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Traffic Safety
Administration

U.S. Department
of Transportation



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Auto Theft and Recovery: Effects of the Anti Car Theft Act of 1992 and the Motor Vehicle Theft Law Enforcement Act of 1984

Report to the Congress
July 1998

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Executive Summary

Motor vehicle theft was a growing problem in the early and mid 1980's. In 1984, Congress enacted the Motor Vehicle Theft Law Enforcement Act in order to reduce the incidence of motor vehicle thefts and facilitate the tracing and recovery of stolen motor vehicles and parts from stolen vehicles. The Department of Transportation implemented the 1984 Act by issuing the Federal Motor Vehicle Theft Prevention Standard, which requires manufacturers of designated high theft passenger car lines to inscribe or affix the Vehicle Identification Number (VIN) onto the engine, the transmission, and 12 major body parts. As an alternative to parts marking, manufacturers could choose to install antitheft devices as standard equipment on a limited number of those lines. The objective of parts marking is to allow law enforcement agencies to identify stolen vehicles or parts removed from stolen vehicles - and to deter professional thieves since they will have difficulty in marketing stolen marked parts and are more likely to get caught if they steal cars with marked parts. The high-theft car lines were designated in 1985, and actual parts marking began with model year 1987.

In 1991, the National Highway Traffic Safety Administration (NHTSA) presented a report to the Congress assessing the auto theft problem in the United States and, in particular, attempting to evaluate parts marking. At that time, however, only two years of theft and recovery data were available for cars with marked parts. Evidence of the effectiveness of parts marking could not be obtained through statistical analysis of theft and recovery rates. Nevertheless, the Department found wide support in 1991 for parts marking from the law enforcement community. Investigators believed that parts marking provided them with a valuable tool for detecting, apprehending, and prosecuting thieves. After considering the analyses, surveys and public comments obtained during the preparation of the 1991 report, the Department recommended that the theft prevention standard be continued with minor changes.

In 1991-92, motor vehicle theft was still a large problem. Thefts had increased from 830,000 in 1984 to 1,270,000 by 1990. In search of stronger remedies, and in response to the Department's recommendation and other information, Congress enacted the Anti Car Theft Act of 1992. The 1992 Act built on the 1984 Act in several ways: Federal penalties were enhanced; a grant program was authorized to help law enforcement agencies concerned with auto theft; steps were taken to

improve motor vehicle titling, registration, and salvage; the Theft Prevention Standard was to be expanded to other passenger car lines and high theft multipurpose passenger vehicles and light trucks with gross vehicle weight ratings of 6,000 pounds or less, which became effective starting with the 1997 model year; rules were established regarding salvage or junk vehicles; a stolen parts information system was to be maintained by the Attorney General; dealing in stolen marked parts became a Federal crime; and random customs inspections were allowed.

The 1992 Act requires the Department of Transportation to provide a report to the Congress updating the findings of the 1991 report and evaluating the effects of the 1984 and 1992 acts. As a first step, the Department published a Preliminary Report for public review and issued a notice in the Federal Register on June 26, 1997 announcing a 45 day opportunity for public comment. Comments received have been summarized and discussed as part of this Final Report that will be transmitted to the Congress.

The goals of this report are:

- To update the detailed statistics on motor vehicle theft and recovery presented in the 1991 report. For this report, theft and recovery data were available from 1984 through 1995, and insurance data from 1986 through 1992.
- To revisit the evaluation of parts marking and antitheft devices, now that extensive data are available on the theft experience of cars with those remedies. (However, since theft data were available only through 1995, the effectiveness of the 1992 Act as regards expanded coverage in 1997 and later models cannot be analyzed at this time.)
- To evaluate other provisions of the 1992 Anti Car Theft Act and the 1984 Act, focusing on changes that have occurred since the 1991 report.

The basic reasons for stealing cars have not changed since the 1991 report. Cars are stolen for transportation, joyriding, export, for repair parts, and to obtain expensive items such as stereo equipment for a quick profit. Since the last report to Congress, a new type of auto theft crime has emerged -- carjacking -- but the theft motives are still the same. Fundamentally, though, two

types of auto theft may be recognized: (1) Professional thefts for profit, such as thefts to supply chop shops, retagging and retitling, or for illegal export. These thefts often result in a total loss to the original owner, but there is hope they can be deterred by remedies such as parts marking. They are believed to account for at least 23 percent of all thefts, and perhaps substantially more. (2) Nonprofessional thefts for purposes such as joyriding or to obtain temporary transportation. The vehicles are mostly recovered; on the other hand, parts marking would not appear as likely to deter these thefts.

