place and time in absence of a capable guardian to prevent the crime.
Rational Choice	• Stealing requires less effort and poses lower risk, but provides more rewards. *Caveat:* • Thief's decision making is subjective. • The choice structuring properties of auto theft vary with types of auto theft.
Crime Pattern	• Being parked at locations that attract many place users and/or locations that particularly attract motivated offenders.
Broken Windows	• Being parked in areas with a high level of disorder.

CHAPTER 3

RISK AND PROTECTIVE FACTORS FOR AUTO THEFT

During the last two decades, especially since Clarke and Harris (1992a) deplored the lack of academic research on auto theft, scholars have examined the offence from various perspectives, including motives behind auto theft (Cherbonneau and Copes, 2006; Copes, 2003; Dahmi, 2008; Light et al., 1993), types of vehicles targeted (Clarke and Harris, 1992b; Sallybanks and Brown, 1999), target availability (van Dijk, 2007a,b; Mayhew, 1990; Copes, 1999), auto theft location (Clarke and Mayhew, 1998; Hollinger and Dabney, 1999; Lu, 2006; Mayhew and Braun, 2004; Plouffe and Sampson, 2004; Rengart, 1996; Walsh and Taylor, 2007), and vehicle security (Ayers and Levitt, 1998; Brown and Thomas, 200; Mayhew et al., 1992; Newman, 2004; Rhodes and Kling, 2003;).

However, studies on auto theft are limited in the U.S. while the majority of those studies come from outside the U.S. from countries such as Australia, Canada, and the United Kingdom (Maxfield and Clarke, 2004). Also, the existing studies, especially those conducted in the U.S., have been disproportionately concerned with spatial aspects of auto theft, addressing questions of where vehicles are often stolen from and/or why auto theft concentrates at a few locations while other areas are crime free. Only a few studies, on the other hand, have addressed the question of why certain vehicle models are more likely to be stolen than others (Brown and Thomas, 2003; Clarke and Harris, 1992b; Sallybanks and Brown, 1999).

This chapter reviews the following factors that are generally found to be related to the risk of auto theft: offender's motive and types of vehicles targeted, vehicle availability, locations of vehicles parked, and vehicle security.

Offender's Motive and Their Targets

There are different types of auto theft, each involving some differences in motives, stealing techniques, and types of vehicles targeted. (Casey, 2007; Challinger, 1987; Clarke and Harris, 1992a and b; Light et al., 1993). For each type, car thieves may consider such factors as security, availability, and locations of cars parked differently when offending. In other words, different factors are more or less important in different types of auto theft. In general, offenders steal vehicles for temporary use, in which case stolen vehicles are usually recovered, or for profit, in which case stolen vehicles are not recovered intact. Stealing vehicles for temporary use includes joyriding, transportation, and for use in the commission of another crime. Theft of vehicles for profit includes stripping for parts, retagging for resale, exporting stolen vehicles, and insurance fraud.

Theft for Temporary Use

Joyriding. Offenders, often young males, steal vehicles for fun or excitement. A number of research studies have described how excitement entices thieves (Copes, 2003; Fleming 1999; Light et al., 1993: Webb and Laycock, 1992). Light and his colleagues (1993) found that over 70 percent of 99 offenders in their study expressed excitement as a reason for their initial involvement in auto theft, and 60 percent reported abandoning a stolen car within a few hours or by the next day. Previous research has estimated that this type of auto theft accounts for the majority of temporary theft which constitutes between 70 and 80 percent of all auto theft (Gant and Grabosky, 2001; NHTSA 1998; Sallybanks and Brown, 1999).

These offenders tend to target cars that are easy to steal, familiar cars with which they feel comfortable driving, and sporty cars with high performance (Clarke and Harris, 1992b; Light et al., 1993; Sallybanks and Brown, 1999). While the ease of stealing is found to influence the thieves' choice of cars to the same extent as car's performance, thieves tend to first target insecure old cars which are often regarded as unattractive to them, and then they move on to sporty/higher performance cars as they gain experience (Light et al., 1993; Webb and Laycock, 1992).

Transportation. Offenders steal vehicles to travel. Fourteen out of 21 auto thieves in the study conducted by Copes (2003) reported that they stole a car because they wanted to go to a party but had no ride or because they went to a party but were left by their friends and no ride to go back. For this type of theft, natural targets would be vehicles that are widely available and have lower levels of security, such as older cars, because neither performance nor monetary value of vehicles matters to offenders.

Use in other crime. Offenders steal vehicles to commit other crimes including robberies, burglaries and another vehicle theft (Krimmel and Mele, 1998). By using a stolen car, offenders can conceal their identity while engaging in other crimes (White and Dean, 2004). Although types of vehicles targeted may depend on types of crimes that offenders are about to commit, performance vehicles with lower levels of security are, in general, deemed to be natural targets. For example, Megan Ambrosio, a crime analyst in the Newark Police Department, mentioned that offenders tend to steal such a high-performance car as the Honda Civic that can make sharp turns and move at relatively high speed to commit robberies because it can assist in evading police detection. Meanwhile, they sometimes steal vans to transport stolen vehicle parts, in which case vans are suited not only for transporting bulky parts but also for riding with co-offenders (personal communication, 2008).

Theft for Profit

Stripping for parts. Offenders, particularly professional thieves, steal vehicles for their parts that are then used to replace damaged parts, upgrade a vehicle, or resold. Although opportunistic thieves may engage in this type of theft, stealing minor components or “come across” goods, their involvement is not close to the magnitude of thefts that are committed by professional thieves (Gant and Grabosky, 2001, p.4). Both newer and older vehicles can be targets of this type of theft. Auto thieves may target newer luxury vehicles that have expensive components (e.g., exotic wheels and tires, headlight, global positioning system). For example, new Cadillac Escalades which have the highest theft rates among vehicles under 4 years old have been stolen for their custom chrome wheels and tires which are sometimes worth over 10,000 dollars (HILD, 2008).

On the other hand, certain models of older vehicles are thought to be particularly susceptible to theft for their parts, which can be sold for at least twice as much as the value of the vehicle itself (Gant and Grabosky, 2001; NICB, 2009). The report by Industry Commission (1995) suggests that demand for stolen parts is greater when legitimate parts are difficult to obtain because of manufacturers ceasing to produce or restrict supply of these parts, or when replacement parts for low-value, older vehicles are too costly in relation to the value of the actual vehicle. For example, NICB (2006) shows that the cost of OEM (Original Equipment Manufacturer) replacement parts of a 1991 Honda Accord retailed at around $3,000 is $5,100. The Highway Loss Data Institute (2002) has mentioned that thieves often steal older Acura Integras and Honda Civics for their replacement parts, particularly their high-performance engines, which are compatible with each other.

Retagging for domestic resale. Offenders, namely skilled professional thieves, steal vehicles and use them to rebuild wrecked ones for sale. In other instances, professionals known as retag operators replace vehicle identification numbers (VINs) of a stolen vehicle with legitimate numbers that can be obtained from a wrecked vehicle of a similar type from insurance auctions or salvage yards. Alternatively, offenders can alter the VIN using the numbers that are not likely to be listed as stolen, and then re-register the revived vehicle with fraudulent documents (National Association of Attorney Generals, 1979; Tremblay et al, 2001). Although any type of vehicles can be retagged, vehicles that are popular or in high demand would be natural targets, while older vehicles that have extremely low resale value are at less risk because of the risk and effort involved in retagging operations.

Theft for export. While little is known about the scope of the problem of theft for export, it has been reported that about 200,000 vehicles stolen in the United States are annually exported to overseas or to destinations with lax documentation and customs controls (Clarke and Brown, 2003). Except Miami, where older vehicles of all types are exported to Caribbean destinations, vehicles targeted for this type of theft are generally thought to be luxury models, sport-utility models, or otherwise desirable models that are not readily available in destination countries. Newer vehicles that are less than 3 or 4 years old are considered to be at the most risk (Brown and Clarke, 2004). Also, it has been argued that vehicle models stolen in the U.S. and exported to Mexico are often those that are also manufactured and commonly owned in the destination country (Miller, 1987).

Insurance fraud. This type of theft, that is thought to constitute about 8 percent of all auto theft, occurs when a vehicle owner disposes of or fraudulently reports his vehicle stolen to collect insurance money (Webb and Laycock, 1992; Webb and Tilley, 2005). To ensure that the vehicle is a write-off, the owner may burn it, submerge it in a lake or bury it underground. Some owners may arrange to have their vehicle stolen or leave it unprotected in a high-theft area, and others may report the vehicle stolen and hide it for 30 days, which is long enough for settling the claim (NICB 2009).

While all types of vehicles are at risk, the more expensive vehicles are probably at higher risk. Theft for insurance fraud often involves either leased vehicles with high mileage whose turn-in costs are high or purchased vehicles whose owners no longer desire to make the monthly payments. This means that older and less valuable cars are also susceptible because an owner can gain more through the insurance claim than through the legitimate resale (Webb and Laycock, 1992).

Although the classification of auto theft described here is not definitive and a single auto theft incident may involve multiple motives (Casey, 2007), it can be inferred that vehicle types targeted by thieves would vary depending on their purpose for stealing (Table 3). With respect to older vehicles, they appear to be particularly at risk of theft for temporary use and for their replacement parts.

Table 3: Key Vehicle Features Associated with Each Type of Auto Theft

Theft of vehicles for	Key vehicle features that would make vehicles susceptible to auto theft
Joyriding	• Low security level • Easy availability • Sporty/high performance
Transportation	• Low security level • Easy availability
Use in other crimes	• Low security level • Easy availability • Functionality
Vehicle parts	• Valued parts
Retagging for resale	• High popularity • High resale value
Export	• High popularity in destination countries
Insurance fraud	• High market value • Leased vehicles with damaged or high mileage

Vehicle Availability

At the global level, the volume of car theft is higher in a country with more cars available than in a country with fewer cars (van Dijk et al., 2007b; Wilkins, 1964). This is also true in the United States. For example, in 2007 the number of vehicles registered was the highest in California, followed by Texas and Florida, and so was the number of vehicles stolen (FBI, 2007; Ward's Auto, 2009). Also, the number of certain types of vehicles stolen is deemed to be positively associated with the number of those vehicles registered. For example, in New Jersey and New York where no pickups ranked in the top 10 most stolen vehicles in 2007, the ratio of registered passenger cars to registered pickups in that year was 7.7 and 16.7, respectively. On the other hand, the ratio in New Mexico and Wyoming where pickups accounted for majority of the top ten lists was 1.7 and 0.9, respectively. That is, the amount of car thefts is higher in a state with more cars, while the amount of pickup thefts is higher in a state with more pickups available (FBI, 2007; Ward's Auto, 2009).

Accordingly, one can reasonably assume that a 1995 Honda Civic, for example, is more frequently stolen than a 2010 Honda Civic because there are more '95 Honda Civics available to steal as of 2010. Also, the fact that Japanese vehicles, especially Honda and Toyota, account for the large portion of the top ten stolen vehicles over the last decade (NICB, 1999-2010) may be explained in terms of their availability. The NICB index shows that the three models, Honda Accord, Civic and Toyota Camry, have dominated the nation's top three stolen vehicles over the years. However, at the same time, these three makes have been also among the nation's top three most produced models over the years, and they tend to remain on the road for a longer period of time because of their high reliability and low repair record (Ward's Auto, 2009). Consequently, there are more of these cars available on the road.

The International Crime Victimization Survey further reveals that not only the volume of car theft but also rates of car theft per car owner tend to increase as the number of cars rises in a country (van Dijk et al., 2007a). Similarly, the HLDI has reported that auto theft rates in an area increase as the number of vehicles per square mile in the area increases (1993). On the other hand, rates of auto theft tend to be lower in a state with higher rates of vehicle ownership.

For example, Nevada had the second highest auto theft rate, followed by Arizona, while Nevada and Arizona had the second and sixth lowest vehicle ownership rates, respectively. On the other hand, the states characterized by lower theft rates, such as South Dakota, North Dakota, and Wyoming, had higher rates of vehicle ownership (FBI, 2007; Ward's Auto, 2009). One possible account for such an inverse relationship between auto theft rates and vehicle ownership rates is that persons are less likely to steal a vehicle for temporary use, a type of theft which generally accounts for majority of auto theft, if they have their own vehicles (Biles, 1977). This might help to explain partially why auto theft rates are much lower in rural areas than in urban areas (FBI, 2010).

The examples discussed above have illustrated an association between vehicle availability and auto theft. With regard to theft of older vehicles, there tends to be more older vehicles available than new ones, so it would be easier for thieves to spot older vehicles parked. Also, as vehicles age and lose value on the used car market, they are more likely to be owned by people in poor neighborhoods where likely offenders generally reside (Clarke, 1999). This means that older vehicles are readily available (more exposed and accessible) to offenders who tend not to travel far to commit crime. Therefore, it may be assumed that these vehicles are more susceptible to theft.

Auto Theft Locations

As can be read from the previous section, vehicle availability and location are closely linked. Certain types of vehicles may be more frequently found at one location than others because there are more vehicles parked (available) at that location. While the previous section focuses on the number of vehicles available at a broad level, this section discusses the influence on auto theft for more specific areas or locations.

Both police-recorded data and victimization data show that the most common location for auto theft is the owner's home or the street outside the home, followed by parking lots/garages (FBI, 2000; BJS, 2011). However, when taking into account the length of time cars are parked, risk of theft is about four times higher for cars parked in public lots than on streets outside the home, and is over ten times higher than for cars parked on private driveways (Clarke and Mayhew, 1998).

The National Crime Victimization Survey has consistently shown that people living in multi-dwelling units, such as apartment, are more victimized by auto theft than those living in single-family homes which often have driveways or garages (Rand and Robinson, 2011). This may be because apartment residents are typically compelled to park their vehicles in semi-public lots or on nearby streets where vehicles are frequently stolen from.

On the other hand, relatively expensive vehicles parked on streets in a suburban (single-family) residential area may be susceptible to theft for profit. This may be because the houses in the area are sometimes surrounded by shrubbery and tall trees, and sometimes lack adequate exterior lighting. Also, there tends to be fewer pedestrians around such areas. Thus, these characteristics - low levels of natural surveillance - provide a thief with a suitable environment where he can steal a car with a low risk of being seen. Residents in such affluent neighborhoods, often characterized by a safe and quiet atmosphere, can become complacent about car security, so they might neglect taking precautions against auto theft, leaving their cars unlocked or the keys inside (Keister, 2007). However, there may be fewer auto thefts in these areas than in areas with apartments or other properties because single-family homes tend to have driveways and/or garages which have been shown to reduce the risk of auto theft (Clarke and Mayhew, 1998).

In general, locations where numerous vehicles are parked are hotspots of auto theft, experiencing large numbers of auto thefts (Lu, 2006). Previous studies have reported that parking lots at shopping malls, movie theaters and stadiums hosting various types of events (Bromley and Cochran, 2002; Fleming et al, 1994: Hollinger and Dabney, 1999; Plouffe and Sampson, 2004) as well as school zones and business districts (Rengert, 1997; Rice and Smith, 2002) are likely to have large numbers of auto thefts because these locations attract large numbers of users, including potential offenders and because many vehicles are usually parked at these locations for extended hours without the owner's attendance.

In addition, Plouffe and Sampson (2004) have shown that trolley station parking lots experienced extremely high rates of auto theft, not just a large number of auto thefts, when taking into account the number of cars parked at those parking lots. Therefore, such locations where large numbers of various types of vehicles are parked for a relatively long period of time are one-stop spots for auto thieves, and in turn, generate more auto thefts.

Surface lots or single, ground-level parking lots tend to have higher rates of auto theft than multi-story parking garages because of lower levels of security (Mayhew and Braun, 2004). Previous research has shown that vehicles are more at risk of theft when parked in parking lots without security measures including exit bars, perimeter fencing, cameras, and security attendants than in lots without these features (Mayhew and Braun, 2004; Plouffe and Sampson, 2004; Poyner, 1991; Webb et al., 1992).

As for other property types, downtown row houses are found to have high rates of auto theft. The downtown row houses are “two or three story older structure with retail sales/services on the first floor and offices and/or apartments on the upper floors. These parcels have little or no on-site parking” (Lu, 2006:160). In the area occupied by downtown row houses, vehicles are usually parked on the streets, and are easily noticed by passer-by potential thieves. Also, such land use reduces natural surveillance from those passing by, interfering with residents’ ability to distinguish between legitimate place users and potential offenders (Lu, 2006). That is, an area with downtown row houses promotes more anonymity, provide little guardianship to the site, and welcome auto thieves.

Locations close to bars or schools, particularly high school and colleges, are also found to have a high level of auto theft because such properties increase a passage of potential offenders as well as the number of vehicles (Perkins et al., 1992; Rengart, 1996: Roncek and Lobosco, 1983; Roncel and Maier, 1991; Rice and Smith, 2002).

Besides land-use patterns, higher levels of physical disorder (e.g., litter, broken windows, graffiti, and dilapidated buildings) have been found to be linked to increased levels of crime while accounting for neighborhood characteristics such as poverty residential stability, and ethnic composition (Perkins et al., 1993; Skogan, 1990; Wei et al., 2005). While research examining a link between disorder and auto theft is limited, Sallybanks and Brown (1999) mentioned that people living in areas with a high level of physical disorder were more at risk of having their cars stolen than those living in areas with lower disorder. Given the fact that a majority of cars are stolen from nearby owners' houses, it can be argued that vehicles parked in an area with high levels of physical disorder are at higher risk of auto theft.

Svensson (2002) has shown that auto theft is a debut crime involving the highest risk for the development of a chronic criminal career. For example, of those whose first conviction was for auto theft, 55% subsequently become either repeat offenders [committing 4 to 8 offences] or chronic offenders [9 or more offences]. Offenders whose conviction is for auto theft will subsequently engage in a range of offenses, including auto theft, larceny theft, assault, and robbery (Suvensson, 2002), and because criminals tend to commit crime in an area close to their home (Brantingham and Brantingham, 1995; Wiles and Costello, 2000), areas with high levels of crime may have an auto theft problem as well. This also implies that areas with high levels of auto theft tend to have high levels of physical disorder because physical disorder and crime are found to be strongly linked (Doran and Lees, 2005: Perkins et al., 1993; Skogan, 1990).

Other studies have linked socio-demographic characteristics of neighborhoods to auto theft. For example, rates of auto theft are found to be higher in low income neighborhoods (Anderson, 2006; Copes, 1999; Sallybanks and Brown, 1999; Walsh and Taylor, 2007). As mentioned earlier, people residing in such neighborhoods are, in general, less likely to afford a new vehicle fitted with leading-edge anti-theft devices. Rather, they tend to own cheaper, older cars with a low level of security that are more susceptible to theft. Also, since auto thieves tend to live in poor neighborhoods (Copes, 1999; Light et al., 1993; Rice and Smith, 2002), vehicles parked in such neighborhoods are closer and more accessible to the offenders, and, thus, are at higher risk of auto theft. Light and his colleagues (1993) have also mentioned that most stolen vehicle models, namely older cars, are often clustered in offenders' poor home environment. In addition, Sampson and Raudenbush (1999) show that low income neighborhoods tend to have higher levels of disorder, implying a possible link between disorder and auto theft.

Vehicle Security

According to Webb and Laycock (1992), 66 percent of 86 auto thieves in their study responded that a car would be more attractive if it was unlocked, while 83 percent of 117 auto thieves interviewed in the Brigg's study (1991) said that they would stay away from a car if they knew it had an alarm. Similarly, Fleming et al. (1994) found that nearly 75 percent of offenders in their study would be deterred by an alarm or other anti-theft devices. Moreover, the ease of stealing has been shown to be the most common reason for thieves to continue their offenses (Light et al., 1993).

Manufacturers have been increasingly fitting cars with some forms of anti-theft devices as standard equipment and improving levels of security on their cars (HLDI, 2000; Ward's Auto, 2009). Vehicle security measures include alarms, central locking, steering column locks, electronic immobilizers, tracking devices, and parts-marking. Although there has been only a limited number of research on anti-theft devices, previous studies have shown that such devices as car alarms, steering column locks, electronic immobilizers, and tracking devices are effective in reducing auto theft (Brown, 2004; JP Research 2006; Rhodes and Kling, 2003; Webb and Laycock, 1992). The 2008/09 British Crime Survey (Walker et al., 2009) indicates that security measures on cars reduce the risk of having cars stolen. For example, it shows that stolen cars stolen are less likely to have an alarm or electronic immobilizer, compared with all main cars within vehicle owning households. On the other hand, cars involved in attempted theft are more likely to have security measures than those stolen (Table 4).

Table 4: Security Measures on Vehicles Targeted in Theft and All Main Vehicles Owned by Households, England and Wales

	Auto Theft		Attempted Theft		All Main Vehicles	
	(2003/04) %	(2008/09) %	(2003/04) %	(2008/09) %	(2003/04) %	(2008/09) %
Car Alarm	31	40	41	53	58	67
Central locking	46	64	59	70	81	91
Electronic immobilizer	22	44	46	61	62	71
Tracking device	1	1	1	2	3	5
Window-etching	57	53	62	50	60	49

Sources: Dodd et al., 2004; Walker et al., 2009

Steering column lock

The steering column lock, which is one of the mechanical immobilizers commonly installed in vehicles during manufacturing, prevents steering of a vehicle without a key. After Germany introduced legislation that required all cars on the road to be equipped with steering column locks by 1962, motor vehicle theft rates in Germany declined immediately and substantially without a displacement of theft to older vehicles, resulting in a reduction of about 40% in 1963 compared with 1960.[4] In contrast, the impact of steering column locks were less effective on vehicle theft rates in the US and Britain where they were fitted only on new cars. The introduction of this device in Britain had resulted in an increase in the overall theft rates. Specifically, theft for permanent use increased whereas temporary theft decreased slightly (Webb, 1997). Also, studies reported that risk of theft for older cars had doubled in three years after the introduction, suggesting a displacement of theft towards older cars without steering column locks (Mayhew, Clarke and Hough, 1980; Webb, 1997).

In the United States, steering column locks which have been made compulsory for cars that are manufactured after 1969 were found to be effective in reducing theft of vehicles, at least for a decade after the introduction (Webb, 1997). Based on the UCR figure which shows that a proportion of juveniles arrested for motor vehicle theft went down to 35% in 1983 from 62% in 1967, the U.S. Department of Justice believes that the regulation was successful in deterring amateur thieves, specifically juvenile joyriders, from stealing cars (Committee on the Office of Attorney General, 1979). On the other hand, the rate of theft from vehicles, however, had nearly doubled in six years after the introduction of the prevention mechanism because opportunistic thieves started to take car accessories or valuables in a car instead of taking the whole car (Webb, 1997). Also, the increase in theft from cars is found to be partly due to the increased presence and attractiveness of cars' audio systems during that time. For example, Volkswagen began fitting quality car radios as standard equipment in certain models, such as VW Cabriolets,

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[4] The drop in the theft rates in Germany had sustained over decades. It has been suggested that the introduction of the steering locks destroyed a "car theft culture" among juvenile almost overnight (Clarke and Harris, 1992).

Sciroccos and Rabbits around that period, and these cars had experienced high rates of theft of their radios (Braga and Clarke, 1994; Webb, 1997).

Electronic immobilizer

While mechanical immobilizers, such as steering column locks, can be defeated through the use of simple tools and physical force, electronic immobilizers prevent hotwiring[5] by disabling power supply to the fuel pump and engine management system without a proper key. The Passkey system developed by General Motors (GM) in the mid-1980s was one of the earliest examples of an electronic immobilizer in the U.S. This system uses a resistor pellet mounted in the blade of the key to confirm that the correct ignition key with the correct resistor is being used to start the engine. However, since GM only designed keys with 15 different resistor levels and blank keys with embedded resistors were available through locksmiths as well as GM dealerships, thieves could easily collect a ring of the 15 different resistor levels keys, which they could then use to steal the GM vehicles with the Passkey system. As a result, this system was phased out in the late 1990's in favor of newer immobilizer systems.

Today, there are two types of factory-installed electronic immobilizers available in the United States: the transponder system and the PassLock system (exclusive to GM vehicles). The transponder systems, the most common immobilizers used worldwide, employ a transponder to deactivate the immobilizer unit, where the vehicle will not start unless a transceiver located near its ignition switch detects a unique signal from the transponder embedded in the key. Some transponders use a single fixed code which can

[5] It is the classic method of auto theft, in which a thief connects the power and ignition wires to start an engine without a key.

be up to 32 characters in length, and others utilize an encrypted code to prevent copying of the codes. Still others use a rolling code, in which the code system randomly generates a new code each time the car is started. Since the introduction of the transponder systems to the U.S. market by BMW in 1995, auto manufacturers in the U.S. have increasingly started fitting their vehicles with electronic immobilizers (Coalition Network of Forensic Examiners, 2009). In the context of other countries, electronic immobilizers were made compulsory for all new cars sold in the European Union (EU) from 1998 and for all new cars sold in Australia from 2001.

Previous research has found that electronic immobilizers are effective in reducing auto theft (Potter and Thomas, 2001; Kriven and Ziersch, 2007), while they are particularly effective in deterring amateur thieves or joyriders (Brown and Thomas, 2003; Brown, 2004). For example, the HLDI report (2000) has shown that after Nissan put an immobilizer system to the 1999 Maxima, theft claim rates dropped to 3.0 from 7.8 for the 1998 model, while the average theft claim rate for all passenger cars (2.5 per 1,000 vehicle years) remained relatively the same (HLDI, 2000). Studies by Brown and Thomas (2003) and Brown (2004) found that the introduction of electronic immobilizers led to a displacement of theft, particularly temporary theft, to older cars without immobilizers. Risks of theft for 14 and 15 year-old cars increased, whereas the average age of stolen cars also increased after the introduction in the UK. The displacement of theft to older cars without electronic immobilizers has been also reported in several studies (Forbes, 2000; Kriven and Ziersch, 2007; Lee et al., 2006). On the other hand, Brown reports that, for permanent theft, displacement to older cars is less likely because thieves tend to steal newer cars which promise greater profits (2004).

While manufacturers have strengthened and redesigned security systems on their vehicles to make them more difficult to defeat, it has been argued that thieves can eventually develop methods to defeat new security systems. In other words, security systems may be inevitably overcome as vehicles age (Sallybanks and Brown, 1999; Michigan Automobile Theft Prevention Authority, 2009). For example, the figures from the British Crime Survey (Table 3) show that the percent of all main vehicles with electronic immobilizers increased by 15 percent in 2008/09 from 2003/04.

The rate of stolen vehicles with electronic immobilizers increased by 100 percent during the aforementioned period. This may indicate that thieves are becoming capable of defeating electronic immobilizers. Copes and Cherbonneau (2006) have noted an evolution of auto theft techniques, arguing that the use of stolen keys or duplicated keys to overcome new vehicle security technologies, such as electronic immobilizers, is becoming more common. In fact, the 2006/07 British Crime Survey shows that the proportion of auto thefts where offenders forced locks decreased from 66 percent in 1997 to 51 percent in 2006/07, while auto thefts where offenders targeted unlocked cars increased from 3 percent to 10 percent and where they used a key increased from 7 percent to 15 percent.

Vehicle tracking systems

Unlike other anti-theft devices, vehicle tracking systems do not physically prevent thieves from stealing vehicles. Rather, they provide police the ability to locate and recover stolen vehicles. In general, there are two types of tracking systems; radio-frequency tracking (e.g., Lojack, Tracker and Boomerang) and GPS-based tracking (e.g., OnStar). Lojack, for example, uses a wireless radio transmitter hidden within a car that can be remotely activated after the car is reported stolen. Once the transmitter is activated, police can track a location of the stolen vehicle, even within buildings and containers, by using a special Lojack receiver that can be installed in a variety of police vehicles including cars, watercraft, and aircraft. On the other hand, OnStar, for example, transmits constant signals to Global Positioning System (GPS) satellites and allows an owner to track his/her vehicle at anytime without police authorization. GPS requires a direct line of sight between the equipment and orbiting GPS satellites to track the vehicle's location, so police will be unable to locate the vehicle once the car is in a garage or placed under dense tree coverage. However, since it constantly transmits location coordinates, police can track the movement path of the vehicle while the signal is still active.

Ayres and Levitt (1998) point out that the presence of Lojack is associated with a sharp decline in overall auto theft rates in central cities, implying a possible diffusion of benefits resulting from installing Lojack. That is, all car owners, not just those who have Lojack-equipped cars, reap the benefits of reduced auto theft rates. For example, since the introduction of Lojack, auto theft rates in Boston, Newark, and Los Angeles declined by 50 percent, 35 percent, and 20 percent, respectively, and those declines represented a break from the past trends. Meanwhile, there was little impact in Chicago where Lojack market shares are extremely low, partly because its law prohibited insurance companies from giving discounts for Lojack until 1996.

Besides Lojack's strength in recovering stolen vehicles, the most important effect is probably its impact on chop shop operations. When thieves steal a car fitted with tracking devices and drive it to the site where they strip the car of its parts, the tracking device can lead police directly to the site. Given the large number of vehicles processed by a typical auto theft ring, there is a high likelihood that at least one Lojack-equipped vehicle will be involved in the operations. Ayres and Levitt (1998) argued that if 100 cars are stripped annually, the likelihood that at least one of these cars has Lojack is 95%. In fact, Lojack has helped police to break up at least 53 chop shops in Los Angeles (Ayres and Levitt, 1998). Since a small proportion of professional thieves who repeatedly steal cars are thought to account for a large proportion of all auto thefts, apprehending a few key players can significantly reduce the number of auto thefts in the areas (Light et al., 1993; Permanent Subcommittee on Investigations, 1979; Suvensson, 2002).

In addition, since a Lojack transmitter is hidden within a car, offenders may not know which cars are equipped with Lojack and which are not. Therefore, the risks associated with buying or possessing stolen vehicles, as well as stealing vehicles, would increase for a wider range of vehicles than really is the case, and in turn a diffusion of benefits, like the one that has been observed in the study of Ayres and Levitt (1998), occurs. Though, offenders may presume that older cars are unlikely to have Lojack which costs at least hundreds of dollars (more than the value of older cars in some instances). This may lead to a displacement of theft to older cars, while other likely Lojack-equipped cars reap the benefits.

Parts marking

Similar to vehicle tracking systems, parts-marking does not physically prevent thieves from entering and starting a vehicle. Rather, it was designed to curb motor vehicle theft primarily by addressing the problem of professional theft including theft for resale of stolen vehicles or their parts and export. The Motor Vehicle Theft Law Enforcement Act of 1984, in which the standard became effective beginning with the 1987 model year, requires major body parts of high-theft lines - passenger car models that are frequently stolen - be marked with a vehicle identification number (VIN). By making parts traceable, parts-marking assists law enforcement agencies in tracking and prosecuting chop shops. Consequently, it can reduce the rewards of auto theft for professional thieves since buyers may stay away from used parts which can be linked to stolen vehicles. Today, parts marking requirements have been expanded to include all passenger cars, multipurpose passenger vehicles, and light trucks with a gross vehicle weight rating of 6,000 or less.[6]

With respect to the effectiveness of parts marking, research has found that it has some benefits in reducing motor vehicle theft, although anti-theft devices are more effective than parts marking (NHTSA, 1998; Rhodes and Kling, 2003; JP Research, 2006). However, NHTSA (1998) has noted that their study "did not generate a reliable quantitative estimate of the reduction of thefts or enhancement of recoveries attributed to parts-making and did not lead to an unequivocal conclusion that parts-marking has been effective" (p. 18). Parts marking requirements have been criticized for failure in discriminating between joyriding and professional theft. Many cars stolen by joyriders

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[6] Vehicles can be exempted from this requirement if they are equipped with anti-theft devices as standard equipment.

were included in the parts marking program that was not designed to prevent temporary theft, while some models often stolen by professionals were not marked (Clarke and Harris, 1992b; Maxfield and Clarke, 2009).

As illustrated above, the effectiveness of security devices vary with types of auto theft. For example, more motivated and skilled thieves who steal cars for parts and resale would overcome anti-theft devices such as steering column locks and electronic immobilizers, but may be deterred by vehicle tracking systems and/or parts-marking that increase the risk of disposing stolen vehicles. On the other hand, non-professional or opportunistic thieves would be easily put off by anti-theft devices, especially immobilizers, but not by parts-marking. If a thief simply wants to steal a car to drive back to home, he may select any car which is readily available or easier to steal while the marking of parts is of no concern to the thief.

Having said that, the ease of stealing a vehicle is shown to be a powerful determinant of vehicle attractiveness for the majority of car thieves (Brigg, 1991; Light et al., 1993; Webb and Laycock, 1992). It is also important to keep in mind that vehicle security wears out as vehicles become older. For example, car thieves can eventually find a way to defeat new security systems, so ten year-old cars give car thieves ten years to learn how to defeat their security. Besides, door and ignition locks physically deteriorate over time after extensive uses (Maxfield and Clarke, 2009). This may partly explain why older vehicles are more at risk of theft than newer ones. In addition, as improved security becomes standard on new vehicles, offenders, namely opportunistic thieves, have been found to displace attention to the older, less secure vehicles (Brown and Thomas, 2003; Kriven and Ziersch, 2007; Webb, 1997).

Summary

This chapter has discussed the risk and protective factors for auto theft: offender motive and types of targets, target availability, vehicle security, and locations of auto theft. While these factors contribute to the vulnerability of vehicles to theft, little is known to what extent they are related to theft of older cars. This provides the rational for the present study. Table 5 summarizes the main statements derived from the literature on auto theft, providing insight into the mechanisms of theft of older cars. The next chapter presents the specific research questions that guide this investigation of why older cars are more stolen than their newer counterparts.

Table 5: Summary of the Risk and Protective Factors of Auto Theft

Factors	Key Findings
Offender Motive **Types of Targets** (*Rational Choice*)	• Different factors are more or less important in different types of theft, each involving differences in motives and types of vehicles targeted. • Older cars seem to be particularly at risk of theft for temporary use and their parts.
Availability (*Routine Activity*)	• The number of certain types of vehicles stolen is deemed to be positively associated with the number of those vehicles registered.
Locations (*Routine Activity*) (*Crime Pattern*) (*Broken Windows*)	*Land use* • Locations where numerous vehicles are parked tend to be hotspots of auto theft. • Certain types of land uses are found to be prone to auto theft, not only because they attract a number of offenders and vehicles, but also due to the anonymity and less guardianship at the sites. *Physical Disorder* • Higher levels of physical disorder are linked to increased levels of crime, including auto theft.
Security (*Rational Choice*) (*Routine Activity*)	• All cars produced after 1969 have steering column locks. • The earliest form of electronic immobilizers were in ‘80 GM cars. • Transponder systems prevent auto theft, but result in displacement of theft to older cars. • Parts-making and tracking systems do not physically prevent thieves from stealing cars. • The former is not as effective as immobilizers. • The latter are aftermarket/optional devices and are expensive, so older cars are unlikely to have such devices.

CHAPTER 4

COMCEPTUAL FRAMEWORK AND RESEARCH QUESTIONS

Mechanisms of Theft of Older Cars

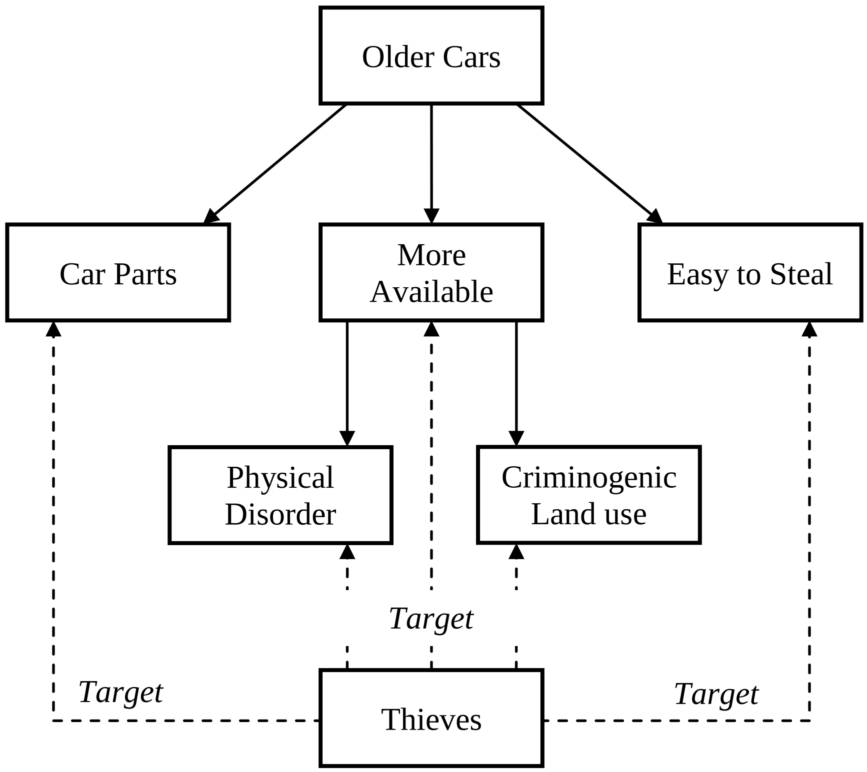
As mentioned previously, offenders steal cars for different reasons. Some steal cars for excitement or just for a means of transportation, while others steal for financial gains. Accordingly, the vehicle models they target vary by their purpose of stealing. In general, car thieves tend to name expensive cars or sporty models as the most attractive target, while old cars are often regarded as unattractive (Light et al., 1993; Webb and Laycock, 1992). However, thieves may not necessarily be able to steal cars that are attractive to them. In other words, cars that are thought to be attractive to thieves may not automatically be the ones that will be stolen. For example, although such high-end cars as Ferrari, Bentley and Rolls Royce may be attractive to thieves, they are rarely stolen for some reasons including limited availability and great risks associated with stealing and driving such easily identifiable cars (Clarke, 1999; NHTSA, 2008). On the other hand, older cars which are sometimes regarded as unattractive to thieves are, in fact, more stolen than their newer counterparts. This is similar to the fact that general consumers are attracted to brand-new expensive cars, but they may end up purchasing other cars which are more affordable.

Several factors constitute what Cornish and Clarke (1987) call “choice-structuring properties” of targets for auto theft. These can be related to the following four main categories: vehicle availability, security, locations, and value of vehicle to thieves. The aforementioned literature suggests that vehicles would be more susceptible to theft if (1) they are more available on the road; (2) they have lower levels of security; (3) they are parked in areas with high levels of physical disorder or in insecure places; (4) and they are valuable to thieves for whatever reasons. In this regard, older cars seem to fit the description of vehicles at risk. However, no study known to the present author has simultaneously examined the influence on auto theft of those factors. Besides, research focusing on theft of older cars, in particular, is rare despite that older cars have been found to be at the most risk of auto theft. Figure 3 displays the hypothetical mechanisms of theft of older cars, visualizing the conceptual framework of this study.

Older cars are disproportionately stolen; possibly only because there are more older vehicles available to steal. They are at more risk of theft; maybe just because they have low levels of security. In other words, insecure older cars may be more likely to be stolen than others regardless of other factors. Older cars parked in areas with physical disorder or at criminogenic locations may be more likely to be stolen regardless of their security. On the other hand, older cars may be vulnerable to theft because of a combination of those factors: they lack adequate security, and at the same time they are more parked in areas whose surroundings make it easier for offenders to steal cars.

Furthermore, just as targets of auto theft vary with offender's purpose of stealing, the choice-structuring properties vary with their purpose (Clarke and Harris, 1992b). That is, different factors are more or less important in different types of auto theft. For example, some of the factors mentioned earlier may be of less concern to thieves who already have a particular car in their mind that they want to steal to make a profit. Ambrosio has pointed out that some thieves are highly specialized in stealing certain vehicle models only. One thief, for example, has admitted searching around the entire city to steal late ‘90s Honda Civics for its VTEC engine, no matter where they were parked and how they were secured (personal communication, 2008).

Figure 3: Proposed Mechanisms of Theft of Older Cars



Older cars are found to be susceptible not only to temporary theft but also to theft for their parts. Parts of older cars may not be as expensive as those of their newer counterparts. However, they may be more costly in relation to the value of the vehicle itself. For example, the price of a front door of a 2010 Toyota Camry is about two times that of a 1991 Toyota Camry, while the used car value for the former model is nearly 10 times that for the latter. (Car-part.com, 2010; Kelley Blue Book, 2010).

On the other hand, there are some cases where parts of older cars are more expensive than those of their newer counterparts. For example, an old, refurbished VTEC B16b, an engine that can be found in 1997-2000 Honda Civic Type-Rs (around $3,500) costs more than three times the price of a standardized k24 engine, in pristine condition, that is often found in the current model year (post-2001 model year) of Honda Civics, Accords, and Integras (Ebay, 2010). This may be partially due to the demand of the old powerful engines by racing communities that often drive 5th and 6th generations (MY1992-2000) of Hondas (Boquiren, 2010). Besides the price, the old, powerful B16b engine can be fitted on a wide range of model years (MY1990 afterwards) of various Hondas including Civics, Integras, Preludes, and Accords with or without custom mounts.

In this sense, parts of older cars are valuable not only because they are expensive but also because they are easily disposable, having great compatibility with a wide variety of car models. Since cars belong to the same generation often share the same parts, including an engine, auto theft is shown to cluster toward certain older cars from sequential model years.