Overall theft and recovery statistics: As in the 1991 report, theft and recovery data come from the FBI's National Crime Information Center. The data do not indicate the motives for individual thefts or separate the "professional" from the "nonprofessional" thefts. Analyses based on aggregate data cannot identify the effectiveness of each subsection of the 1984 and 1992 Acts, but can provide insights on the trend in thefts and recoveries.

The principal finding of this evaluation is that the auto theft problem, which was growing during the mid 1980's, leveled off or even began to decline after 1989-90. In 1995, there were 1,180,000 motor vehicles stolen, a decline of seven percent from the all-time peak of 1,270,000 experienced in both 1990 and 1992. However, the 1995 thefts are still 39 percent more than the 830,000 experienced in 1984. The theft rate per 100,000 registered vehicles increased from 543 in 1984 to 714 in 1990, but had dropped back to 597 by 1995.

Passenger cars account for 71 percent of all motor vehicle thefts, followed by light trucks - pickup trucks, sport utility vehicles and vans - at 24 percent. The remaining thefts are split between heavy trucks and motorcycles. Theft rates for all four vehicle types have declined since 1990.

Recoveries of stolen vehicles have kept pace with thefts over the years - recovery rates have remained stable at close to 80 percent of thefts throughout 1984-95. Passenger cars have slightly higher recovery rates than light trucks. Motorcycles have substantially lower recovery rates, and they have gotten worse. It is estimated that the annual economic loss resulting from vehicle thefts - and from the fact that many vehicles are never recovered or only recovered in a damaged condition - is at least \$4 billion and could be as high as \$8 billion.

Effect of parts marking and antitheft devices: The average consumer cost of parts marking in 1995 models was \$4.92 per car. At that cost, just a 2 percent reduction in the theft rate would create consumer benefits exceeding the cost of parts marking.

Theft and recovery rates for car lines that got parts marking in 1987 were compared to the rates for the same car lines before 1987 and to the rates for car lines that did not get either parts marking or antitheft devices. However, the fact that, originally, only high-theft car lines got parts marking resulted in biases in the data that made it essentially impossible to reliably attribute a specific percentage reduction in thefts or increase in recoveries to parts marking. Still, the analyses provided five indications (hedged with caveats) that parts marking quite possibly had beneficial effects at times, apparently greater than 2 percent:

- There was a conspicuous shift in theft rates in model years 1986-87, coinciding with the introduction of parts marking. Cars with marked parts had lower theft rates than expected, while those with unmarked parts had higher rates than expected. The effect was as strong as 20 percent when cars were new, but it weakened as they became older and seemed to have vanished by the time they were two years old. The latter is a noteworthy finding, since it is consistent with the view that many professional thieves subsequently learned how to obliterate the markings, and found them less of a deterrent.
- Recovery rates for 1987 cars with marked parts were consistently higher than for corresponding 1986 models, even as the cars got older. However, this favorable effect in model year 1987 consistently deteriorated in later model years.
- In calendar year 1987, the unrecovered-theft rate of model year 1987 cars with parts marking was 26 percent lower than expected. As the model year 1987 cars got older, the benefit diminished, but still persisted at about 6 percent. However, the latter estimate is within the “noise range” of possible biases in the data and it cannot be attributed to parts marking without considerable doubt.
- Almost all car lines had lower theft rates in their early 1990's models than in their late 1970's models. However, the long-term reduction was substantially greater in the car lines that got

parts marking or antitheft devices than in the car lines that did not. It is not so clear what happened during the crucial intervening years, the 1980's.

- There was a strong reduction after 1987 in the percentage of vehicles that were only recovered in-part - i.e., missing their engine, transmission or a major body part (those which for high theft lines are required to have markings). There was a corresponding increase in percentage of vehicles recovered in-whole (no major parts missing) or intact. This trend was especially strong in the car lines with marked parts.

By contrast, for at least one type of factory-installed antitheft device, the available data unequivocally show effectiveness. The system installed by a domestic manufacturer as standard equipment in various car lines during 1989-94 was associated with an immediate, and persistent 70 percent reduction in the theft rate and a 58 percent reduction in the unrecovered-theft rate. This device appears to be quite effective in reducing both "professional" and "casual" thefts. Of course, a system of this type has a far higher cost than parts marking.