The nature of older car parts, together with the literature on offender motive, implies that it would be necessary to examine the influence of both car characteristics and place characteristics on different types of auto theft individually, in order to understand mechanisms of theft of older cars. Accordingly, this study addresses its main research question, why older cars are more stolen than their newer counterparts, from the perspectives of target availability, vehicle security, physical environments of where vehicles are parked (in terms of physical disorder and land use), and offender motive. In addition, it must be borne in mind that there is considerable variation in the risk of theft among vehicle makes, as is evident from a number of sources (e.g., the top ten stolen vehicle lists by NICB, the HLDI reports, and U.K. Car Theft Index).

Research Questions

This study examines why older cars are more stolen than their newer counterparts through answering the following secondary research questions.

Availability

1. *Are there more older cars available to steal*?

Car theft is found to increase in both number and rate per car on the road as the number of cars increases in areas (van Dijk et al., 2007a,b: HLDI, 1993). The number of certain types of vehicles stolen appears to be positively associated with the number of those vehicles registered. Honda Accord, Honda Civic, and Toyota Camry have ranked among the nation's top three most stolen vehicles over the years, and at the same time, they have also been among the nation's top three most produced models (NICB, 2020; Ward's Auto, 2009). Besides, these models are well known for their high reliability records as well as long life span (Ward's Auto, 2009). That is, the differing proportions of stolen vehicles may be a function of the actual number of those vehicles that are available on the road. Similarly, variation in auto theft at locations is a function of the actual number of vehicles available to steal at the locations. Therefore, it can be argued that older cars are more stolen because there are more those cars available to steal.

Security

2. *Are older cars easier to steal*?

The ease of stealing has been shown to be a main factor that makes some cars more attractive to steal than others (Fleming et al., 1994; Light et al., 1993; Webb and Laycock, 1992). While the effectiveness of anti-theft devices such as electronic immobilizers in preventing auto theft is acknowledged, these devices tend to result in displacement of thieves' attention towards insecure older cars from secure new cars (Brown, and Thomas, 2003; Kriven and Ziersch, 2007).

Locations

3a. *Are older cars found more on the streets with a high level of physical disorder*?

3b. *Are older cars found more on the streets where criminogenic land use is more common*?

Higher levels of physical disorder have been shown to be linked to increased levels of crime (Perkins et al., 1993; Skogan, 1990; Wei et al., 2005), including auto theft (Sallybanks and Brown, 1999). Also, Sampson and Raudenbush (1999) show that levels of disorder are higher in low income neighborhoods that tend to have higher auto theft rates (Anderson, 2006; Walsh and Taylor, 2007). Because older cars, whose retail price is often lower than their newer counterparts, tend to be owned more often by people residing in poor neighborhoods (Light et al., 1993), it can be argued that older cars may be found more in areas with a higher level of disorder, generating more auto thefts in those areas.

Certain types of land uses are also found to be prone to auto theft (Lu, 2006; Plouffe and Sampson, 2004; Rengart, 1996; Rice and Smith, 2002; Weisel et al., 2006). Hence, it can be argued that older cars are more stolen than their newer counterparts because they are more often parked at such locations. However, previous research on auto theft does not examine how those land uses influence theft of older cars or how they affect spatial distribution of older cars parked.

Offender motive/Types of theft

4a. Are *older cars stolen more than newer cars for temporary use*?

4b. *Are older cars stolen more than newer cars for their parts*?

4c. *Do these effects remain constant across different types of car theft?*

Temporary theft, where stolen vehicles are recovered, constitutes the majority (70 to 80 percent) of all auto thefts (NHTSA 1998), and is often committed by opportunistic thieves who exploit easier crime opportunities (Copes, 2003; Fleming, 1995; Light et al., 1993; Webb and Laycock, 1992). For this type, older cars are thought to be a natural target because of their availability and low security levels. On the other hand, older cars are also found to be susceptible to theft for their parts because of the reasons described previously (Gant and Grabosky, 2001; NICB, 2009; Sallybanks and Brown, 1999). Clarke and Harris (1992b) suggest that, the choice-structuring properties of targets vary with offenders' purpose of stealing. In other words, different factors (availability, security, and locations) may become more or less important in different types of auto theft.

Summary

This chapter has discussed mechanisms of theft of older cars and presented seven research questions that guide this study to investigate why older cars are more stolen than their newer counterparts. Those questions are based on the arguments that older cars are more often stolen because they are more available, because they are easy to steal, because their environments are prone to auto theft, and because they are targeted by both opportunistic and professional thieves. This study simultaneously examines the influence of both car characteristics and place characteristics on different types of auto theft because different factors are thought to be more or less important in different types of auto theft. The next chapter describes how this study addresses its research questions, presenting sampling procedure, data sources, measurements, and analysis procedure.

CHAPTER 5

METHODOLOGY

Research Site

The City of Newark, New Jersey was chosen as the research site, because of the quality and wealth of auto theft data maintained by the Newark Police Department and because of the author's familiarity with its data and the geography of the city. Newark, with a population of nearly 280,000, is the largest city in New Jersey and is located about 8 miles west of Manhattan, NY. The southeast part of the city is occupied by Port Newark and Newark Liberty International Airport, each being one of the busiest facilities of its type in the U.S. As of the 2010 Census, the most common ethnicity was black or African-American, making up about half (49.8%) of Newark's population, followed by Hispanic (33.8%) and white (11.6%). About a quarter (24.3%) of Newark residents were estimated to be living below poverty level, while the city's median household income in 2009 was estimated at $35,507 (U.S. Census Bureau, 2009 American Community Survey).

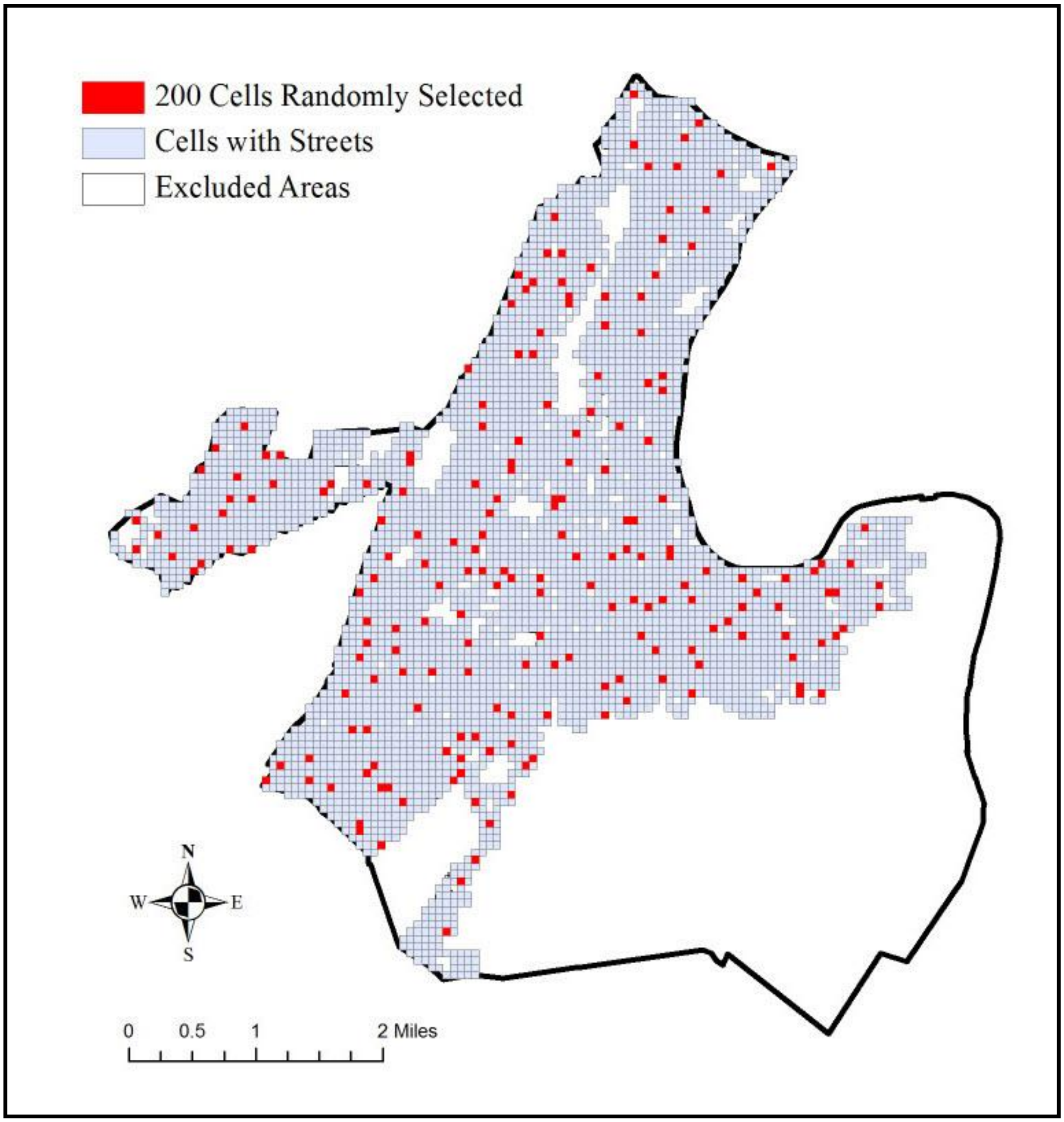
As for the problem of auto theft, Newark has been widely considered to be a thieves' paradise (NICB, 2006). Between the late '80s and mid '90s, Newark had the highest auto theft rates among U.S. cities with a population of 100,000 and greater. For example, the auto theft rate in Newark was 5,369 per 100,000 population in 1990, whereas the rate in the US was 655 (FBI, 1985-2010). Although auto theft rates in Newark have been declining, the theft rate in Newark in 2009 was still more than four times the national average.

Sampling Procedure

This study observes a sample of streets in Newark to record detailed information on all vehicles parked on the street, physical disorder, and land use. In order to select the streets, this study first created a grid of 300×300 foot cells, as an overlay to the digital GIS map of the city using ArcGIS 9.2. The cell size of 300 feet is chosen here because the average street segments in the city is about a little over 300 feet. The following steps were taken to obtain a final sample for this study.

- Cells that do not contain streets are excluded. This produces a total of 5,090 cells covering all streets in the city.
- Cells that cover unpopulated areas, such as an airport and seaports (799 cells) are dropped from the sampling frame.
- Two hundred cells are randomly selected from the 4,291 cells using the ArcGIS extension (Figure 4).
- Street segments within those cells are selected, but cells that are next to another cell and include a street segment that is already selected by another cell are deleted.
- Cells that are placed on the middle of a street segment are moved to the closest intersection in order to maximize a sample size and to balance the number of street segments within each cell.
- Consequently, all 782 street segments within the 193 cells are selected and observed. Two East-West street segments and two North-South street segments defined by the sampled cell are accumulated for analysis to account for overrepresentation of streets with no incidents. This results in a total of 384 streets.

Figure 4: Sampling Procedure - Final Sampling Frame



Data Sources

Auto Theft Data

Auto theft data from the Newark Police Department (NPD) are used to measure the extent to which vehicles are involved in different types of auto theft. NPD data include considerable detail on stolen and recovered vehicles. Examples include specific make and model, which parts are taken from the stolen vehicles, where and when vehicle models/model years are stolen or recovered. This study uses incident-level NPD theft data for the years 2005-2009 so that this study can have sufficient incidents to analyze the nature of vehicles involved in different types of auto theft, and to minimize the impact of annual variations. However, the analyses which deal with stripping of stolen vehicles use 2005-07 auto theft data only because the department ceased recording the condition of vehicles recovered during and after 2008.

Vehicle Security Data

While there are different types of anti-theft devices available, it is very difficult, if not impossible, to identify which car has what type of security systems (Rhodes and Kling, 2003). However, *Ward's Automotive Yearbook* (annual) compiles information on factory-installed anti-theft devices in equipment listings for all automobiles and light trucks (pickups, sports utility vehicles, vans) sold in the United States. Information is available for 1991 or newer model year domestic cars, for 1997 or newer model domestic light trucks and import cars, and for 2002 or newer models of import light trucks.

Data from Ward's are supplemented with data from the Coalition Network of Forensic Examiners[7] (CNFE), which lists all vehicles - both domestic and import models - equipped with factory-installed electronic immobilizers by vehicle model and model year. While there are two types of factory-installed electronic immobilizers (the transponder system and the Passlock system) available in the U.S. today, CNFE data classifies vehicle models with immobilizers into three groups: transponder based vehicles, Passlock vehicles, and VATS (Vehicle Anti-Theft System) vehicles. The VATS developed by General Motors in the mid-1980s was one of the earliest examples of an electronic immobilizer in the U.S. It was phased out in the late 1990's in favor of newer immobilizer systems.

Vehicle Availability and Physical Environment Data

This project utilizes Google Street View (GSV) for two purposes: (1) to estimate the number of vehicles parked on the sampled streets in Newark; and (2) measure land use and physical disorder at the street level. GSV provides high-resolution street-view images for virtually all streets in Newark (Figure 5). These images make it possible to identify vehicle models and generation, if not model year, of parked vehicles, as well as to observe physical conditions of streets and buildings. Users can view and navigate street-level imagery as if they are driving down the streets because the street-level images, 360° horizontal and 290° vertical panoramic views, are available every 10 to 20 meters

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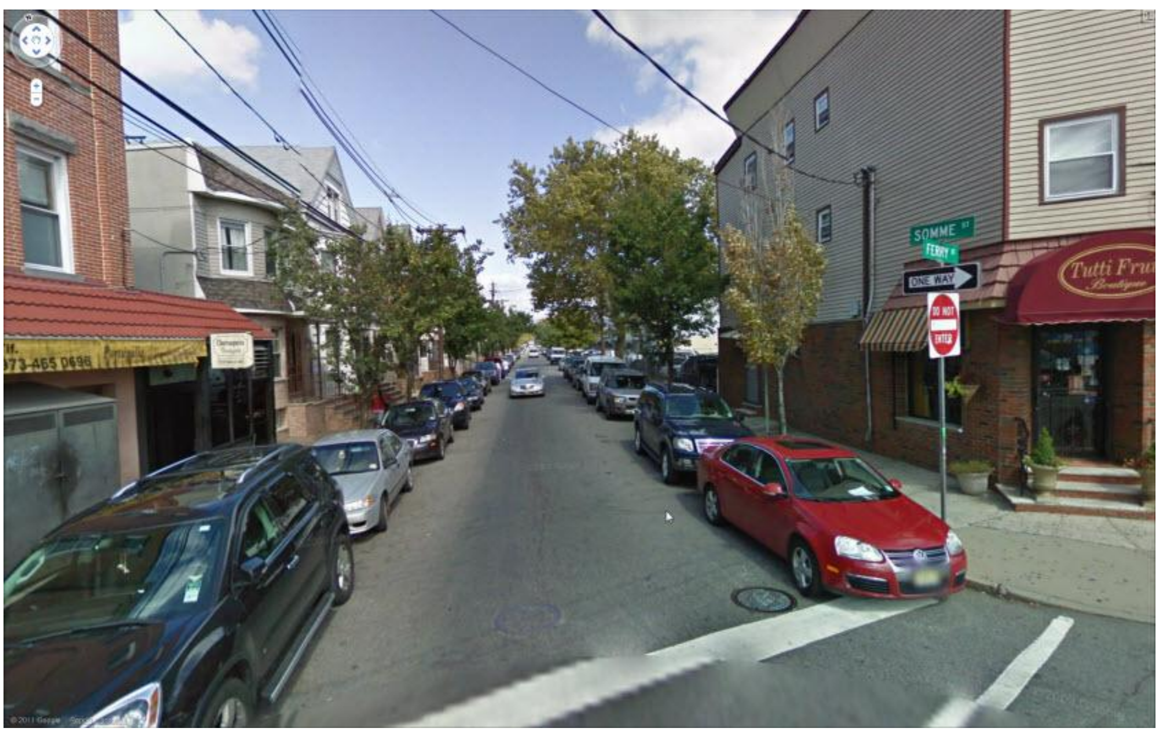
[7] The Coalition of Network of Forensic Examiners (CNFS) is composed of creditable nationwide experts in the field of auto theft forensic examinations, the microscope forensic examination of locks, keys and lock components, vehicle mechanism analysis, and a full line of forensic locksmith services. The charter members of the CNFS which include, but not limited to, Sterling Investigation Services, North American Technical and Forensic Services, and NJ Vehicle Theft Investigators, are qualifies as expert witness in courts of all venues providing testimony on auto theft, auto arson, and forensic automotive locksmithing matters and provide training and instruction to the low enforcement and insurance industry in the fields of auto theft (CNFS, 2009; Sterling Investigation Services, 2009).

for most streets in major cities. GSV images for the city of Newark are dated 2009 and earlier as of September 2010.

Google Street View, integrated in Google Earth and Google Maps, was first released in May, 2007, and is still in its infancy, although its coverage has been considerably expanded. Because of that, the viability of using GSV to measure neighborhood characteristics, including social and physical disorder, has not been fully articulated. In fact, there have been no studies that examine crimes employing variables measured using GSV. However, a few epidemiological studies have shown that GSV can be employed to audit neighborhood characteristics as an alternative to in-person observation, also called systematic social observation, that is often time-consuming and expensive to conduct (Clarke et al., 2010: Rundle et al., 2011).

Figure 5: Example of Google Street View Image



The City of Newark

The 2009 digitized parcel data, also called tax assessor data, provided by the City of Newark are used to identify the size and type of each property along the sampled streets. The data classify properties into twelve broad classes: residential, apartment, commercial, industrial, public school, other school, church, cemeteries, public property, railroad, and vacant land. Within these classes are a variety of land uses. Although there are a number of unspecified properties in the data, every single property used in this study is identified and verified via Google Street View images.

Measures of Key Concepts

Types of Auto Theft / Offender Motive

This study refers to auto theft as theft of passenger cars and light trucks that serve the primary purpose of transporting people. These include all sedans, station wagons, coupes, convertibles, sport utility vehicles, minivans, and pickups. Although the Uniform Crime Reporting program defines motor vehicle theft as the theft or attempted theft of a motor vehicle, auto theft in this study means completed auto theft in which vehicles are stolen, not attempted to be stolen. Attempted thefts are examined separately because they can provide insight into the factors that may thwart thieves from stealing vehicles. For example, vehicles equipped with immobilizers may tend to be more involved in attempted theft relative to auto theft.

In this study, auto theft is classified into two categories: (0) *permanent theft*, in which case stolen vehicles are not recovered; and (1) *temporary theft*, in which case stolen vehicles are recovered.   Within temporary theft are two types: (0) *theft for nonprofit*, in which case stolen vehicles are recovered intact; and (1) *theft for parts*, in which case the recovered vehicles are stripped of their parts including headlights, battery, A/C, audio system, seat, tire/wheel, door, bumper, engine, radiator, and transmission. It should be noted, however, that stolen vehicles can be stripped after thieves leave them without taking anything, or vehicles that are stolen for their parts may not be recovered if they are, for example, completely disassembled to rebuild wrecked vehicles for resale. Because the data do not allow this study to identify offender motive involved in each incident, it is inferred based on the conditions of stolen vehicles.

Vehicle Age

Vehicle age is calculated by subtracting the model year (MY) of a vehicle from the calendar year when the vehicle was stolen. Thus, if a 2005 MY car, was stolen in 2005, the age of the car will be coded as zero. If that car was stolen in 2009, its age will be coded as four years old. Also, the 2005 MY car can be stolen in 2004 because it is available from the third quarter of 2004. In this case, that car will be treated as a 2004 MY car. Such cases constitute only 0.1 percent of all auto theft incidents used in this study. As mentioned in the first chapter, this study refers to vehicles aged over 9 years old as older vehicles, whereas newer vehicles mean those aged 9 years old and younger.

Unlike stolen vehicles whose model year is specified, it is very difficult, if not impossible, to identify an exact model year of vehicles observed in GSV images. This is because vehicle models which belong to the same generation look very similar to each other. For example, the 6th-generation or 6G (MY1998-2002) Honda Accords all look alike, but are easily distinguishable from the 5G (MY1994-1997) and 7G (MY2003-2007) Honda Accords by their appearance. In some cases, it is possible to distinguish between the first-half and the second-half of a generation. Honda Accord, for example, often undergoes a mid-generation facelift, so the first-half 6G (MY1998-2000) looks slightly different from the second-half 6G (MY2001-2002). Therefore, this study records the specific generation of each vehicle parked on the sampled streets and classifies vehicles into an age group based on their generation.

Figure 6: Classification of Vehicles by Generation (Honda Accord)

6G (MY1998-2000)

6G (MY2001-02)

5G (MY1994-97)

7G (MY2003-04)

Note: All images were taken from Google Street View

Within the broad category of *newer* and *older,* this study classifies newer vehicles into two groups: *new* vehicles and *relatively new* vehicles. Similarly, older vehicles are also classified into two groups: *old* and *relatively old* (Table 6). There are, however, many cases that one vehicle's generation belongs to two different age groups. For example, the age of the first-half of 6G (MY1998-2000) Honda Accords stolen in 2009 is between 9 and 11 years old, so the MY1998 Honda Accord (11 years old) and MY 1999 Honda Accord (10 years old) belong to the age group of *relatively old* whereas MY2000 Honda Accord (9 years old) belongs to the group of *relatively new*. Since this study cannot distinguish MY2000 Accord from MY1998-1999 Accords, the MY2000 Accord (9 years old) is allocated into the age group of *relatively old* under majority rule. This procedure is applied to all vehicle models observed.

Table 6: Age Classification of Vehicles

Value	Vehicle Age	Age Group	General Term
1	Under 5 years old	New	Newer Vehicle
2	5-9 years old	Relatively New	
3	10-14 years old	Relatively Old	Older Vehicle
4	15 years old and older	Old	

Vehicle Availability

Counts of vehicles by make/model and generation are obtained for a sample of Newark streets and serve as a proxy estimate of vehicle availability. In other words, vehicle availability is measured by the number of parked vehicles observed on the sampled streets. Previous studies have often measured vehicle/target availability using variables derived from decennial census data, such as population and the number of vehicles available to household. For example, Weisel and her colleagues (2006) treat population as a statistical control variable in their study, stating that with all other things being equal, there would be more auto thefts where there are more vehicles, and there tends to be more vehicles where there are more people residing. Copes (1999) uses two items - car density and road density - to measure vehicle/target availability. The former is the quotient of the total number of vehicles available to household in a census tract and that tract's size in square miles, whereas the latter is the quotient of the number of roads in the tract and its size in square miles.

While those measures used in previous research could serve as a rough proxy indicator of vehicle availability, they are not, however, capable of answering the question of how many certain types of vehicles are available on the road, or whether or not there are more old cars than new cars on the road. The actual counts of vehicles by make/model and model year or generation would be necessary to answer the above question. However, no information exists on the distribution of particular vehicles (e.g., vehicle registration) across geographic areas smaller than the city level. Thus, this study manually counts the number of vehicles parked on the sampled streets and identifies their make, model, and generation using Google Street View.

Although this will produce an estimate that does not match theft dates, vehicle counts obtained in this way are a more valid measure of availability than registration data. This is because many cars parked on Newark streets and cars stolen in Newark are registered in other jurisdictions. The particular mobility of vehicles means their vulnerability to theft extends beyond where they are registered. The limitations of treating counts of vehicles obtained from GSV as a measure of target availability will be further discussed in the last chapter.

In the analysis which performs multilevel logistic regression to examine the effects of predictor variables on the likelihood of vehicles being stolen, data on parked vehicles observed (N=7,365) are combined with stolen vehicles data (N=4,277) to form the dependent variable. That is, parked vehicles observed are treated as vehicles that were not stolen. This may seem like a far-fetched assumption, because they do not accurately represent vehicles that were not stolen. However, it can be argued that these vehicles observed were not stolen at the time when GSV photos were taken although some of them might had been stolen right after the photo was taken or the photo was taken right after stolen cars were abandoned. Since it is very hard to verify whether or not these vehicles observed were actually not stolen, parked vehicles observed serve as a proxy estimate of vehicles not stolen, just as they serve as a proxy estimate of vehicle availability.

Vehicle Security

Due to the lack of information available on different types of anti-theft devices on vehicles and after-market security devices, this study focuses on factory-installed electronic immobilizers only. Vehicle security is operationalized by the presence or absence of factory-installed immobilizers: 1= vehicles with any type of factory-installed electronic immobilizers and 0= vehicles without factory-installed immobilizers. As discussed earlier, electronic immobilizers connect the ignition, starter, or fuel system and prevent a car from being started unless it received the correct signal. Previous research has consistently shown the effectiveness of electronic immobilizers in preventing auto theft, especially temporary theft that accounts for the majority of auto theft (Brown, 2004; Kriven and Ziersch, 2007; Potter and Thomas, 2001). However, it is also found that offenders, particularly opportunistic thieves, have been displacing attention towards older cars without the immobilizers as they become a standard feature on new cars (Brown and Thomas, 2003; Kriven and Ziersch, 2007).

Physical Disorder

While disorder can take two forms, social and physical,[8] only physical disorder has been found to be related to auto theft (Sallybanks and Brown, 1999). Therefore, this study focuses on physical disorder only. Three measures of physical disorder are used in this study. These are street cleanliness (litter), graffiti, and building conditions. Although previous studies have identified various types of physical order, they are generally classified into the three general types mentioned the above. For example, the physical disorder index used by Sampson and Raudenbush (1999) consists of 10 items, in which 5 items (cigarettes, beer bottles/cans, condoms, needles, and garbage on street) are related to street cleanliness, 4 items (tagging, gang, political message, and other types of graffiti) are about graffiti, and one item is abandoned cars. Doran and Lees (2005), who compared a crime hotspot map with a map showing concentrations of physical disorder, have assessed physical disorder using a similar method to that of Sampson and Raudenbush (1999), but added 4 more items related to building conditions, such as

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[8] See Sampson and Raudenbush (1999) as an example. They describe ten items intended to measure physical disorder and 7 items to measure social disorder.

abandoned houses, lack of exterior maintenance, vandalism to buildings, and vandalism to public structures.

Similar to the study by Sampson and Raudenbush (1999), the three types of physical disorder used here are measured by observation rather than through the subjective perceptions of residents because resident's perceptions of disorder are often influenced by their criminal victimization, fear of crime, and socio-demographic status (Perkins et al., 1993: Sampson and Raudenbush, 1999; Skogan, 1990; Taylor, 1995).

While some studies record the presence or absence of physical disorder (Sampson and Raudenbush, 1999; Wei et al., 2005), this study rates the level of each type of physical disorder based on how extensive they are so that we can gain a better understanding of how physical disorder is likely to impact auto theft, particularly theft of older cars.

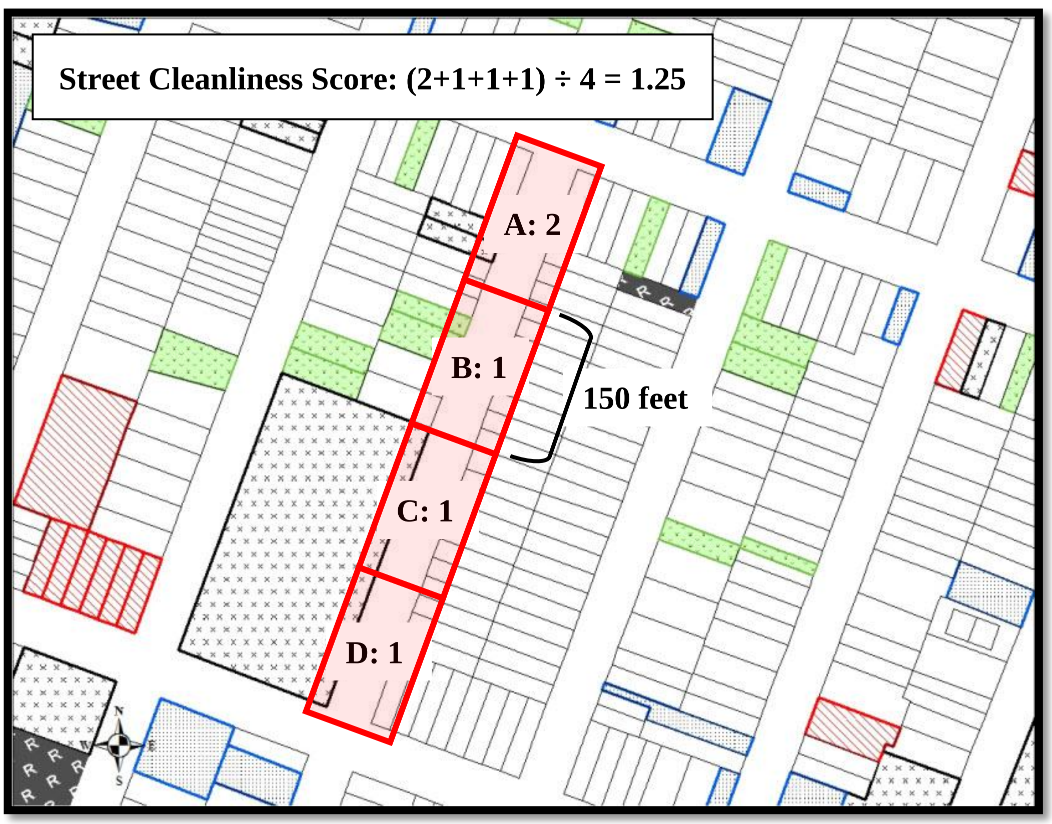
For example, if offenders are to perceive that the chances of being interfered with or caught is low in an area with physical disorder because nobody cares about happenings in the place, they may be more likely to assume this with piles of litter along the curb than an area with one cigarette butt on the street. Also, a dichotomous coding of litter, for example, may become more problematic when it is combined with other indicators of physical disorder, such as abandoned buildings and graffiti, to produce a physical disorder index. For example, the index used by Wei and her colleagues (2005) consists of the sum of five dichotomous items collected from observations of face-blocks: the presence (1) or absence (0) of different forms of physical disorder. In such a case, a face-block with a few cigarette butts on the street and a face-black with a few abandoned cars will have the same level of physical disorder, a score of 1, unless some type of weighting systems are adopted.

This study develops observation rating scales for three measures of physical disorder: street cleanliness, graffiti, and building conditions. These scales are created together with actual photos taken from GSV in order to minimize inconsistency in rating (See Appendix A for the photo-based scales). The street cleanliness or litter scale in this study is adopted from the Scorecard inspection program run by the New York City Mayor's Office of Operations (2010) to measure and monitor the street and sidewalk cleanliness in the city. Street cleanliness is rated on a unique 6-point scale, with 1 being the cleanest and 2.5 being the dirtiest. Street cleanliness score of less than 1.5 is considered to be clean. The graffiti scale was developed based on the number of pieces and intense of graffiti on structures. The level of graffiti is assessed on a simple 5-point scale, with 0 being no graffiti and 4 being the most intense. The building condition scale was adopted from the work of Cohen and her colleagues (2000) who examined the relationships between neighborhood conditions and gonorrhea. Ratings of buildings are based on a 4-point scale, with 0 being no visible damages and 3 being major structural damages.

This study uses GSV to rate each sampled street segment and each building or structure on both sides of the street. Unlike assessing the level of graffiti and building condition where each individual building or structure is observed and receives a score, litter occurs without clear boundaries. Also, litter may concentrate in one section of the street while no litter occurs in another section of the same street.

Therefore, this study divides a street segment into 150 feet segments, about the half the average length of the city's street segment, and rates street cleanliness separately. The street cleanliness scores from each segment are aggregated to the street segment level, and then an average score for the street segment is calculated. For example, if one street segment is 600 feet long, it will be divided into 4 sections (A, B, C, and D), with each section being 150 feet long, and each section receives the street cleanliness score. Suppose the score for the section A is 2 and for the other three sections is 1, the street cleanliness score for the street segment will be 1.25, (2+1+1+1)/4 = 1.25. This coding method is illustrated in Figure 7.

Figure 7: Illustration of Measuring Street Cleanliness/Litter



Land Use

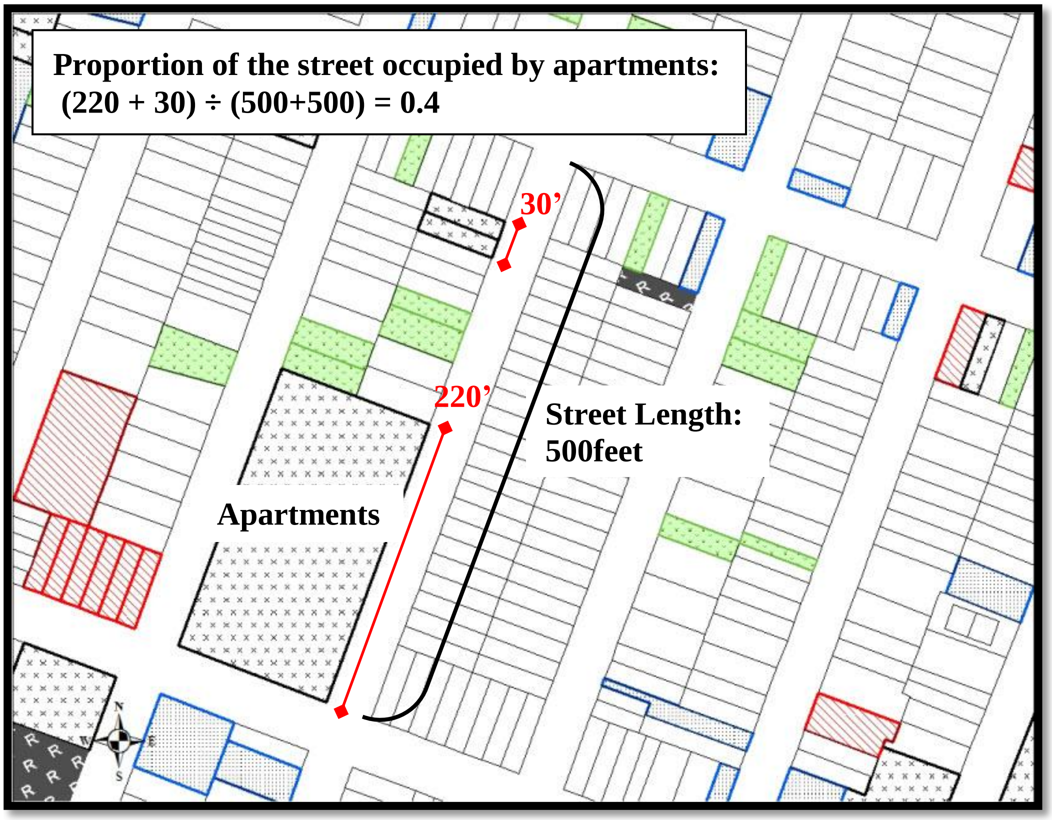
Criminogenic land uses mean those that have been found to be associated with auto theft. These include *apartments* (dwellings with more than 5 families), *single-family homes*, *offices* (e.g., banks, insurance/travel agencies, and business buildings), *shopping plazas* (multi-store locations and malls) *downtown row types* (buildings with retail sales/services on the first floor and apartments on the upper floor), *bars* (pubs/taverns and nightclubs), *schools* (all types of schools), *warehouses/industry*, and *vacant lots*. Although certain types of land uses tend to be prone to auto theft (Fleming et al, 1994; Hollinger and Dabney, 1999; Lu, 2006; Plouffe and Sampson, 2004; Rengart, 1996; Rice and Smith, 2002; Roncel and Maier, 1991; Weisel et al., 2006), previous studies make no reference to how those land use patterns influence theft of older cars or how they affect spatial distribution of older cars parked.

What is known is that such land uses as *apartments*, *downtown row types*, *shopping plazas*, and *restaurants/bars* are prone to auto theft, not only because they attract large number of people, some of whom can be offenders, and vehicles but also because they promote more anonymity and less direct supervision by place managers (Lu, 2006; Rice and Smith, 2002). On the other hand, *single-family homes* may serve as a mitigating factor of auto theft because they often tend to have driveways and/or garages which have been shown to reduce the risk of auto theft (Clarke and Mayhew, 1998; Weisel et al., 2006). *Offices* and *schools* are found to have high levels of auto theft,because they attract large number of people who are associated with them (Rengart, 1996; Rice and Smith, 2002). Areas with more *warehouses* and *vacant lots* tend to have more auto thefts because they provide little guardianship to the site (Rice and Smith, 2002). Taylor (1995) found that those areas tend to have more physical deterioration, so *warehouse/industry* and *vacant lots* may present more of an appearance of physical disorder.

Each type of land use mentioned earlier except bars is operationalized as the proportion of the street occupied by that land use. For example, if there are two apartments on one side of the street that is 500 feet long and the total length of apartment along that street is 250 feet, then the proportion of the street occupied by the apartments will be 0.4 or 40%, $250/(500\times2) = 0.4$ (Figure 8). The length of the street is multiplied by two, because there are buildings on both sides of the street.

On the other hand, the presence of bar is separately measured by dichotomous coding: (0) No and (1) Yes. This is because the presence of bar itself is found to increase the level of auto thefts in the area which contains such property (Rice and Smith, 2002; Roncel and Maier, 1991) and because the sampled streets barely include more than one bar per each if they have one. In addition, the length of all sampled street segments is measured using ArcGIS and is used as a control variable.

Figure 8: Illustration of Measuring Land Use



Analysis Procedure

This study draws on the principle of triangulation, gathering an array of evidence from different analyses using data from different sources to investigate mechanisms of theft of older cars. A series of analyses are conducted for each of the four main factors: vehicle availability, vehicle security, locations where vehicles are found, and offender motives. Data sources, sample size, hypotheses, and analytical techniques used to address the research questions described earlier are summarized in Table 8.

The unit of analysis in this study is cars found on a sample of streets, including both parked cars observed and cars stolen. On the other hand, the analyses of vehicle locations are conducted at a street level as well as car level. Multilevel negative binominal regression is selected for the street-level analyses to account for the cluster effects and overdispersion in the count dependent variables (One dependent variable had the mean of 6.4 with variance of 55.7 and another had the mean of 10.6 with a variance of 104.5).

The cluster effect or intracluster correlation occurs when the data collected have a nested structure. In this study, a sample of streets is selected within the cells that are randomly selected. In other words, sampled streets are nested within the cells. Therefore, outcomes of streets within the same cell are likely to be correlated, resulting in erroneous conclusions about the effect of some predictor variables in the model (Hox, 2002). Multilevel models treat streets as the unit of analysis, but also take into account the dependence of streets nested within the same cell.

The multilevel models are also used for the analyses of offender motive which perform logistic regression to determine the effects of predictor variables on the likelihood of theft, recovery, and stripping of stolen vehicles' parts. This is because the cars that are found on sampled streets are the unit of analysis. Again, these cars are nested within streets that are further nested within cells. In these analyses, as well as the analyses of location that are conducted at the car level, the physical disorder scores and land-use values (the percentage of streets occupied by certain types of properties) are assigned to each car based on the street where it was found. This means all cars (both parked cars and stolen cars) found at the same street receive the same location scores.

In the analyses that use car as the unit of analysis, the same analysis is conducted for each of the selected vehicle makes because there is found to be considerable variation in the risk of theft and the age of stolen cars among vehicle makes. As shown in Table 7, older Hondas and Toyotas (imports) are more frequently stolen, but newer Dodges and Fords (domestics) are more stolen. Also, the imports are more likely to be stripped of their parts compared to the domestics. Therefore, the effects of vehicle age on auto theft may vary depending on vehicle makes. The two most stolen vehicle makes in the data are selected, each from domestic and import makes.

Table 7: Modal Theft Profile: Variability in Age and Vehicle Makes

	Frequency			Age most frequently involved in		
Makes	Theft	Recovery	Stripping	Theft	Recovery	Stripping
All	4,284	3,618	626	13	12	11,12
Dodge	768	668	91	8	8	8
Ford	354	293	34	5	7	9
Honda	535	456	107	15	15	14
Toyota	242	210	49	15	15	16

The last analysis tests for interaction effects between age and make to determine how the effect of vehicle age on auto theft is influenced by vehicle makes. As mentioned earlier, older cars of some makes may be at more risk of theft than their newer counterparts, and vice versa. Failure to account for such interactions may result in misunderstanding of the nature of theft of older cars. Conversely, understanding the interaction effects between age and make can provide insight into auto thieves' target selection. In addition, prior to conduct each multivariate analysis, variance inflation factor tests were performed to examine for multicollinearity. It was not, however, found in any of the predictor variables (tolerance values range from 0.4 to 0.89) used in this study.