Fewer data were available on the antitheft devices factory-installed by other manufacturers. Specific estimates were not obtained, but there appeared to be considerable variation in effectiveness. With some of the devices, little change was seen in theft rates; with others, there were reductions comparable to those for the domestic manufacturer. No data were available for evaluating the effect of aftermarket antitheft devices.

On the whole, the analysis results seem to suggest that the approach of Chapter 331 of the Anti Car Theft Act, which views both parts-marking and factory-installed antitheft devices as effective deterrents to automobile theft, has had benefits. There is some indication that the effect of parts marking might have been greater than two percent needed for cost-effectiveness, at least at certain times. Parts marking and antitheft devices have complementary roles: antitheft devices make it harder to steal a car, while parts marking deters professional thieves because it makes it easier to apprehend and convict them. The two remedies seem to be integral components of a larger program to combat auto theft. That program has, on the whole, had an impact, as evidenced by the leveling off and reduction of theft rates after 1990.

Discussion of other provisions of the 1984 and 1992 Acts: Collection and dissemination of theft and recovery information has improved since 1991, primarily because technical advances in communications and computer equipment made databases more complete and accessible to agencies needing the information. The two systems called for in the Anti Car Theft Act of 1992 - the National Motor Vehicle Title Information System and the National Stolen Auto Part Information System - are either not completely in place or are so new that their effects on vehicle theft (prevention, recovery or apprehension of thieves) cannot be evaluated at this time.

In tandem with the number of motor vehicle thefts, arrests for auto theft peaked in 1989 and have leveled off since then. In 1994, an estimated 200,000 were arrested for auto theft or attempted theft in the United States.

While recent surveys of district attorneys and law enforcement agencies did not provide detailed statistical data on arrests, prosecutions, and convictions for auto theft, they present an even more encouraging picture than corresponding surveys in the earlier report. Since 1991, there have been moderate increases in the number of prosecutions under both Federal Acts. There have also been increases in the level of effort directed to each prosecution. Now that they have better evidence with which to work, both prosecutors and officers are willing to invest more effort at obtaining a conviction. By 1996, prosecutors saw an increase of over 20 percent in the number of prosecuted cases, and 10 percent said that theft rates had declined in their jurisdictions. By 1996, in contrast to almost no effect seen in 1991, almost half of the district attorneys reported an increase in convictions - and most of them attributed it to the Federal Acts. Stiffer sentencing was occurring in 45 percent of the convictions, including a 75 percent increase in jail sentences. This could be even higher, they report, but for prison overcrowding.

Law enforcement agencies report the same attitudes about the deterrent effects of parts marking in 1996 as they did in 1991. They feel that auto thefts for chop shop operations will continue if there is a demand for a part, marked or not. But almost half of the investigators feel that parts marking makes professional thieves more cautious or even deters them completely from stealing cars with marked parts. All investigators thought parts marking had no effect on amateur thieves.

Parts marking seems to have the greatest effect on chop shop operators because of the increased cost of “doing business.”

Auto theft investigators feel that parts marking is a valuable tool for arresting and prosecuting thieves. In 1991, they saw little or no effect, but by 1996, most of them felt that parts marking did assist in identifying and recovering stolen parts and vehicles. About three fourths of the law enforcement agencies in big cities said parts marking helped in arresting both chop shop operators and professional thieves. Auto theft investigators, as in 1991, still say that more permanent methods for parts marking are needed. Even though it is unlawful to remove labels from marked parts and the labels are required to leave evidence that they were once on the marked part, thieves have found methods for removing both the label and its “footprint”. The investigator then has to be sufficiently knowledgeable to recognize that the part should have a label. Also without the label it is very difficult to trace the part back to the vehicle from which it was stolen.

Data received from the Customs Service since the 1991 report, indicates it has improved its ability to recoup stolen vehicles.

Insurance companies have not reported any effects of parts marking on insurance premiums. Some insurance companies do offer discounts on comprehensive premiums for vehicles equipped with certain types of anti theft devices. Analysis of claim payments also has not shown any specific effects of either parts marking or antitheft devices. Insurance companies report that their used part policies have not changed since 1986. About three fourths of the reporting companies encourage the use of used parts for crash repairs. Most companies rely on the repair shops to obtain parts from reputable sources.