Table 8: Summary of Analysis Procedure

Study & Data	Sample	Question and Hypothesis	Analysis	Technique
Availability NPD GSV	N=11,642 Cars parked (N=7,365) Cars stolen (N=4,277)	***Are there more older cars available to steal?*** Older cars are more stolen because there are more older cars parked. The percentage of stolen cars that are older is the same as the percentage of parked cars that are older.	Compare the two age distributions: stolen cars and parked cars	Graphical Chi-square tests Vehicles (0) *Newer* (1) *Older* Events (0) *Stolen* (1) *Parked*
Security NPD GSV Ward's Auto CNFE	N=8,113 Cars parked (N=4,041) Cars stolen (N=4,072) Attempted (N=314) also used	***Are older cars easier to steal?*** Older cars are less likely to be involved in attempted theft than newer cars. Older cars are not involved in attempted theft to the same extent as they are involved in auto theft. Older cars are less likely to have electronic immobilizers than newer cars.	Compare the proportions of older to newer cars among cars stolen, parked, and attempted to be stolen. Compare the proportions of cars that have immobilizers between cars parked and cars stolen	Graphical Chi-square tests Vehicles (0) *Newer* (1) *Older* Immobilizers (0) *No* (1) *Yes*

Physical Environment NPD GSV	N=11,642 Cars parked (N=7,365) Cars stolen (N=4,277)	***Are older cars more likely to be parked on streets with physical disorder?*** Older cars are more often parked on streets with physical disorder than on streets without physical disorder. Older cars are more likely to be parked on streets with physical disorder than newer ones.	Compute the proportion of older cars that are parked on streets with disorder. Compare that proportion with newer cars. Compare the mean ratings of physical disorder between older cars and newer cars.	Chi square tests Vehicles (0) *Newer* (1) *Older* Physical Disorder (0) *No* (1) *Yes* T-tests
	N=384 Streets (N=384) Within cells (N=189)	***Are older cars found more on the streets where criminogenic land use is more common?*** Physical disorder and certain types of land uses are related to higher counts of older cars parked on streets. Physical disorder and certain types of land uses are related to higher counts of older cars stolen from streets.	Interpretations of IRR (Incidence Rate Ratio) *Dependent variables:* Count of older cars parked Counts of theft of older cars	Multilevel NB regression

Motives NPD	N=2,957 Cars stolen between 05-07	***Are older cars stolen more for temporary use than new cars?*** ***Are older cars stolen more for their parts than new cars?***	Compute percentages of stolen cars that are not recovered, recovered intact, and recovered with their parts missing, by age group and car make.	Graphical Descriptive
		How does the effect on different types of theft of the above factors change?		
NPD GSV Ward's Auto CNFE	Stolen (N=7,919)	Age, make, security, and physical disorder are related to a higher probability of vehicles being stolen, holding land uses and other relevant variables constant.	Interpretation of Odds Ratios Perform the same model using different dependent variables.	Multilevel logistic regression with interaction terms
	Recovery (N=2,811)	Age, make, security are related to a higher probability of vehicles being stolen, holding other relevant variables constant.	*Dependent variables*: (0) Parked (1) Stolen (0) No (1) Recovered (0) No (1) Stripped	
	Stripping (N=2,432)	Age and make are related to higher probability of stolen vehicles being stripped, holding other relevant variables constant.		

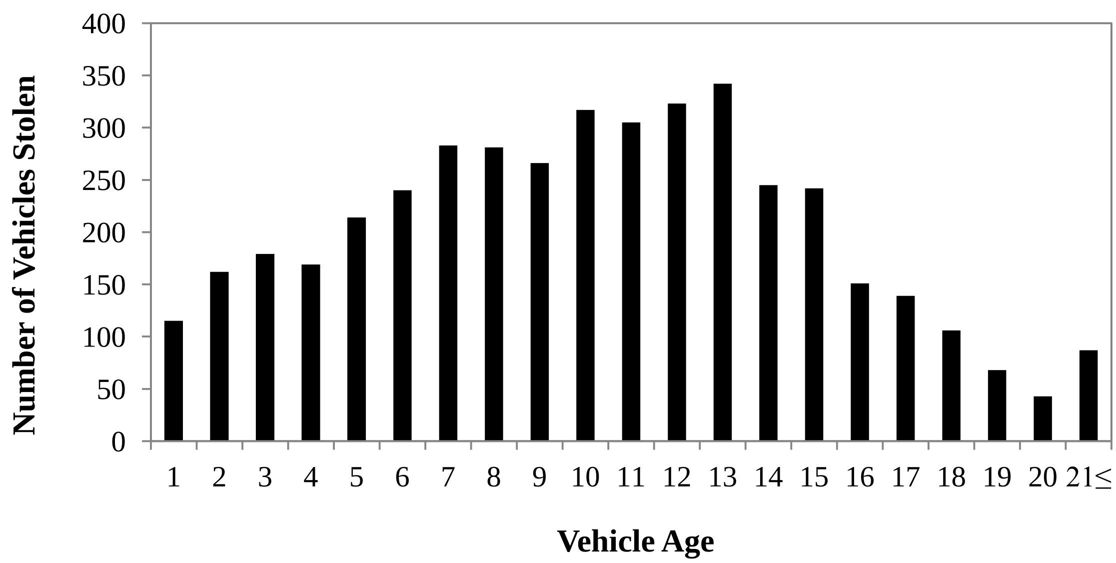
CHAPTER 6

FINDINGS

Vehicle Availability

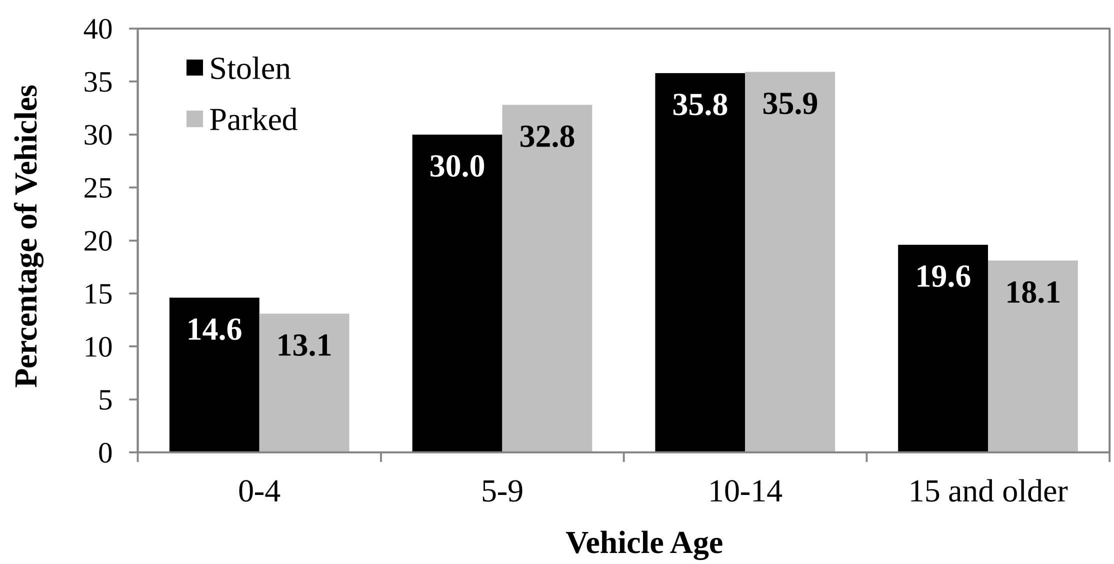
Figure 9 displays the age distribution of vehicles stolen from sampled streets in Newark. Consistent with car theft indices from the U.K. and Australia, the number of vehicles stolen is shown to increase with vehicle age. However, that pattern is reversed once vehicles turn 14 years old. This is similar to the general age-crime curve for criminal acts such as assault that are frequent in mid teens to mid twenties, but infrequent both in early and later ages. The age-theft curve for the sampled stolen vehicles was similar to that for all vehicles stolen in the city, indicating that the sampled stolen vehicles reflect all stolen vehicles in this study (Table 9). This also implies that the sampled streets used in this study closely reflect the entire city.

Figure 9: Age Distribution of Stolen Vehicles (2005-09, N=4,277)



Since a median age of vehicles that are scrapped is about 9 to 10 years old (Ward's Auto, 2009), vehicles are gradually dropping out from the fleet as they pass their peak age, hence, there would be fewer of these vehicles available to steal. This may explain why auto theft is infrequent in old vehicles. The U.K. Car Theft Index also shows that the risk of car theft increases until 15 years old but drops afterwards. In this sense, it would be wise to focus particularly on the older vehicles that belong to the age group of *relatively old* (those aged between 10 and 14 years old) defined by this study. The age distribution of stolen vehicles is aggregated to age groups and is compared with that of cars parked on the sampled streets in Figure 10.

Figure 10: Age Distribution of Stolen Vehicles and Parked Vehicles



It shows that the relatively old vehicles (10-14 years old) are most frequently stolen, and at the same time, they are the most frequently parked on streets. Although there are slightly more older vehicles stolen (54%) than newer ones, these vehicles are also more often parked on streets (55%). In fact, the age distribution of stolen vehicles shown in Figure 4 almost mirrors that of vehicles parked. That is, the differing proportion of stolen vehicles in terms of vehicle age is a function of the actual number of those vehicles that are parked on streets. However, this changes considerably once vehicle make is taken into account (Figure 11).

Figure 11: Age Distribution of Stolen and Parked Vehicles, Dodge & Honda

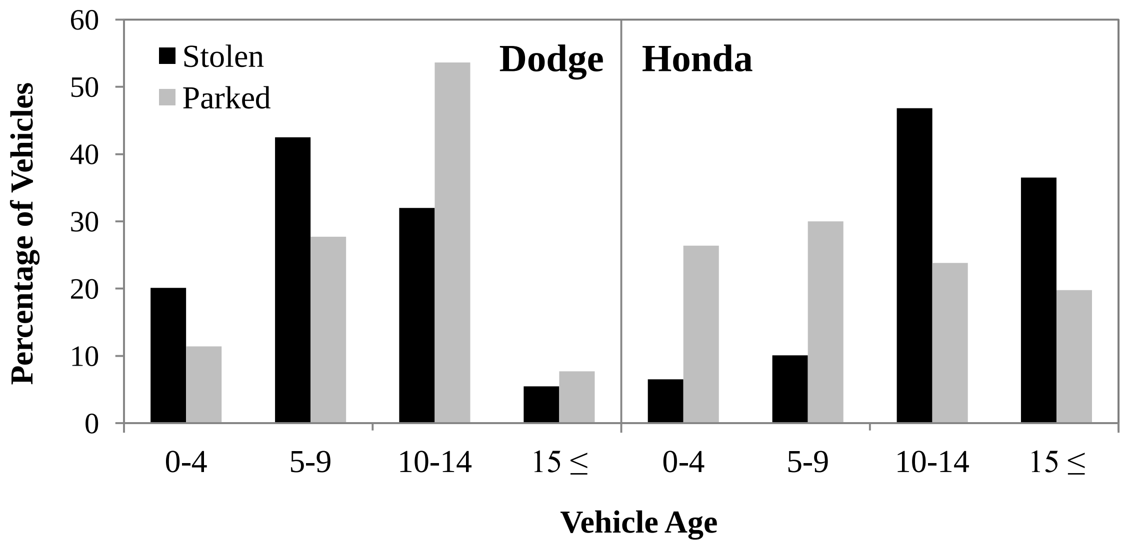


Figure 11 shows a comparison of the age distribution of vehicles stolen and that of vehicles parked for Dodge and Honda, the two most common stolen makes in the city. The age group which is most frequently stolen is relatively new (5-9 years old) for Dodge and relatively old (10-14 years old) for Honda, whereas the age group which is most frequently parked on streets is relatively old for Dodge and relatively new for Honda. Specifically, the newer Dodges constitute about 63 percent of all Dodges stolen while constituting about 40% of those parked. That is, newer Dodges are more stolen than older ones although there are more older Dodges available. On the other hand, the older

Hondas account for 83 percent of all Hondas stolen while constituting about 43 percent of those parked. Contrary to Dodge, older Hondas are far more stolen than newer ones despite that there are more newer Hondas parked on streets (See also Table 9).

Table 9: Age Distribution of Stolen Vehicles and Parked Vehicles by Makes

Makes	Age	Cars Parked		Cars Stolen From Sampled Streets		Cars Stolen From Newark	
ALL	0-4	965	13.1	625	14.6	2,957	15.3
	5-9	2,418	32.8	1,284	30.0	5,680	29.4
	10-14	2,647	35.9	1,532	35.8	6,910	35.8
	14 <	1,335	18.1	836	19.6	3,742	19.4
	Total	**7,365**	**100%**	**4,277**	**100%**	**19,289**	**100%**
Dodge	0-4	39	11.4	154	20.1	687	20.8
	5-9	95	27.7	326	42.5	1,305	39.6
	10-14	184	53.6	246	32.0	1,100	33.4
	14 <	25	7.3	42	5.5	203	6.2
	Total	**343**	**100%**	**768**	**100%**	**3,295**	**100%**
Ford	0-4	48	6.1	66	18.6	261	16.2
	5-9	253	32.2	145	41.0	604	37.5
	10-14	342	43.6	107	30.2	555	34.5
	14 <	142	18.1	36	10.2	189	11.7
	Total	**785**	**100%**	**354**	**100%**	**1,609**	**100%**
Honda	0-4	148	26.4	35	6.5	167	7.4
	5-9	169	30.1	54	10.1	318	14.1
	10-14	133	23.7	251	46.8	986	43.8
	14 <	111	19.8	195	36.5	779	34.6
	Total	**561**	**100%**	**535**	**100%**	**2,250**	**100%**
Toyota	0-4	118	20.6	40	16.5	197	17.9
	5-9	154	26.9	32	13.2	143	13.0
	10-14	122	21.3	38	15.7	138	12.5
	14 <	179	31.2	132	54.6	623	56.6
	Total	**573**	**100%**	**242**	**100%**	**1,101**	**100%**
Others	0-4	612	12.0	295	15.5	1,645	14.9
	5-9	1,747	34.2	557	29.3	3,310	30.0
	10-14	1,866	36.6	642	33.8	4,131	37.4
	14 <	878	17.2	405	21.3	1,948	17.7
	Total	**5,103**	**100%**	**1,899**	**100%**	**11,034**	**100%**

Table 9 summarizes the age distribution for both stolen vehicles and parked vehicles by vehicle make. Ford is shown to have a similar pattern as Dodge does, while Toyota follows a similar pattern as Honda. That is, there are more older Fords available on the streets, but newer Fords are more frequently stolen than older ones. On the other hand, older Toyotas are more stolen than would be expected. For example, older Toyotas account for about 70 percent of all stolen Toyotas despite that about 52 percent of all Toyotas parked on streets are older Toyotas (10 years and older). All else being equal, if 50 percent of vehicles that are available to steal are old, old vehicles should be expected to account for 50 percent of stolen vehicle population. A good example of this is shown in Figure 10.

To confirm the phenomenon discussed above, chi-square analyses are conducted to determine whether or not the relative frequency of stolen vehicles that are older is the same as the relative frequency of parked vehicles that are older, and are summarized in Table 10. The tests confirm that older Hondas and Toyotas are more stolen than expected, while the opposite is true for Dodges and Fords. This discrepancy is the largest for Honda (phi= -.41). Surprisingly, the test suggests that *the Honda phenomenon*, older cars being stolen proportionately more than newer cars, applies to all makes (phi=.03), but this is probably because of the large sample size which can detect such tiny effect.

In sum, older vehicles are more frequently stolen, not necessarily because there are more of these vehicles on streets, and this is probably even more so for Japanese makes as Honda and Toyota.

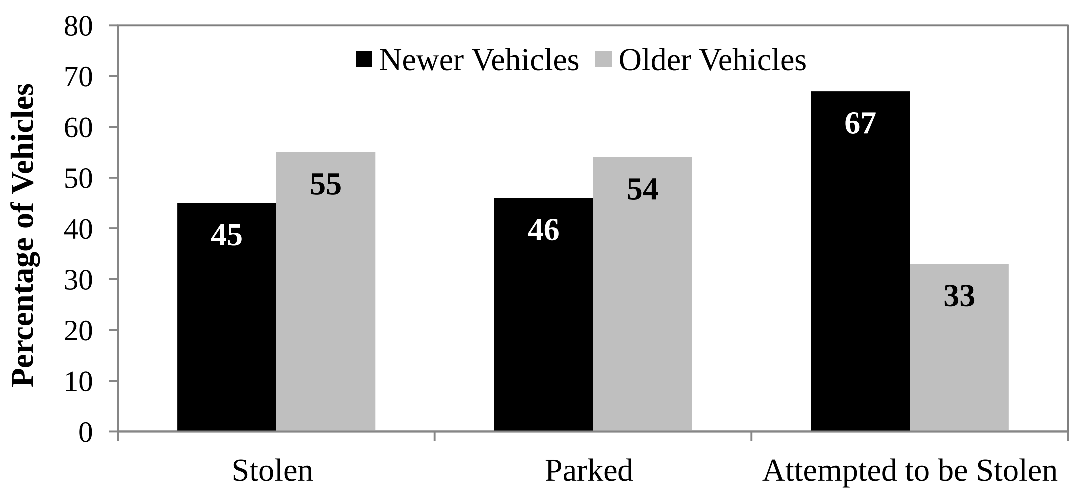
Table 10: Chi-square Tests of (1) Older Vehicles and (1) Stolen by Makes

	n	χ^2	P<	Phi
All Makes	11,642	14.2	.01	.03
Dodge	1,111	52.7	.001	-.22
Ford	1,139	44.6	.001	-.20
Honda	1,096	186.7	.001	.41
Toyota	815	21.9	.001	.16
All Others	5714	11.9	.01	.05

Vehicle Security

Figure 12 shows the differences in the percentage of vehicles that are older/newer among those stolen, parked, and attempted to be stolen. Attempted theft is included because it can provide insight into what factors can make stealing of vehicles unsuccessful. Older vehicles appear to be less often involved in attempted theft (33%) compared to successful auto thefts (55%), while 54 percent of all vehicles parked on streets are older ones. Conversely, the percentage of newer vehicles involved in attempted theft (67%) is higher than in auto theft (45%) as well as parked vehicles (46%).

Figure 12: Vehicles Stolen, Parked, and Attempted to be Stolen by Age Group



Although older vehicles represent over one half of stolen vehicles as well as parked vehicles, they account for only 33 percent of attempted theft. This means that theft of older vehicles is more likely to result in success than theft of newer vehicles. All else being equal, when 54 percent of vehicles that are parked (available to steal) are older ones, older vehicles are expected to account for 54 percent of those involved in attempted theft as well, but they are not involved in attempted theft to the same extent as they are involved in auto theft nor represent the parked vehicle population. In sum, stealing older cars appears to be easier than stealing newer cars. One of the reasons may be that they are less likely to be equipped with electronic immobilizers that are shown to be effective in preventing auto theft. The effectiveness of immobilizers is somewhat evident in Figure 13.

Figure 13: Vehicles Stolen, Parked, and Attempted to be Stolen by Presence of Electronic Immobilizers

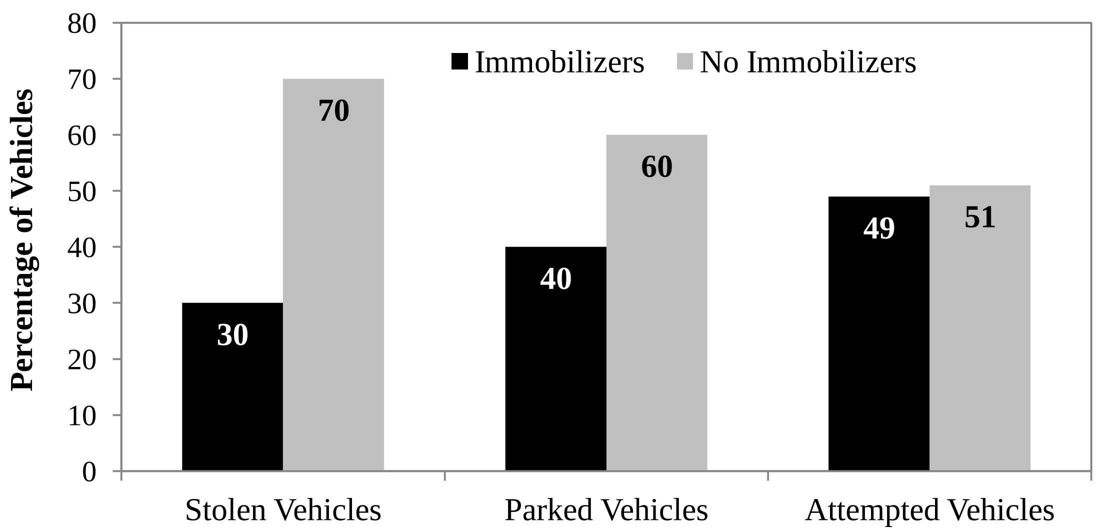
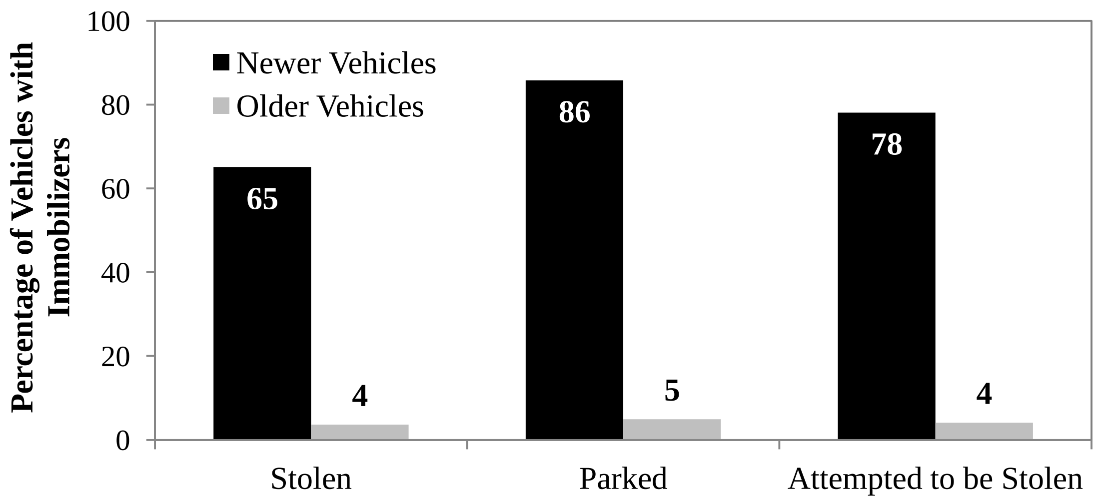


Figure 13 shows the differences in the percentage of vehicles that are equipped with or without electronic immobilizers among those involved in the different types of events (stolen, parked and attempted to be stolen). Like older vehicles, those that are not fitted with electronic immobilizers as standard equipment are less often involved in attempted theft (51%) than in auto theft (70%), while they represent 60 percent of vehicles parked on streets. In other words, the percentage of vehicles with immobilizers involved in auto theft (30%) is lower than in attempted auto theft (49%). That is, stealing of vehicles with immobilizers is less likely to result in success than theft of those without immobilizers. This may imply the effectiveness of electronic immobilizers in thwarting vehicles from being stolen as well as vehicles without immobilizers being preferred by thieves over those with immobilizers.

Figure 14 compares the differences in the percentage of vehicles that have immobilizers among different types of events they are involved by age group. What is probably most apparent in Figure 14 is that only 5 percent of older vehicles parked on streets are equipped with electronic immobilizers. Conversely, the vast majority (95%) of the older vehicles do not have factory-installed electronic immobilizers. This is not surprising when considering that all vehicles produced before the mid-90s are, in fact, not equipped with electronic immobilizers as standard except some VATS-fitted GM models. However, it is now confirmed by this study that 95 percent of older vehicles (10 years old and older) parked on the sampled streets in Newark lack electronics immobilizers that are shown to be effective anti-theft devices. Similarly, about 95 percent of older vehicles involved in auto theft and attempted auto theft are not fitted with electronic immobilizers.

In addition, Figure 14 shows that the percentage of newer vehicles that are equipped with immobilizers is the lowest for vehicles stolen (65%), followed by vehicles attempted to be stolen (78%) and those parked (86%). This may suggest that thieves prefer stealing newer vehicles without immobilizers over those with immobilizers, or that immobilizers are preventing vehicles from being stolen. Again, with all other things being equal, newer vehicles with immobilizers are expected to account for 86 percent of all vehicles stolen if these vehicles represent 86 percent of all vehicles available to steal.

Figure 14: Vehicles with Immobilizers Stolen, Parked, and Attempted to be Stolen by Age Group



To determine whether or not older vehicles are less likely than newer vehicles to have electronic immobilizers regardless of their makes, chi-square analyses are performed, and the results are summarized in Table11. The tests reveal a negative relationship between the age and the presence of electronic immobilizers for all vehicles, including Dodge, Ford, Honda, and Toyota. That is, older cars tend not to have immobilizers regardless of their makes. Such association tends to be stronger for vehicles parked (phi= -.82) than for those stolen (phi= -.66), and this is true for all selected makes. This may imply that older vehicles parked on streets are especially less likely to have electronic immobilizers than their newer counterparts. In other words, stolen vehicles include more older vehicles with immobilizers than parked vehicles, suggesting that some thieves have stolen older vehicles with immobilizers.

Table 11: Chi-square Tests of (1) Older Vehicles and (1) Presence of Immobilizers by Makes

	Stolen Cars				Parked Car			
	n	χ^2	P<	Phi	n	χ^2	P<	Phi
All Makes	**4,072**	**1800**	**.001**	**-.66**	**4,041**	**2700**	**.001**	**-.82**
Dodge	725	309	.001	-.65	280	259	.001	-.96
Ford	331	75	.001	-.47	518	316	.001	-.78
Honda	530	283	.001	-.73	551	366	.001	-.82
Toyota	237	152	.001	-.80	511	231	.001	-.84
All Others	2,249	955	.001	-.65	1,987	1400	.001	-.67

Locations of Parked and Stolen Vehicles

Table 12 shows crosstabulations of physical disorder and vehicle age group (older vs. newer) for both parked vehicles and stolen vehicles. As for street cleanliness (or litter), older vehicles are more often parked on the streets with higher levels of litter than on the streets with lower levels, and so are newer vehicles. About 78 percent and 69 percent of the older and newer vehicles, respectively, are parked on the filthy streets. The chi square test reveals a weak positive relationship between vehicle age and street cleanliness (ϕ=.11 p <.001), suggesting that older vehicles are more likely than newer vehicles to be found on the filthy streets.

Table 12: Crosstabulation of Physical Disorder and Vehicle Age Group

(Numbers are shown in percentages otherwise noticed)

	Parked Vehicles			Stolen Vehicles		
	Newer	**Older (1)**	**All**	**Newer**	**Older (1)**	**All**
Street						
0. Clean	31	22	**26**	25	23	**24**
1. Filthy	69	78	**74**	75	77	**76**
Total %	100	100	100	100	100	100
(Total #)	(3383)	(3982)	(7365)	(1909)	(2368)	(4277)
			χ^2= 85.37** ϕ = .11			χ^2= 4.2* ϕ = .03
Graffiti						
0. None	52	52	**52**	54	55	**55**
1. Yes	48	48	**48**	46	45	**46**
Total %	100	100	100	100	100	100
(Total #)	(3383)	(3982)	(7365)	(1909)	(2368)	(4277)
			χ^2= .001			χ^2= .17
Building						
0. No Damages	46	37	**41**	34	30	**32**
1. Damages	54	63	**59**	65	70	**69**
Total %	100	100	100	100	100	100
(Total #)	(3383)	(3982)	(7365)	(1909)	(2368)	(4277)
			χ^2= 57.10** ϕ = .09			χ^2= 13.16** ϕ V = .12

Note: Total may exceed 100 percent due to rounding error. (*p<.05 **p<.001)

The proportion of the older vehicles that are on the filthy streets was about the same for both parked car (78%) and stolen car groups (77%). In other words, older vehicles are more frequently stolen from the filthy streets than from the clean streets because there are more older vehicles parked on those streets. On the other hand, newer vehicles are more frequently stolen from the filthy streets than they are expected to be. About 75 percent of newer vehicles were stolen from the filthy streets, while 69 percent of newer vehicles were observed being parked on the filthy streets. This may imply that thieves tend to prefer stealing newer vehicles parked on filthy streets over those parked on clean streets.

As for graffiti, vehicle age, whether vehicles are older or newer, is found not to affect the likelihood of vehicles being parked on streets with graffiti or without graffiti, and this is also confirmed by a chi square test (Table 12). A little less than one half (48%) of both older and newer cars are parked on the streets with graffiti, whereas about 46 percent of both older and newer cars were stolen from the streets with graffiti.

With respect to building condition, there are more vehicles parked on the streets with damaged buildings (59%) than on the streets without such buildings. Similarly, vehicles are more frequently stolen from the streets with damaged buildings (69%). Older vehicles are slightly more likely than newer vehicles to be parked on the streets with damaged buildings (ϕ=.09 p <.001). Overall, the proportion of vehicles that are stolen from the streets with damaged buildings (69%) is higher than the proportion of vehicles that are parked on those streets (59%), and this was true for both older and newer vehicles. This may suggest that vehicles parked on the streets with damaged buildings are more likely to be stolen than those parked on the streets without such buildings. Also, it seems that the effect of building damages on the likelihood of vehicles being stolen is bigger than that of street cleanliness or litter.

These findings were confirmed by the t-tests analyses that compared the average of physical disorder scores between older and newer vehicles (Table 13). Higher scores indicate higher levels of disorder for each dimension. As mentioned earlier, the physical disorder scores were assigned to each vehicle based on the streets where it was found, hence, vehicles parked on the same street all received the same score. T-tests were performed for both parked vehicles and stolen vehicles. In general, older vehicles receive higher scores of litter and building damage than newer vehicles. This difference is statistically significant at the .001 level. This means that older vehicles tend to be parked on the streets with higher levels of litter and building damages, compared to their newer counterparts. On the other hand, the level of graffiti is unrelated to vehicle age for both stolen and parked cars.

As for stolen vehicles, older stolen vehicles are shown to have higher levels of litter and building damage, compared to their newer counterparts. In general, it appears that thieves are a little more likely to steal vehicles that are parked on streets with higher levels of litter and building damage. This is because the litter and building damage ratings are slightly higher for stolen vehicles than for parked vehicles.

Table 13: Comparisons of Physical Disorder Score between Vehicles Age Groups

	Parked Vehicles			Stolen Vehicles		
	n	Mean	SD	n	Mean	SD
Litter	7,365	1.60	.21	4,277	1.61	.21
Newer cars	3,383	1.57	.21	1,909	1.59	.20
Older cars	3.982	1.62	.21	2,368	1.62	.21
		*T=-11.57**			*T=-3.60**	
Graffiti	7,365	4.27	7.93	4,277	3.95	7.83
Newer cars	3,383	4.30	7.85	1,909	3.94	7.59
Older cars	3.982	4.25	8.10	2,368	3.96	8.02
		T= .24 ns			*T=-.63 ns*	
Building	7,365	3.53	5.94	4,277	3.88	6.28
Newer cars	3,383	2.88	5.21	1,909	3.51	5.79
Older cars	3.982	4.08	6.45	2,368	4.19	6.64
		*T=-8.67**			*T=-3.53**	

* P<.001

The chi-square tests and t-tests that have been presented here were also conducted for each of the selected vehicle makes: Dodge, Ford, Honda, and Toyota. The results are not included here, but each make conforms to the general patterns discussed earlier. However, the differences in the mean scores of physical disorder between older vehicles and newer vehicles were not significant for all of the four selected makes except Ford.

Location Study: Street-level Multivariate Analysis

This study has shown so far that both older and newer vehicles are more frequently parked on the streets with litter and damaged buildings, and accordingly, they are more frequently stolen from those streets. Based on bivariate analysis, older vehicles are found to be more likely than newer vehicles to be parked on the streets with higher levels of litter, as well as more damaged buildings. To further examine the relationship between older vehicles and physical settings where they are parked and stolen, this study conducted a series of multivariate analyses, while shifting its focus to a street level from an individual car level and including land-use variables.

Table 14 reports the descriptive statistics for the dependent variables and predictor variables in the analysis of location. The result of bivariate correlations between those variables is displayed in Table 15. The dependent variable which is tested first in this section is the count of older vehicles parked on sampled streets. This variable is shown to be positively and significantly associated with the length of street in feet, all three types of physical disorder (litter, graffiti and building conditions/damages), single-family homes, and multi-dwelling units, while it is negatively and significantly related with warehouses and vacant lots. For example, the number of older cars parked on the street increases as the length of street, levels of physical disorder, and the percentage of that street occupied by single-family or multi-dwelling unit increases.

The second dependent variable tested is the count of older cars stolen from the streets. The correlation matrix shows that it is positively and significantly correlated with the number of older cars parked, street length, physical disorder (litter, graffiti, and building damages), multi-dwelling units, shopping plazas, and that it is negatively and significantly associated with the percentage of street occupied by warehouses or vacant lots. Many of these correlations are consistent with the literature on auto theft, but warehouse and vacant lots that are expected to be positively related with the count of theft of older cars are, in fact, negatively correlated with that outcome. This is probably because these land uses are also negatively related with the number of older cars parked, and hence, there may be fewer targets available to steal around warehouses and vacant lots.

As for other significant relationships, the three types of physical disorder, as well as street length, are all found to be positively and moderately correlated with each other. This makes sense because longer streets can have more buildings or structures that can be subjected to graffiti and physical damages although the rating of street cleanliness (or litter) takes into account the length of street when measured. The level of litter is found to increase as the percentage of streets occupied by single-family homes, downtown row types, warehouse, or vacant lots increases, but the streets where offices dominate tend to have lower levels of litter, suggesting that they are doing a good job of keeping their premises clean. The streets mainly occupied by office buildings have fewer damaged buildings, but they are more subjected to graffiti which is also often found on the streets with more warehouses and vacant lots. This may imply that smooth surfaces or walls of the offices and warehouses in which place managers are often absent after business hours tend to be suitable targets for grafittiers. These variables mentioned above and displayed in Table 14 are then put into the multilevel negative binominal regression models to examine their influence on the count of older cars parked, as well as the count of theft of older cars.

Table 14: Descriptive Statistics for Environmental Predictors of Outcomes

Variable	Mean	Standard Deviation	Maximum Value
Outcomes			
Theft of Older Cars	6.4	7.4	57.0
Total Older Cars Parked	10.6	10.2	66.0
Control Variables			
Street Length (ft)	795.3	426.2	2662.0
Total Cars parked	19.6	18.63	116.0
Physical Disorder			
Litter	1.68	0.2	2.3
Graffiti	2.9	5.4	51.0
Building Condition	2.5	4.4	31.0
Land Use (Percent)			
Single-Family	23%	23	100
Multi-Dwellings	19%	28	100
Office	4%	7	54
Shopping Plaza	7%	5	54
Downtown Row	3%	7	72
School	3%	3	53
Warehouse	10%	23	100
Vacant lots	8%	13	60
Bar	0.17	0.37	1

N: 384 streets within 189 cells

Table 15: Bivariate Correlations

Variable	Theft of Old 1	Old Cars 2	Length (ft) 3	Total Cars 4	Litter 5	Graffiti 6	Building 7	Single-home 8	Multi-home 9	Office 10	Plaza 11	DT Row 12	School 13	Warehouse 14	Vacant lot 15
1. Theft of old cars															
2. Old cars parked	**.61**														
3. Street length (ft)	**.50**	**.68**													
4. Total cars parked	**.56**	**.92**	**.64**												
5. Litter	.12	**.16**	**.17**	.05											
6. Graffiti	**.16**	**.26**	**.31**	**.27**	**.23**										
7. Building Condition	**.33**	**.37**	**.50**	**.25**	**.36**	**.32**									
8. Single-family home	.06	**.13**	.05	.08	**.13**	-.11	.09								
9. Multi-dwellings	**.19**	**.20**	.01	**.19**	-.04	-.07	-.06	**-.20**							
10. Office	-.04	-.03	-.02	.06	**-.24**	.11	-.11	**-.26**	-.06						
11. Shopping Plaza	.10	-.05	-.01	-.01	-.05	.02	-.03	-.07	-.04	.06					
12. Downtown row	.01	-.01	-.09	.01	.11	.09	.03	**-.17**	-.09	.07	.07				
13. School	.00	.08	.04	.09	-.08	-.06	.00	-.11	**.14**	-.03	-.05	-.06			
14. Warehouse	**-.18**	**-.14**	.06	**-.13**	.10	**.18**	-.11	**-.34**	**-.20**	-.09	-.04	-.09	**-.15**		
15. Vacant lot	**-.14**	**-.20**	.00	**-.24**	**.15**	.04	**.17**	**-.28**	**-.14**	-.10	-.04	-.05	-.11	.00	
16. Bar	.08	.04	.08	.10	-.02	.12	.05	**-.18**	-.11	.11	**.25**	**.31**	**-.14**	.01	.01

Note: Highlighted coefficient values indicate $p < .001$; bold values indicate $p < .01$, otherwise $p < .05$; gray-colored values = n.s.

Table 16 shows the results of the multilevel negative binominal regression analyses with the count of older cars parked on streets being the dependent variable. The first model includes the three types of physical disorder (litter, graffiti, and building conditions) and both street length and the total number of cars parked serving as statistical control variables.

Table 16: Environment Predictors of Counts of Old Cars Parked on Streets

	Count of Older Cars Parked							
Variables	**IRR**	**SE**	**Z**	**P<**	**IRR**	**SE**	**Z**	**P<**
Street Length (ft)	1.00	0.00	3.06	.01	1.00	0.00	4.17	.001
Total Cars Parked	1.03	0.00	15.00	.001	1.02	0.00	11.80	.001
Litter	1.76	0.14	3.98	.001	1.87	0.14	4.27	.001
Graffiti	0.98	0.00	-4.31	.001	0.98	0.00	-4.04	.001
Building	1.05	0.02	2.67	.01	1.04	0.02	2.18	.05
Single-Family					1.02	0.13	0.16	n.s.
Multi-Dwellings					1.24	0.21	1.26	n.s.
Office					0.77	0.33	-0.60	n.s.
Shopping Plaza					0.56	0.36	-0.90	n.s.
Downtown Row					1.39	0.55	0.82	n.s.
School					1.41	0.47	1.05	n.s.
Warehouse					0.78	0.14	-1.32	n.s.
Vacant lots					0.47	0.11	-3.09	.01
Bar					1.62	1.70	0.47	n.s.
Model fit χ^2	619.2			.001	616.6			.001
Pseudo R2	0.164				0.174			
Street N: 384								
Cell N:189								

The physical disorder variables are found to be statistically significant. Given that street length and the total count of cars parked are held constant, one unit increase in the level of litter and building damage is expected to increase the counts of older cars parked by a factor of 1.76 and 1.05 percent, respectively. On the other hand, the expected count of older cars parked decreases by 0.98 for one unit increase in the level of graffiti. Both of the control variables are positively and significantly related to the count of older cars parked. These findings confirm the statements mentioned earlier that older cars tend to be more often parked on streets with higher levels of litter and damaged buildings.

The three physical disorder variables, as well as control variables, remain significant even after adding the land-use variables. Only one land-use variable, vacant lots, is significant, and its impact is greater than that of building conditions. Specifically, for each one percent increase in the percentage of street occupied by vacant lots, the expected count of older cars parked decreases by a factor of 0.47. This is consistent with the finding derived from the previous bivariate correlation. Overall, the second model appears to be slightly a better predictor of the count of older cars parked than the first model which includes physical disorder variables and control variables only because of a higher pseudo R^2 in the second model.[9]

The same analyses are performed but using the count of older cars stolen from the streets (theft of older cars) as the dependent variables (Table 17). The first model, which includes physical disorder variables and control variables, shows that building condition is related to higher counts of theft of older cars ($p<.001$), while graffiti is related to lower counts of the theft ($p<.05$), after controlling for all other variables in the model. On the other hand, the level of litter is found to be not significant in predicting counts of theft of older cars. The variable, graffiti, becomes not significant when the land-use variables are included in the model, while building conditions remain a strong predictor

[9] Since this regression model does not generate the R-squared measure found in OLS regression, it was calculated based on Iteration Log (Il): [Il(null)-Il(model)]/Il(null). McFadden's R-square [1-Il(model)/Il(null)] generates the same value. This statistic does not indicate what R-square does in OLS regression. However, it will be useful to determine how a model improves from the null model with no predictors to fitted model.

Table 17: Environment Predictors of Counts of Older Cars Stolen from Streets

	Counts of Older Cars Stolen							
Variables	**IRR**	**SE**	**Z**	**P<**	**IRR**	**SE**	**Z**	**P<**
Street Length (ft)	1.00	0.00	2.69	.01	1.00	.000	4.34	.001
Total Old Cars	1.02	0.00	7.63	.001	1.01	.002	4.99	.001
Litter	1.10	0.12	0.52	n.s.	1.26	.253	1.14	n.s.
Graffiti	0.96	0.01	-2.08	.05	0.99	.006	-1.47	n.s.
Building	1.13	0.03	4.51	.001	1.10	.029	3.64	.001
Single-Family					0.78	.145	-1.31	n.s.
Multi-Dwellings					1.23	.308	0.79	n.s.
Office					0.48	.279	-1.26	n.s.
Shopping Plaza					6.19	3.92	2.88	.01
Downtown Row					1.29	.746	0.44	n.s.
School					0.36	.196	-1.88	n.s.
Warehouse					0.34	.094	-3.88	.001
Vacant lots					0.40	.135	-2.70	.01
Bar					1.06	.115	0.58	n.s.
Model fit χ^2	276.0			.001	330.6			.001
Pseudo R2	.083				.100			
Street N: 384								
Cell N:189								

As for the land-use variables, shopping plazas are found to be related to higher counts of theft of older cars. The count of theft of older is expected to increase by a factor of 6.19, for each one percent increase in the percentage of street occupied by shopping plazas. The effect of shopping plazas should be interpreted with caution. The streets occupied by shopping plaza tend to have higher levels of auto theft because they attract large numbers of place users including both cars and potential thieves. However, such an effect found in this study may also be an artifact of data limits. This is because this study compares vehicles stolen to vehicles not stolen from streets (strictly, vehicles parked on streets). Vehicles that are stolen include those stolen from parking lots as well as streets although the former account for less than 5 percent of all stolen vehicles in this study. This means that vehicles that are not stolen from the parking lots are not taken into account in this study. Consequently, the risk of theft at shopping plazas' parking lots will be higher if it is calculated based on the number of vehicles parked on the streets along the plaza, rather than the number of vehicles parked in its lots.