In conclusion, it appears that parts marking and other provisions of the 1984 and 1992 Acts have given the law enforcement community tools they can use to deter thefts, trace stolen vehicles and parts, and apprehend and convict thieves. Theft rates leveled off after 1989-90 and have begun to drop. While the program to reduce auto theft has had an impact, there appear to be four areas with potential room for improvement: (1) Insurance companies and motor vehicle departments could take better advantage of the existing parts marking program by routinely requiring

inspection of the markings of used parts acquired at body shops and used vehicles brought in for new titles. The current setup, where some models have parts marking and others do not, may discourage routine inspections. (2) To the extent that current parts markings can be obliterated, their long-term deterrent effect may be diminished. (3) Since many vehicles still do not have marked parts, the deterrent effect of parts marking at this time may be offset by increased thefts of the vehicles without marked parts. (4) Appropriate antitheft devices can substantially reduce all types of thefts, but are currently standard equipment on only a limited number of car lines. However, to the extent that antitheft devices and parts marking are complementary strategies, more extended availability of antitheft devices ought not come at the expense of eliminating parts marking. The best results are likely to be obtained when vehicles have both remedies.

Recommendations

Section 33113(b)(11) of Title 49, USC Chapter 331 requires the Department to "...include recommendations (including, as appropriate, legislative and administrative recommendations) for (A) continuing without change the standards prescribed under this chapter, (B) amending this chapter to cover more or fewer lines of passenger motor vehicles, (C) amending this chapter to cover other classes of motor vehicles, or (D) ending the standards for all future motor vehicles."

Some analyses of the data suggest that parts marking has shown effectiveness as a theft deterrent at times greater than the two percent cost beneficial threshold. Comments received from the law enforcement community, prosecutors, and motor vehicle administrations indicate that parts marking has been an aid in detecting, apprehending, prosecuting and convicting auto thieves. These officials also recommend extending parts marking to all passenger motor vehicles, requiring more permanent marking methods, adding other parts for marking, and eliminating antitheft device exemptions. In contrast, the auto industry favors discontinuing parts marking, or if that is not done, having more exemptions for antitheft devices.

Insufficient information was received from the public comments to determine the cost of more permanent marking methods. Likewise, no information was provided on the cost of marking air bags - the one part that appears worthy of consideration for addition to the list of major parts to be marked. Airbags are expensive to replace costing between \$500 and \$1,500 and are frequently stolen. Because the Justice Department is required to evaluate the effectiveness of antitheft devices by December 31, 1999, decision making regarding exemptions should be postponed until that time.

Within the authority provided by the current legislation, the Department is considering taking several actions:

The Department is considering issuing an Advance Notice of Proposed Rulemaking to obtain data on parts marking methods. This information was requested when the preliminary report was published. No public comments were received on parts marking methods. Currently, parts

marking sources are being surveyed for more information and there is some indication that more permanent marking methods are under development. If there is sufficient information obtained from the advance notice to indicate that more permanent methods beyond adhesive labels can be used which have a cost less than the cost limitations specified in Section 33105 of Chapter 331, then the Department could proceed with rulemaking to require more permanent marking methods.

This action is warranted because the analyses suggest that the reason parts marking effectiveness seems to be short termed is that professional thieves have discovered ways to remove the adhesive marking labels along with the label's footprint. There is also evidence that professional thieves are counterfeiting labels. In one case, a vehicle had the VIN plate on the dashboard replaced with a plate and counterfeit labels that had the same VIN were put on major parts in place of the original labels. Hence more permanent marking methods should increase effectiveness to the extent that benefits exceed the added marking cost.

The Department is contemplating issuing another Advance Notice of Proposed Rulemaking to obtain data on the cost of marking air bags and glazing. Currently information is being sought from the auto industry. One manufacturer indicated that it costs them about \$2 per vehicle to mark airbags and maintain cross reference information after a one time cost of about \$14 per vehicle for facilities investments. Another manufacturer indicated that they used a low-cost adhesive label to mark its airbags. No manufacturer reported marking glazing. If there is sufficient information obtained from the Advance Notice to indicate that one or both can be marked so that the total parts marking cost is less than the cost limitations specified in Section 33105 of Chapter 331, then the Department could proceed with rulemaking to require air bags and/or glazing be marked.

This action is warranted for air bags which, in addition to being a safety item, cost \$500 to \$1,500 to replace (based on one comment received). Air bags are theft targets (several comments indicated this). While air bags do have serial numbers, they may not easily be identified with the vehicles from which they were taken. Some manufacturers indicate that they are cross-referencing the air bag serial number with the VIN. Marking air bags with the VIN, which would have to be done during the assembly process, would aid in parts recovery and for use as evidence

of vehicle theft. Marking glazing is not for the purpose of preventing glazing from being stolen but to act as a theft deterrent, especially for retag operations. Marking glazing has been previously considered and rejected for cost reasons. However, it might be worth taking another look at this alternative since it has a great deterrent possibility.