Warehouses and vacant lots are found to be mitigating factors of theft of older cars. Unlike shopping plazas, the count of theft of older cars is expected to decrease by 66 percent and 60 percent, for each one percent increase in the percentage of street occupied by warehouses and vacant lots, respectively. This is consistent with the finding from the bivariate correlation analysis. One of the reasons why these land uses are related to lower counts of theft of older cars may be that older cars are less likely to be parked at these locations. However, these types of land use are found to significantly reduce the counts of theft of older cars on streets even after holding other relevant predictors constant, including the number of older cars parked on the streets. This may mean that warehouses or vacant lots tend not to attract both auto thieves and the drivers of older cars.

In sum, the analyses have shown that the greater building damage is associated with more parked older cars and more stolen older cars, holding land uses and other control variables constant. Higher levels of litter are related to higher counts of older cars parked on streets, but not to theft of older cars. On the other hand, none of land uses except vacant lots is found to be associated with the counts of older parked cars and theft of older cars.

Offender Motive / Types of Theft

This study has already examined the potential effects on theft of older cars of target availability, vehicle security, and physical settings where vehicles are parked. The mechanisms of theft of older cars are now examined from a different perspective. This section describes the involvement of older cars in different types of theft, while inferring offenders' motive for stealing older cars. Detailed descriptions on different types of auto theft are presented after a brief overview of auto theft activities observed on sampled streets.

Figure 15 displays the overall auto theft activities, including auto theft, recovery and stripping of stolen vehicles, for the selected vehicle makes. The size of bubbles shown in the figure is in proportion to that percentage, so the bigger bubble equates to higher stripping rates (the number of stolen vehicles stripped divided by the number of all stolen vehicles). Also, for each make, the age group that is most often involved in the stripping case is listed and color-coded in the figure.

First, there seems to be little variation as to which vehicles are less likely to be recovered, because the number of vehicles stolen appears to be related to the number of stolen vehicles recovered for each vehicle make. However, the percentage of stolen vehicles that are stripped varies with vehicle makes. Japanese vehicles such as Honda and Toyota are more often stripped of their parts (33% and 27%, respectively) than domestic ones such as Dodge and Ford (16% and 14% respectively). More specific, old Japanese vehicles (15 years and older) are more frequently stripped of their parts than their newer counterparts, while relatively old Dodges (10-14 years old) tend to be vulnerable to stripping. On the other hand, relatively new Fords (5-9 years old) are most frequently involved in the stripping case. When looking at the percentage of cars stripped and the most targeted age group (that is, the size and color of bubbles) simultaneously, it seems that there is a relationship between those two factors. When old vehicles are more frequently targeted for stripping than their newer counterparts, the vehicles as a whole, including both new and old, tend to have higher stripping rates. In other words, when vehicles are more frequently stripped, their older group is targeted more for stripping than their newer group. That is, old vehicles appear to result in higher stripping rates.

Figure 15: Recovery and Stripping of Stolen Vehicles by Selected Makes

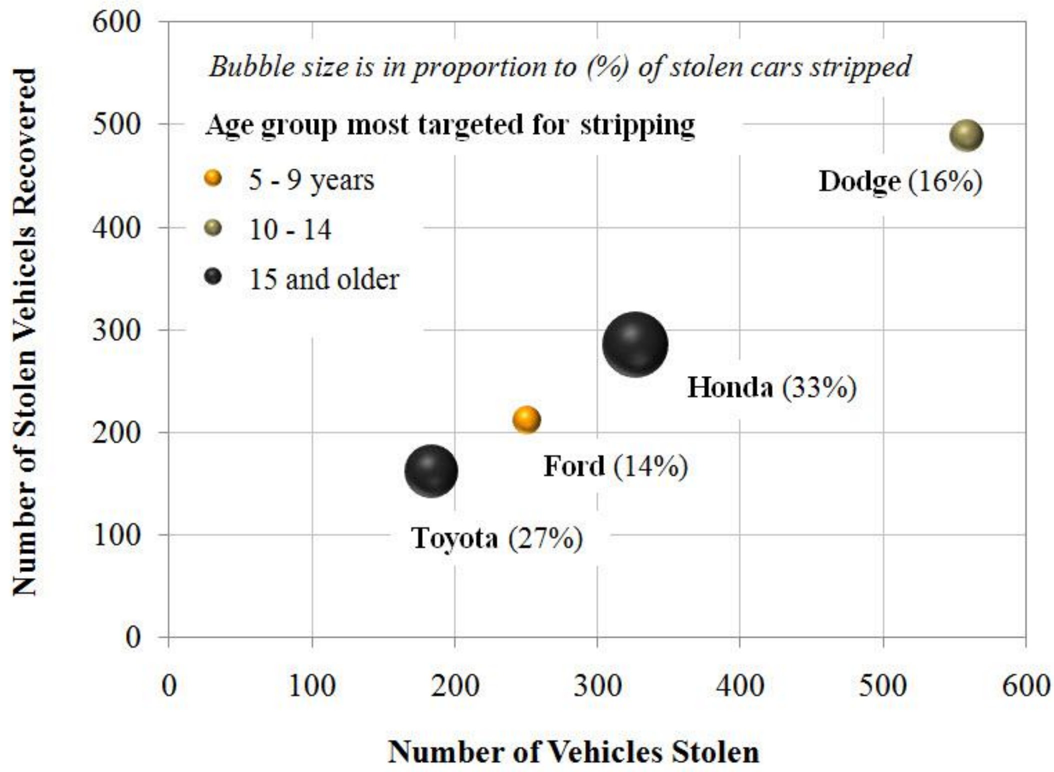


Table 18 shows more specific information on the nature of stolen vehicles that are not recovered (permanent theft), recovered intact (temporary theft, specifically theft for non-profit), and recovered with their parts taking (theft for parts). Overall, about 65 percent of all vehicles stolen from the sampled streets between 2005 and 2007 were recovered intact, 21 percent were recovered with their parts taken, and 13 percent were not recovered.

In general, new vehicles were least often recovered compared to other age groups. Among the four age groups, relatively old vehicles (10-14 years old) accounted for the most (34%) of vehicles that were not recovered, just as they accounted for the most (35%) of all vehicles stolen. However, about 12 percent of relatively old vehicles were not recovered whereas 16 percent of new vehicles (0-4 years old) were not recovered, representing that these vehicles were more often involved in cases where stolen vehicles were not recovered than any other age groups. This is consistent with previous arguments that new cars tend to be involved in permanent theft where stolen vehicles are not recovered.

Stolen Fords were most often not recovered (16%), while about 12 percents of Dodge, Honda, and Toyota were not recovered. About 30 percent of new Hondas stolen were not recovered, and they were the least often recovered vehicle compared to other age groups. On the other hand, old Hondas were least likely to be involved in permanent theft (4%). Old vehicles were most often involved in permanent theft in the case of Dodge (15%) and Ford (26%). The new Hondas might be targeted for retagging operations or might be driven to other jurisdictions, while old Dodges and Fords might be completely chopped down for their parts or driven to other cities. Both older and newer Toyotas were likely to be involved in permanent theft.

As for the thefts where stolen vehicles were recovered intact, 69 percent of new vehicles were recovered intact compared to 58 percent of old vehicles. This is somewhat inconsistent with this study's hypothesis that older vehicles are likely to be stolen for temporary theft, such as joyriding and theft for transportation. Within the selected makes, stolen Dodges and Fords were more often recovered intact than Hondas and Toyotas. This may suggest that domestic vehicles may be more likely to be stolen for temporary use than Japanese makes.

Dodge, Ford, and Toyota appear to confirm with the general pattern that newer cars are more often involved than older ones. This is probably because these newer cars were more attractive to opportunistic thieves or joyriders in terms of their better appearance and performance compared to older ones. However, in the case of Honda, old vehicles (15 years and older) are more often recovered intact than any other age groups, although they are most likely to be stripped as well. This may imply old Honda can be as attractive as new one to drive for thieves. This is consistent with the arguments that the racing communities as well as joyriders prefer driving older Hondas.

In general, old vehicles were more often stripped (27%) than any other age groups; only 13% of new vehicles were stripped. Auto theft for parts becomes more frequent as vehicle's age increases. This would provide insight for identifying a possible underlying cause of theft of older cars. As discussed earlier, stolen Hondas and Toyotas were far more often stripped of their parts (33% and 27 percent, respectively) than all the other makes[10], including Dodges (16%) and Fords (14%).

Consistent with this study's hypotheses, old and relatively old vehicles tend to be stripped of their parts more than their newer counterparts. This is especially the case with Hondas and Toyotas. Older Hondas (over 9 years old) accounted for 87 percent of stolen Hondas that were stripped, while representing 80 percent of all Hondas stolen. To put it differently, about 35 percent of older Hondas were stripped after being stolen whereas 21 percent of newer Hondas were stripped. Similarly, about 29 percent of older Toyotas were stripped compared to 18 percent of newer Toyotas (calculation based on Table 18).

Older Dodges and Fords were also more often stripped of their parts after being stolen than newer ones, but not to the same extent as Honda and Toyota. This clearly shows that older vehicles, especially Hondas and Toyotas, are more frequently stripped of their parts than their newer counterparts, acknowledging the role of older vehicles' parts in influencing offender's choice of targets.

[10] Stolen Acuras had the highest stripping rates (number of stolen cars stripped/number of all stolen cars), but are not included here because they were less frequently stolen than the selected makes used in this study, and because Honda which share many characteristics similar to Acura is included in this study.

Table 18: Age Distribution of Stolen Vehicles by Recovery Status

	Not Recovered			Recovered Intact			Recovered Stripped			All Stolen Vehicles (2005-2007)		
(Age)	*f*	C%	R%	*f*	C%	R%	*f*	C%	R%	*f*	C%	R%
All Cars												
0-4	75	19.9	16.2	322	16.7	69.4	62	9.9	13.4	464	15.7	100
5-9	98	26.1	10.5	644	33.4	69.2	177	28.3	19.0	931	31.5	100
10-14	129	34.3	12.5	653	33.9	63.5	241	38.6	23.4	1029	34.8	100
15 ≤	74	19.7	13.9	310	16.1	58.2	145	23.2	27.2	533	18.0	100
Total	**376**	**100%**	**12.7**	**1,929**	**100%**	**65.2**	**625**	**100%**	**21.1**	**2,957**	**100%**	**100**
Dodge												
0-4	16	24.2	12.0	102	25.6	76.7	15	16.6	11.3	133	23.8	100
5-9	23	34.8	9.7	174	43.7	73.4	37	41.1	15.6	237	42.4	100
10-14	24	36.4	14.2	109	27.3	64.5	34	37.8	20.1	169	30.2	100
15 ≤	3	4.5	15.0	13	3.2	65.0	4	4.4	20.0	20	3.6	100
Total	**66**	**100%**	**11.8**	**398**	**100%**	**71.2**	**90**	**100%**	**16.1**	**559**	**100%**	**100**
Ford												
0-4	8	20.5	15.1	42	23.7	79.2	3	8.8	5.7	53	21.1	100
5-9	10	25.6	10.1	72	40.7	72.7	16	47.1	16.2	99	39.4	100
10-14	15	38.5	19.7	49	27.7	64.5	12	35.3	15.8	76	30.3	100
15 ≤	6	15.4	26.1	14	7.9	60.9	3	8.8	13.0	23	9.2	100
Total	**39**	**100%**	**15.5**	**177**	**100%**	**70.5**	**34**	**100%**	**13.5**	**251**	**100%**	**100**
Honda												
0-4	7	17.9	30.4	11	6.2	47.8	4	3.7	17.4	23	7.0	100
5-9	8	20.5	19.0	24	13.5	57.1	10	9.3	23.8	42	12.8	100
10-14	20	51.3	12.0	86	48.3	51.5	59	55.1	35.3	167	51.1	100
15 ≤	4	10.3	4.2	57	32.0	60.0	34	31.8	35.8	95	29.1	100
Total	**39**	**100%**	**11.9**	**178**	**100%**	**54.4**	**107**	**100%**	**32.7**	**327**	**100%**	**100**
Toyota												
0-4	4	18.2	20.0	12	10.7	60.0	4	8.2	20.0	20	10.9	100
5-9	2	9.1	8.3	18	16.1	75.0	4	8.2	16.7	24	13.0	100
10-14	5	22.7	23.8	13	11.6	61.9	3	6.1	14.3	21	11.4	100
15 ≤	11	50.0	9.2	69	61.6	58.0	38	77.6	31.9	119	64.7	100
Total	**22**	**100%**	**12.0**	**112**	**100%**	**60.9**	**49**	**100%**	**26.6**	**184**	**100%**	**100**

Total includes burn-out whose information is not presented in the table. Burnt-out stolen cars constitute less than 1% of auto theft. This can be included as stripped when necessary.

Offender Motive/Types of Theft: Car-Level Multivariate Analysis

This study has already examined the influence on auto theft, specifically theft of older cars, of target availability, vehicle security, and physical settings where vehicles are parked, and has shown that these factors contribute to the vulnerability of vehicles being stolen to some extent. However, these factors may become more or less important in different types of auto theft. This study now turns to report the results of multivariate analyses that examine the risk and protective factors for different types of auto theft.

Table 19 reports the results of logistic regression analyses using a three-level random intercept model to account for the cluster effects. As mentioned in the previous chapter, the same analysis was conducted for each of the three dichotomous dependent variables: (1) auto theft, (2) recovery, and (3) stripping. Vehicles that were stolen and parked vehicles that were observed were combined to construct the dependent variable, auto theft, while the latter serving as a proxy estimate of vehicles that were not stolen.

The interaction effects between age and vehicle makes were included in the model because this study has already found that the relationship between age and auto theft differs considerably with makes. For example, the multivariate analysis without interaction terms (not shown here) reveals that newer vehicles are slightly more likely to be stolen, holding all the other variables constant. However, this study understands that this may be true for Dodge and Ford, but not for Honda and Toyota whose older counterparts are more likely to be stolen. Since the models with and without interaction terms have yielded similar outcomes, with the former being more informative, only the results of analyses with interaction terms are presented here (Table 19).

Table 19: Factors Predicting the Likelihood of Vehicles being Stolen, Recovered, and Stripped

	Stolen			Recovered			Stripped		
	OR	Z	P <	OR	Z	P <	OR	Z	P <
Vehicle Features									
Age	0.57	-14.45	.001	0.95	-3.17	.001	1.04	2.29	.05
Make									
Dodge	6.84	7.31	.001	1.09	0.25		0.51	-2.05	.05
Ford	2.58	3.57	.001	1.70	1.13		0.40	-1.49	
Honda	0.08	-10.78	.001	0.15	-3.96	.05	1.42	0.73	
Toyota	0.09	-8.94	.001	0.28	-2.28	.01	0.82	-0.34	
Others (ref.)									
Age×Dodge	0.60	-5.15	.001	0.98	-0.44	.05	1.06	1.62	
Age×Ford	0.58	-5.71	.001	0.92	-1.89		1.03	0.58	
Age×Honda	2.45	11.28	.001	1.19	4.10	.001	1.01	0.30	
Age×Toyota	1.89	6.26	.001	1.12	2.54	.001	1.02	0.61	
Immobilizers	0.25	-17.06	.001	0.64	-2.49	.001	1.06	0.38	
Physical Settings									
Total Cars	0.98	-7.30	.001	1.00	-0.96		1.00	1.08	
Street Length	1.00	2.61	.01	1.00	-0.27		1.00	-0.29	
Litter	1.05	0.22		2.68	2.67	.05	1.76	1.76	
Graffiti	0.99	-0.42		0.96	-1.42		1.04	1.50	
Damages	1.10	3.33	.001	0.92	-1.76		0.95	-1.29	
Detached	0.90	-3.35	.001	1.06	2.01		1.07	0.27	
Apartment	1.09	2.64	.01	1.02	0.78		0.80	-0.63	
Office	0.16	-3.14	.01	1.66	0.54		0.17	-1.90	
Plaza	9.73	3.19	.01	0.70	-0.52		2.22	1.02	
Downtown	1.03	0.06		1.03	0.03		0.63	-0.53	
School	0.33	-2.22	.05	0.98	-0.02		0.83	-0.29	
Warehouse	0.44	-2.94	.01	0.66	-0.98		1.16	0.37	
Vacant lot	1.21	0.55		0.63	-0.94		2.72	2.19	.05
Bar	1.32	2.64	.01	0.90	-1.64		1.11	0.73	
Chi-square	834.9		.001	62.9		.001	75.1		.001
Pseudo R^2	.364			.090			.066		
N	7,919			2,811			2,432		

Under the probability column, black spaces indicate $p \geq 0.05$.

Overall, all predictors except litter, graffiti, and two types of land uses (downtown row types and vacant lots) are found to predict the likelihood of vehicles being stolen. Hondas, Toyotas, vehicles with immobilizers, and vehicles stolen from streets with higher levels of litter are less likely to be recovered. Significant predictors of theft for parts or stripping are vehicle age, Dodge, and vacant lots only.

As for auto theft, interaction terms indicate that older vehicles are less likely to be stolen than newer vehicles when they are not any of the four selected makes, assuming that vehicles observed are not stolen. By holding all the other relevant factors shown in Table 19 constant, newer Dodge and Ford are particularly vulnerable to theft, in comparison to other makes. On the other hand, older Hondas and Toyotas are, as expected, at more risk of theft than other makes.

When vehicles are new, the odds of Dodge and Ford being stolen is about 6.8 times and 2.6 times, respectively, that of other vehicles, whereas Honda and Toyota have odds about 0.1 times that of other makes being stolen. The odds of other makes being stolen is shown to decrease by a factor of 0.57, for every one unit increase in age group. Interaction terms indicate that Dodge and Ford confirm to this pattern, but Honda and Toyota do not. For each one unit increase in the age group, the odds of Dodge and Ford cars being stolen decrease by about one-third (0.60×0.57 and 0.58×0.57 respectively), whereas the odds of Honda and Toyota cars being stolen increase by a factor of 1.4 (2.45×0.57) and 1.1 (1.89×0.57), respectively. In sum, although Honda and Toyota are less likely to be stolen than others when they are new, the likelihood of their being stolen increases as they become older while that of other makes decreases. The opposite is true for Dodge and Ford.

Vehicle age is also significantly related to recovery and stripping of stolen vehicles, and is the only predictor which is related to all of the three dependent variables in this study (Table 19). With all else being equal, the odds of stolen vehicles that are other makes being recovered decreases by a factor of 0.95 as they get one year older, and the odds of those stolen vehicles being stripped increases by 4 percent. That is, stolen vehicles, other than the four makes included in the study, tend to be less frequently recovered but more likely to be stripped as their age increases. This supports the argument that older vehicles are more likely than newer vehicles to be stolen for their parts. The reason why they are less likely to be recovered may be also because they are completely disassembled, or they are driven to neighboring towns by opportunistic thieves.

By looking at specific makes, interaction terms indicate that the odds of stolen Dodges being recovered decreases with their age. In contrast, the odds of stolen Honda and Toyota being recovered increases as they become older. Dodge, Ford, and other makes have the same odds of being recovered when their age is zero. However, holding vehicle age at zero and all else constant, the odds of stolen Hondas and Toyotas being recovered is 0.15 times and 0.28 times, respectively, that of other vehicles being recovered. That is, although the odds of Honda and Toyota being recovered increases as they become older, they are much less likely than other makes to be recovered when they are new. This is also evident in Table 18 which shows that permanent theft is more common for newer Hondas.

With respect to stripping of stolen vehicles, Dodge has odds about 0.51 times that of other makes of being stripped when they are new. The combined effect of vehicle age and make are unrelated to stripping for other makes. However, the same model without interaction terms (not shown here) was consistent with previous findings showing that Honda are much more likely to be stripped of their parts while Dodge and Ford are less likely to be stripped compared to other makes. This inconsistency may occur because stolen Hondas are more frequently stripped than others regardless of age.