Pending the Justice Department's 1999 evaluation, the Department would consider making a recommendation to have the legislation changed to eliminate granting exemptions from parts marking for vehicles equipped with antitheft devices which meet certain requirements. This report found that parts marking and antitheft devices address different theft problems. Antitheft devices tend to have a greater deterrent effect on amateur thieves who steal vehicles for joy riding or transportation. Professional thieves and chop shops still want vehicles that are likely to have antitheft devices because these vehicles are often more expensive and thus these vehicles and their parts will potentially bring a better price on the illicit market. The evidence to support these conclusions is the fact that vehicles equipped with antitheft devices show lowered theft rates but their recovery rates, which were always lower than the average stolen vehicle, does not improve to the same level as vehicles without antitheft devices. Vehicles that are stolen by amateurs have a high recovery rate. Vehicles stolen by professional thieves and for chop shops are more often either dismantled or exported and are less likely to be recovered.

Parts marking deters professional thieves and chop shops because the marked parts aid law enforcement in detecting a stolen vehicle or part and also help get the criminals convicted of motor vehicle theft. Parts marking also helps in recovering stolen vehicles and parts. Thus, antitheft devices systems are not a replacement for the parts marking system. Both systems complement each other. Having vehicles with antitheft devices and with marked parts should prove to be sufficiently effective to warrant the cost of both the devices and the cost of parts marking.

After receiving the Justice Department findings, the Department will determine whether to propose that the theft prevention standard be amended to require all passenger vehicles, rated at 6,000 pounds gross vehicle weight or less, to have marked parts, except pickup trucks and vehicles granted exemptions for antitheft devices.

Discussion of Recommendations Received from Commenters

Section 614(c)(4) states that at least 90 days before submitting this report to Congress, the Secretary shall publish the proposed report for public review and for an opportunity for written comment of at least 45 days. The Secretary shall include a summary of such comments with the final report.

Comments were received from 17 companies, automobile manufacturers, automobile associations, and state enforcement agencies recommending modifications to the parts marking standard. Listed below is a summary by issue of recommendations received from commenters. All comments received are discussed in Appendix D.

Extend Parts Marking to Other Vehicles

Eight commenters recommend extending the parts marking to other vehicles currently exempt. Seven commenters (Florida Motor Vehicle Theft Prevention Authority (FL MVTPA), Advocates for Highway and Auto Safety, Dade County Multi-Agency Auto Theft Task Force, State Farm Insurance Companies, International Association of Auto Theft Investigators (IAATI), 3-M Safety and Security Systems, and Iowa State Police) recommend extending parts marking to all passenger vehicles (passenger cars, sport utility vehicles, and light duty trucks). Advocates, IAATI, Florida Auto Theft Intelligence Unit (FL ATIU) and 3-M also recommended extending the parts marking to vehicles with antitheft devices. State Farm wants to extend parts marking to vehicles with ineffective antitheft devices. Two commenters (IAATI and 3-M) even recommend eliminating the 6,000 pounds weight exemption.

The auto industry comments were opposed to parts marking. They feel that parts marking should either be terminated, phased out, or limited to only high theft lines. The industry favors antitheft devices over parts marking because of demonstrated effectiveness. Auto manufacturers say that parts marking costs are higher than the government estimate, hence they say the cost benefit is either lower or nonexistent.

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RESPONSE:

The Department tentatively believes that parts marking should be extended to other passenger vehicles and light trucks for the following reasons: (1) parts marking has shown effectiveness that at times exceeded the threshold for cost effectiveness, and (2) law enforcement, prosecutors, and motor vehicle administrations have presented evidence that parts marking is effective in detecting, arresting, prosecuting, and convicting auto thieves. If all passenger vehicles are marked, law enforcement officers, repair shops, and insurance agents will know that any used major part from vehicles made after the effective date must be marked.

While the position of the auto industry is understandable, parts marking effectiveness has been demonstrated even though it is difficult to quantify. We agree that antitheft devices are effective but not necessarily as a substitute for parts marking which acts both as a deterrent and for tracing stolen parts and vehicles. The government calculation of the cost for parts marking has been estimated by two different sources with similar results using recognized-standard estimating procedures. Little cost information was provided by the auto manufacturers - only estimates from Nissan and Volkswagen which were higher than the government estimates, but still within the statutory cost limit. Nissan stated that other manufacturers with low volume production lines subject to parts marking might have costs in excess of the Congressional ceiling.