Vehicle security is shown to be strongly related to auto theft and recovery of the stolen vehicle. With all else being equal, cars with immobilizers are four times (1/0.25) more likely to be stolen and about 1.6 times (1/0.64) more likely to be recovered after stolen. That is, vehicles that are easy to steal are more likely to be involved in theft for temporary use. On the other hand, security is not significantly related to the likelihood of stolen vehicles being stripped. This makes sense because immobilizers are not designed to prevent cars from being stripped. In general, offenders who mainly steal vehicles for their parts are thought to have more skills and will to do so, in comparison to opportunistic thieves who are more likely to be put off by anti-theft devices. Therefore, this finding supports the argument that immobilizers do not matter to thieves who steal cars for their parts.

With respect to the characteristics of theft locations, the results of the multivariate analyses confirm earlier findings showing that vehicles parked on streets with more damaged buildings are more likely to be stolen than those parked on streets with less damaged buildings. As the broken windows thesis suggests, thieves may perceive the streets with more damaged buildings as uncontrolled streets, and hence, the risk of being interrupted is low compared to the streets with well-maintained buildings.

The levels of street cleanliness and graffiti, which tend to be less temporally stable, than building conditions (Rundle et al., 2011) are not significantly related to auto theft. However, once vehicles are stolen from streets with a higher degree of litter, they are more likely to be recovered than those stolen from cleaner streets. Since older vehicles are more often parked and stolen from filthy streets than clean streets, they may be more visible and proximate to opportunistic thieves who tend to live in an area with a high level of physical disorder. On the other hand, none of physical disorder predicts the likelihood of stolen vehicles being stripped. Similar to vehicle security, the location does not matter to thieves who steal vehicles for parts. In addition, none of the land-use variables except vacant lots are related to stripping.

Different land use variables are associated with auto theft. Vehicles are more likely to be stolen from the streets that are more occupied by apartments/multi-dwelling units or shopping plazas. The odds of vehicles being stolen increase by a factor of 1.1 and 9.7, for each one unit increase in the percentage of streets occupied by apartments and shopping plaza, respectively, after taking into account all the other variables, including street length and the number of vehicles parked on those streets. In addition, vehicles are more likely to be stolen from streets with bars than from streets without them.

These findings are consistent with those from research that argues that such land uses are often characterized by attracting large numbers of potential offenders and promote more anonymity. As discussed earlier, the effect of shopping plazas found in this study should be interpreted with caution.

Auto theft is low for several land use types, including single-family houses, offices, schools, and warehouses. This may be explained by more direct supervision and control by place managers in these types of locations. However, this may also be an artifact of data limits. Again, auto theft incidents are compared to the pool of available vehicles that are estimated based on Google Street View images taken during daytime. The risk of auto theft for the streets running along offices, schools, or warehouses may become lower when it is calculated based on the number of vehicles parked during the daytime.

Suppose that 10 vehicles are stolen from the street occupied by offices or warehouses, while there are, on average, about 100 vehicles parked during a day, 200 vehicles parked during the daytime and 10 vehicles parked during the nighttime. The overall risk of auto theft at the location will be 0.1 per vehicle parked. However, it becomes 0.05 if the daytime counts are used as a denominator, and becomes 1.0 if the nighttime counts are used. Because this study uses the daytime counts, those streets may appear to be less risky than they actually are. Besides, the earlier finding (Table 17) shows that any of the four land-use variables, except warehouse, that are shown to be a mitigating factor of auto theft in Table 19 are not significantly related to higher levels of theft of older cars on the streets.

Summary of the Main Findings

Availability: *Are there more older cars available to steal? Generally, yes, but it varies by vehicle makes.*

- In general, the age-theft curve mirrors the age-fleet curve, which peaks between 10 and 14 years old. However, these two curves vary among vehicle makes.
- Older Hondas are disproportionately stolen despite that there are more newer Hondas available to steal. The opposite is true for Dodge and Ford.
- All else being equal, cars become less likely to be stolen as they get older. However, interaction terms indicate that Honda and Toyota become more likely to be stolen as they get older, and the opposite is true for Dodge and Ford.

Security: *Are older cars easier to steal? Yes.*

- Stealing older cars is more likely to result in success than stealing newer vehicles.
- The vast majority of older vehicles lack electronic immobilizers.
- Cars without immobilizers are more likely to be stolen, with all else being equal.

Location: *Are older cars found more on the streets with a high level of physical disorder? Yes.*

- Older cars are more frequently parked on the streets that exhibit physical disorder, including litter and building damages, and they are more likely than newer cars to be parked on such streets.
- The higher the levels of litter and building damage on the streets are, the more older cars are parked on the streets, holding land uses and street length constant.

- Higher levels of building damage are related to higher levels of theft of older cars on the streets. A multivariate analysis also confirms the influence of building condition on the likelihood of cars being stolen.

Location: *Are older cars found more on the streets where criminogenic land use is more common? No.*

- The number of older cars parked on the streets decreases as the percentage of the streets occupied by vacant lots increases. This is the only significant predictor.
- As for theft, the higher the percentage of the streets occupied by shopping plazas, the more theft of older cars occurs on those streets. The opposite is true for warehouses and vacant lots.
- All else being equal, apartments, shopping plazas, and bars are aggravating factors for auto theft, while single-family houses, offices, schools, and warehouses appear to be suppressors of auto theft.

Motive: *Are older cars stolen more for temporary use?*

Yes, but so are newer cars. It also depends on car make.

- About 87 percent of both older and newer cars are recovered after being stolen, suggesting that the majority of them are stolen for temporary use.
- However, newer cars are generally more likely to be recovered intact (69%) than older cars (62%). Opportunistic thieves may take minor car parts when leaving their cars.

- The likelihood of stolen Hondas and Toyotas being recovered increases with age. The opposite is true for Dodge and other makes.
- Stolen cars without immobilizers are more likely to be recovered, implying that older cars are also more likely to be recovered.

Motive: *Are older cars stolen more for their parts? Yes, especially Japanese makes.*

- In general, the likelihood of stolen cars being stripped increases with age. This is especially the case with Honda.
- Stolen Hondas and Toyotas are more often stripped of their parts (33% and 27 percent, respectively) than all the other makes, including Dodges and Fords (16% and 14% respectively).
- Higher stripping rates of stolen cars, as a whole, are attributed to older cars being stripped.

Caveat: Other Results from the Multivariate Analysis

- Vehicle age is the only predictor which is related to all of the three outcomes.
- Hondas and Toyotas are less likely to be recovered when they are newer.
- Immobilizers do not predict the likelihood of stolen cars being stripped.
- None of physical disorder predicts the likelihood of stolen vehicles being stripped.
- None of the land use variables are significantly related to the likelihood of stolen cars being recovered or stolen cars being stripped (except vacant lots for stripping).

CHAPTER 7

CONCLUSION

Discussion

This study has conducted a series of analyses to investigate mechanisms of theft of older cars and answer its main question: "*Why are older vehicles more likely to be stolen than their newer counterparts?*" The main question has been addressed from the perspectives of target availability, vehicle security, locations of where vehicles are found, and offender motive. While the pieces of evidence derived from each analysis may not stand alone, triangulation of these pieces will shed light on the complexity of the problem. This study now reflects on the findings reported in the previous section and draws out the conclusion.

The NICB index shows that Honda Accord, Honda Civic, and Toyota Camry have been dominating the nation's top three stolen vehicles over the years, but at the same time, these three makes, that are well known for their reliability records and longer life span, have been also among the nation's top three produced models over the years (Ward's Auto, 2009). This leads to the argument that the differing proportion of stolen cars is a function of the actual number of those cars available on the road. At the general level, this study has witnessed that the age-theft curve in fact mirrors the age-fleet curve, confirming that older cars are more stolen because they are more available to steal.

However, the study has found that this pattern varies considerable among vehicle makes. For example, there are more newer Hondas parked on streets than older ones, but older Hondas are far more often stolen than their newer counterparts. This is also true for Toyota, but for Dodge and Ford. This suggests that something else accounts for the differing proportion of stolen vehicles. That factor may be related to their security, locations where they are parked, or thieves who target particular vehicles.

The ease of entry to a car has been shown to be a main factor that makes the car more vulnerable to thefts, and this study supports that argument. The vast majority of older vehicles are found not to have electronic immobilizers. This study found that security, namely electronic immobilizer, had the strongest effect on the likelihood of cars being stolen, net the effects of the physical environmental. Thus, it acknowledges that older cars are more likely to be stolen because they lack security. However, security alone does not explain why older Dodges and Fords are less likely to be stolen than their newer counterparts despite the fact that more of these cars are available on the road or why they become less likely to be stolen as they age. In contrast, Hondas and Toyotas become more likely to be stolen as they get older, with all else being equal.

The finding of this study implies that if stealing newer cars is as easy as stealing older cars, thieves will target newer Dodge and Ford cars but older Hondas and Toyotas. The former selection is understandable because newer and expensive cars have been shown to be an attractive target for thieves. It is similar to general consumer preferences where a consumer might prefer to buy a bland new car if it has the same price as its 10 year old model. On the other hand, in the case of Honda and Toyota, there seems to be some other factors influencing their attractiveness to thieves besides their security. Although physical disorder, particularly building damages, and certain types of land use do have some impact on the likelihood of older cars being stolen, their strength of predicting such an outcome is not close to that of security, vehicle age and makes.

According to the literature, factors that contribute to theft of older cars, in particular, are deemed to be linked to their parts.

Consistent with previous research, this study has found that stolen cars, in general, become more likely to be stripped as they get older. In the case of theft for parts, the level of car security and physical environments where cars are parked do not matter to thieves, while vehicle age and make being the most important factors to them. Older Hondas and Toyotas were found to be particularly vulnerable to theft for their parts, in which case stolen cars are stripped of their parts, but Dodges and Fords were not. This finding indicates that Japanese makes such as Honda and Toyota are stolen to supply a demand for their parts which have been shown to have great value with high levels of compatibility (Car Parts, 2009).

For example, an old VTEC B16b engine of 1997 Honda Civic is sold on Ebay for about three times the price of a K24 engine which is found in the current model of Civic, and that engine can be relatively easily fitted on 1992-2000 Honda Civics without much modifications. Why would people pay for the older engine that costs a few times the price of the newer engine that has as much horse power? This is partially because the racing communities prefer driving older Hondas. One person who has been in such cultures says that “every addiction needs a drug, and for racers and gangsters it is the older model imports” (Boquiren, personal communication, 2010).

While walking around Newark, it is not hard to spot customized older Honda Civics. If one figures the shell costs several thousand less than a newer model, people can spend more money on customizing and boosting their older cars. Thus, 5G and 6G Honda Civics which have been ranked among the nation’s top three most stolen vehicle almost over the last decade may be considered as blank tapestries waiting to be personalized. The desire of customizing older cars can also be understood from a point of view of mass media which depicts boosting older Japanese cars as an exciting lifestyle.

As a result, the value of older Honda parts, together with a low level of security, makes them attractive to thieves. This study also has found that Honda and Toyota become more likely than other makes to be recovered as they get older, suggesting that they are targeted by thieves who steal cars for temporary use, such as joyriding and transportation. This also makes sense because these older cars often have an engine which has as much horse power as newer one, and of course they lack factory-installed immobilizers. Considering the magnitude of temporary thefts that are committed by opportunistic thieves, vehicle security may be the most powerful determinant of theft of older cars.

In sum, the fact that older vehicles account for the majority of vehicle thefts in the U.S. implies that a successful reduction in theft of older vehicles will lead to a significant reduction in overall motor vehicle thefts. Gaining insight into the mechanisms underlying the theft of older vehicles allows for more efficient deployment of preventive efforts as well as development of effective strategies to tackle the overall vehicle theft problem. A better understanding of why older cars attract theft would help drivers to be aware of ways to protect their vehicles. It would also help societies realize the role of automobile manufacturers in combating auto theft. While this study acknowledges the role of vehicle security in preventing theft, it also stresses that prevention measures would become more effective if they are focused on the stolen car parts market rather than retrofitting anti-theft devices to insecure older cars that are targeted for their parts.

Limitations

The findings from target availability analysis could have been validated by vehicle registration data if they were readily available from public, such as in U.K. or Australia. However, even so, no information exists on the distribution of particular vehicles across geographic areas smaller than the city level. Vehicle registration data are useful if research examines the problem of auto theft across cities or states. However, such research cannot answer questions about how physical environments influence the likelihood of vehicles being stolen. Previous research has shown that physical disorder and land use types have an impact on offender behavior. Also, just as auto theft clusters at certain locations, the spatial distribution of cars varies within a city. Older cars may be concentrated in particular neighborhoods, such as those characterized by physical disorder.

This study manually counted the number of vehicles parked on the streets while identifying their make, model, and generation using Google Street View. Then, it treats counts of vehicles by make and generation as a proxy estimate of vehicle availability. This procedure for estimating the vehicle population at risk is unique, and has other potential applications for understanding features of locations where crimes occur. However, it cannot be used without limitations.

As mentioned elsewhere in this study, the date/time information on street-view imagery is not available and those images across the city were not taken on the same date. There may be more vehicles parked on the streets in residential areas during the weekend, while these vehicles may be driven to work or school during the weekdays. Also, since the street-view images are generally taken during the day, they do not accurately reflect what are parked in the night, the time when vehicles are at most risk of theft.

However, vehicle counts obtained using GSV can be a more valid measure of availability than registration data. This is because many cars parked on Newark streets and cars stolen in Newark are registered in other jurisdictions. The particular mobility of automobiles means that their vulnerability to theft extends beyond where they are registered. On the other hand, some studies measures vehicle availability using census information, such as population and vehicles available to household. Obviously, such measures are not useful in this study because they do not answer how many older Honda are, for example, available at certain locations.

This study faces a problem similar to what Sampson and Raudenbush (1999) in their study testing the association between violent crime and disorder, including both physical and social. They conducted systematic social observation by videotaping block-faces between 7am and 7pm to observe disorder, while acknowledging that it was not an ideal time to view disorder, particularly social disorder that tend to be frequent after dark. They were limited by available technology at that time (e.g., could not record well in the dark). Similarly, this study has been conducted using the technology available today, bringing out the potential utility of Google Street View.

Conclusion

Why are older cars more often stolen than their newer counterparts? That is because they lack security features. Although many other variables have been examined and discussed here, this study concludes that vehicle security contributes to the vulnerability of older cars to auto theft the most of all the tested factors. This is the same with newer cars.

The answer this study has provided is probably clear common sense. However, the importance of vehicle security in preventing auto theft seems to be underestimated in the United States. Regulations concerning vehicle security are much less stringent in the U.S. compared to other Western countries, such as Australia and the U.K. There is little political will to impose requirements on auto manufacturers. The manufacturers themselves seem unwilling to devote extra resources to develop new vehicle security systems despite the fact that security wears out.

In the context where the majority of residents have not been victimized by auto theft, it is also likely that vehicle security does not figure much into decisions to purchase vehicles. However, this study stresses that insecure vehicles are mother's milk to auto thieves, and that we should keep it in mind all the time.

While increasing the limited knowledge on theft of older cars, this study has also added to the literature on *ecometrics* by introducing the potential utility of Google Street View as an ecometric tool for criminology. Ecometrics, measures of ecological settings, have been ordinarily collected through Systematic Social Observation (SSO) or visual audits of built environments. In contrast, this study has used Google Street View to measure vehicle availability, physical disorder, and land use at street level. The reliability and viability of ecometric data obtained through GSV for criminological research have not been articulated since no study have examined crimes employing variables measured using GSV. However, this study found that criminologists can employ GSV to audit neighborhood characteristics, such as social/physical disorder, land use, and vehicular or pedestrian traffic as an alternative to SSO that can be time consuming and expensive to conduct.

The quality of GSV images and its coverage have been considerably increasing over a few years. At the same time, criminologists have begun to take a micro approach to places, examining certain types of crimes at specific locations, such as block faces, street segments or street corners. In this context, GSV which is more time and cost effective compared to SSO would be a ground-breaking tool to collect ecometric data. Researchers have long used census data that offer measures on demographic, social, and economic characteristics of small areas. On the other hand, GSV data offer measures on physical conditions of smaller areas. In this sense, Google Street View can be thought of as somewhat equivalent to the Census Bureau.

Researchers may use GSV data in the same way they use census data, or they can combine both forms of data to simultaneously analyze the impact on individual behavior of demographic, socioeconomic, and physical characteristics in the small areas. Although there are some limitations mentioned earlier, GSV-based ecometric data may be used for empirical research that examines the relationship between place characteristics (e.g., physical disorder and criminogenic land-use) and street-oriented crime, such as auto theft, robbery, assaults, or shootings. They may be useful to examine the physical conditions of the locations where stolen cars are abandoned.

Ecometric data collected using GSV may also be useful in defensible space research examining how layout of buildings, placement of structures, or intensity of land use influence levels of street crimes, or how street networks or permeability influence crime levels. Although the latter (street networks/permeability) can be analyzed using a digital street map, streets are often shown as lines on the map. Digital maps combined with GSV images will provide more information and better understanding of how built environments affect individuals' behavioral patterns. Furthermore, GSV-based ecometric data will be useful for studies examining the relationship between fear of crime and disorder that are observed, not disorder that are perceived by residents.

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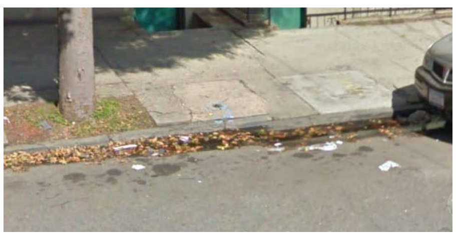
APPENDIX A

Photo-Based Observation Scales: Street Cleanliness/Litter

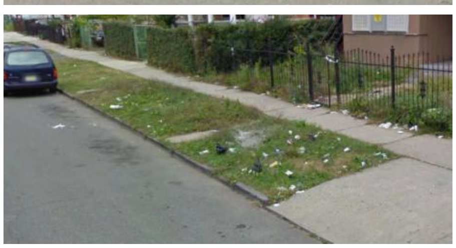
(All images shown here were taken from Google Street View)

1.0 A clean street. No litter

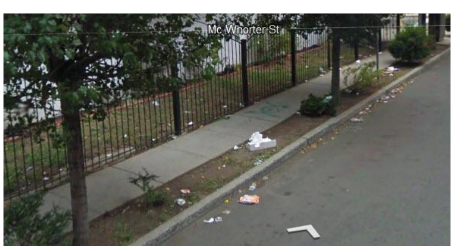
1.2 A clean street, except for a few traces of litter.



1.5 More than a few traces,
but no concentration of litter.
There are no piles of litter, and there are large gaps between pieces of litter.



1.8 Litter is concentrated in spots; there may either be large gaps between piles of litter, or small gaps between pieces of litter.



2.0 Litter is concentrated; there are small gaps between piles of litter.

2.5 Litter is highly concentrated; there are no gaps in the piles of litter. The litter is a straight line along the curb.

Photo-Based Observation Scales: Graffiti

0.0 No Graffiti

1.0 Small pieces of graffiti on the object.

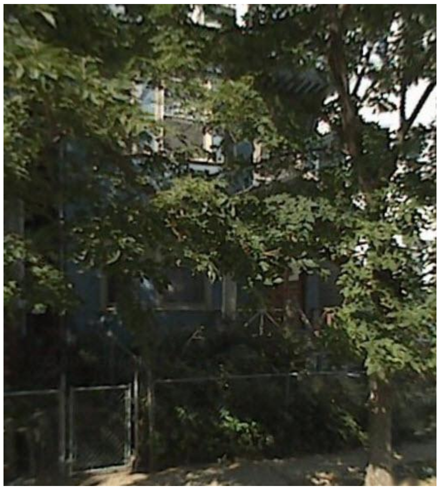
2.0 1 or 2 pieces of graffiti on the structure.

3.0 3 to 5 pieces of graffiti on a structure. Graffiti are clustered on certain part of the structure.

4.0 More than 5 pieces of graffiti or large graffiti, covering all over the structure.

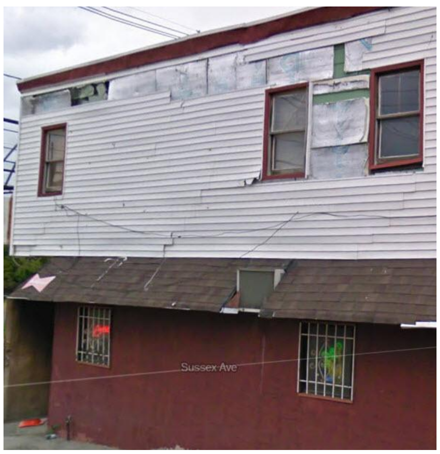
Photo-Based Observation Scales: Building Condition

0.0 No visible damage



1.0 Minor cosmetic damage

- peeling paint
- dirty walls
- overgrown lawn



2.0 Minor structural damage

- foundation
- wall
- roof

3.0 Major structural damage

- deteriorated condition
- boarded up and abandoned

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