Extend Parts Marking to Additional Parts

Six commenters recommend extending parts marking to additional parts. FL MVTPA, Dade County, FL ATIU, State Farm, 3-M, and Iowa State Police recommend parts marking for air bags. Three of these commenters (Dade County, FL ATIU, and State Farm) also recommend parts marking for glazing and two of these commenters (3-M and Iowa State Police) also recommend parts marking for sound systems. Toyota opposes marking glazing because of the unreasonable labor costs to coordinate marked glazing to their respective vehicles and the lack of demonstrable benefits.

RESPONSE:

One comment indicated that the replacement cost of air bags was between \$500 and \$1,500. While air bags have serial numbers, tracing an air bag back to its rightful vehicle without parts marking is more difficult to do. Marking glazing has a deterrent effect but its cost may exceed the Congressional limit per vehicle. The cost estimate of marking glazing was excessive a few years ago when the Department considered rulemaking to require glazing be marked. The theft of sound systems is more related to theft of vehicle contents rather than stealing the entire vehicle. Thus, the Department does not support marking sound systems.

No data on the cost of marking for any of these additional parts was provided with the comments received. To consider rulemaking for inclusion of any of these parts, the Department would have to obtain cost data. In addition, information would be needed to indicate that marking any of these parts would reduce vehicle thefts. Rulemaking would only proceed if there was evidence that adding one or more of these parts could be done without increasing the total cost of parts marking above the Congressional threshold and that there would be sufficient reductions in auto thefts to pay for the costs.

Make Parts Marking More Permanent

FL MVTPA, Advocates, Dade County, and FL ATIU recommend making parts marking more permanent. FL ATIU mentions invisographic type labels which leave the full VIN as its footprint if the label is peeled off.

RESPONSE:

While more permanent marking methods have merit, no data were provided in the comments received to support this initiative. The Department is interested in pursuing this recommendation but needs additional information before arriving at a final decision. Parts marking manufacturers have given some indication that such technology is under development.

Expand Exemptions of the Parts Marking Standard

Volkswagen of America, Inc recommends that NHTSA request Congress to allow exempting at least two car lines per year, instead of one and Association of International Automobile Manufacturers (AIAM) recommends expanding antitheft device exemptions.

RESPONSE:

The Department made this recommendation in the 1991 Report to Congress. However, given the variety of effectiveness of antitheft devices, the Department defers any decision making until the Justice Department has finished its 1999 study.

AUTO THEFT AND RECOVERY

Effects of

The Anti Car Theft Act Of 1992

and

The Motor Vehicle Theft Law

Enforcement Act Of 1984

July 1998

Auto Theft and Recovery

Introduction

Every year, more than one million motor vehicles are stolen. Estimates show that the economic loss resulting from these thefts is at least \$4 billion, and it could be as high as \$8 billion. In 1991, the National Highway Traffic Safety Administration presented a report to the Congress assessing the auto theft problem in the United States and the measures employed to fight theft. The basic reasons for stealing cars have not changed since the 1991 report. For example, cars are stolen for transportation (including unauthorized use of a vehicle or for use in transporting stolen goods or committing other types of crimes), joyriding, export, for repair parts, and for obtaining expensive stereo equipment to sell for a quick profit. A substantial economic loss continues to result from thefts motivated to meet the demands for replacement parts. Since the last report to Congress, a new type of auto theft crime has emerged -- carjacking -- but the motives for auto theft are still the same.

Auto theft was an escalating problem that caused Congress to enact the Motor Vehicle Theft Law Enforcement of 1984 (the 1984 Theft Act). The Theft Act was designed to reduce the incidence of motor vehicle thefts and simplify the tracing and recovery of parts from stolen vehicles. The Act directed the Secretary of Transportation to issue a theft prevention standard requiring manufacturers to inscribe or affix numbers or symbols on major parts of passenger-car, high-theft lines for identification purposes. The Act also addressed other issues such as criminal penalties, export of stolen motor vehicles, and comprehensive insurance premiums.

In October 1985, the Department issued the Federal Motor Vehicle Theft Prevention Standard (49 CFR Part 541) which requires manufacturers of designated high theft passenger car lines to inscribe or affix the vehicle identification number (VIN) onto the following major parts: engines, transmissions, fenders, doors, bumpers, quarter panels, hoods, and decklids/tailgates and/or hatchbacks. In the case of engines and transmissions, either the 17-digit vehicle identification number (VIN) or an eight digit VIN derivative must be engraved or stamped. Manufacturers can meet the affixation requirements with indelibly marked labels that cannot be removed without becoming torn or rendering the number on the label illegible. The labels must also leave a residue on the part after being removed.

As a further theft deterrent, the 1984 Act allowed for an exemption from the parts-marking requirements for certain car lines where antitheft devices were installed as standard equipment in factory-delivered passenger cars. The Act limited each manufacturer to two car line exemptions per model year. The manufacturer has to petition NHTSA for an exemption which is granted if it is determined that the devices are likely to be as effective in reducing and deterring motor vehicle theft as compliance with parts marking. The common features of antitheft devices installed as standard equipment for which exemptions have been granted include "passive" systems, which means that the system engages automatically without any extra action by motorists. Such systems are activated automatically by removing the key from the ignition and locking the doors. Sensors located in the doors, hood, trunk, and key cylinders activate alarms when unauthorized entry is attempted. The approved systems have a starter or ignition interrupt and power (battery) protection. Most systems granted exemptions in full have an audio and/or visual alarm (some of the GM systems which use the PASS-Key have been granted exemptions in full but have no visual or audio alarm). Systems granted a partial exemption because they do not have the audio/visual alarm, must have the engines and transmissions marked.

In the 1991 report, theft rates between marked and unmarked cars was found to be statistically insignificant. Recovery rates also showed no statistically significant differences between marked and unmarked car lines. Cars with antitheft devices did not show a significant difference in theft rates of cars containing marked parts. Recovery rates of antitheft device equipped cars appeared to be lower than those of marked cars. Analysis of theft claims costs resulted in the same conclusion. At the time of the 1991 report, evidence of the effectiveness of the theft standard could not be obtained through statistical analysis of the data sets examined.

However, the Department did find wide support in 1991 for parts marking from the law enforcement community. Law enforcement agents concerned with prevention and deterrence of motor vehicle theft or the capture and prosecution of perpetrators believed that marking parts provided them a valuable tool.

After considering the analyses, surveys, and public comments obtained during the preparation of the 1991 report, the Department recommended that the theft prevention standard be continued with several minor changes.

As a result of the Department's recommendation and other information received by the Congress, the Anti Car Theft Act of 1992 was enacted. This Act built on the 1984 Act in several ways: Federal penalties for auto theft were enhanced. A grant program was authorized to help state and local law enforcement agencies concerned with auto theft. Experts were called on to look into and report on motor vehicle titling, registration, and salvage (the report was published in February 1994). The National Motor Vehicle Title Information System was to be established and the states were required to participate in the system; the Theft Prevention Standard was expanded, rules were established to check if salvage or junk vehicles are stolen; and the Attorney General is to maintain a National Stolen Auto Part Information System. Selling or distributing marked parts that are stolen became a Federal crime. Random customs inspection to detect stolen vehicles being exported were allowed. A pilot study on a nondestructive inspection system was authorized. As in the 1984 Act, the Anti Car Theft Act of 1992 calls for a report to the Congress on the effects of the Act on trends in motor vehicle thefts and recovery. The report is due five years after the legislation was enacted (October 25, 1992). As in the 1984 Act, a preliminary report was published in June 1997 and announced in the Federal Register (June 26, 1997 page 34494) with a 45 day comment period ending August 11. The comments received are summarized and discussed in Appendix D of this report.

The 1992 Act's amendments on theft prevention include: expanding coverage to selected lines that were below the 1990/1991 median theft rate, and including high theft multipurpose passenger vehicles and light trucks that are rated at not more than 6,000 pounds gross vehicle weight under the provisions of the theft standard. These changes had to be made two years (1994) after the enactment of the Act. Three years later (1997), based on the Attorney General's findings, the Secretary of Transportation shall designate all remaining such lines of passenger motor vehicles (other than light-duty trucks), unless the Attorney General determines such additional parts marking would not substantially inhibit chop shop operations and vehicle thefts. By the end of 1999, the Attorney General shall determine if the rules have been effective in inhibiting chop

shops and vehicle theft and send these findings to the Secretary. These findings are to include an analysis of the effectiveness of factory-installed antitheft devices as a substitute for parts marking.

The rulemaking process and manufacturer comments regarding lead time to implement parts marking resulted in expansion of the Theft Prevention Standard to a selected group of low theft line vehicle lines and other passenger vehicles beginning with the 1997 model year. The most recent theft data available for this report from the National Crime Information Center is the 1995 file. Thus the effectiveness of the Anti Car Theft Act as regards to expanded coverage cannot be determined with the available data at this time. Other provisions of the 1992 Anti Car Theft Act and the effectiveness of the 1984 Act are evaluated in this report.

Both the 1984 and the 1992 Acts require the Secretary to include the following information in the evaluation report: motor vehicle theft and recovery statistics as well as their collection and reliability; the extent to which motor vehicles are dismantled or exported; the market for stolen parts; the cost and benefit of marking parts; arrest and prosecution of auto theft offenders; the Act's effect on the cost of comprehensive premiums; the adequacy of Federal and State theft laws; and an assessment the potential benefits of parts marking on other classes of motor vehicles. The 1991 report studied and discussed each of these topics in depth. This report focuses on changes that have occurred since the 1991 report. It also updates detailed statistics on motor vehicle theft and recovery. Theft data were available from 1984 through 1995, and insurance data from 1986 through 1992.

The Department obtained data from sources specified in the Act and available elsewhere, including: the FBI's National Crime Information Center (NCIC), the U.S. Attorney Generals Office, the Bureau of Customs, the Highway Loss Data Institute (HLDI), the National Insurance Crime Bureau (NICB), and individual insurance companies. Surveys or interviews were conducted with officials of state, county and city enforcement agencies, motor vehicle administrations and court systems; and with personnel at auto body repair shops.

In preparing this report, the Department worked with and consulted the Department of Justice's National Institute of Justice.

Motives and the Market

Thieves differ in their motives for stealing motor vehicles. The 1991 report included two surveys, performed in 1989, that estimated the distribution of car thefts by motive. Fundamentally, some vehicles are stolen in more or less professional operations for profit, while other thefts are typically the work of individuals, for profit or for other reasons. Here are some of the most common motives for theft:

Thefts to supply vehicles or parts for resale:

- Chop shop operations: businesses that acquire stolen vehicles or hire thieves to provide vehicles so that parts can be removed and sold for profit. These parts may eventually be sought by others to repair damaged vehicles, since they sell for substantially less than original equipment parts. (The 1989 surveys estimated that chop shops account for between 10 and 16 percent of all thefts.)
- Theft and retag: vehicles are stolen and sold for profit to be registered under another VIN. The new VIN and title are obtained by purchasing a junked vehicle of the same make-model. The VIN plate is transferred from the junked vehicle to the stolen vehicle and the title may need slight alteration to match the stolen vehicle (an estimated 15 percent of thefts).
- Thefts for export: vehicles are stolen and illegally shipped out of the United States to be sold for profit (4 to 17 percent of thefts).

Other motives for theft:

- Insurance fraud: “stealing” your own car, or having somebody else “steal” and hide it, so you can collect its insured value. After the insurance company pays off, the vehicle may be abandoned by the thieves, eventually recovered, and end up as the property of the insurance company. Insurance fraud might be contemplated, for example, if the owner has financial distress, or if the vehicle is in much worse shape than its insured value (9 to 23 percent of thefts).
- For concealing one’s identity while committing another crime: stealing a vehicle as temporary transportation to and from the scene of another crime. The stolen vehicle does not belong, and cannot be traced, to the criminal. Soon afterwards, it may be abandoned and eventually recovered (an estimated 13 percent of thefts).
- Joyriding or temporary transportation: the vehicle is usually abandoned and recovered after a matter of hours or days (estimates ranged from 25 percent up to 68 percent of thefts).

Of the million vehicles stolen each year, 200,000 are never recovered. Chop shop operations, export, insurance fraud, and retagging are believed to account for most of the unrecovered vehicles. Before parts marking, passenger cars represented 57 percent of the unrecovered vehicles, but from 1987 through 1995, this has increased to over 62 percent. The number of unrecovered passenger cars has varied from as few as 87,000 in 1985 to over 170,000 in 1991.

No new surveys have been conducted on the distribution of thefts, by motive. Assuming, for the moment, that the distributions were similar in 1995 and 1988, the estimated counts and costs for chop shop operations, fraud and export in 1995 are as follows:

- Between 84,000 and 135,000 passenger cars valued from over \$600 million to almost \$1 billion were stolen to remove parts in chop shops.
- Fraud of all kinds accounted for anywhere between 75,000 to 320,000 stolen passenger cars, valued from \$550 million to \$2.4 billion; and

- Between 30,000 and 123,000 of the 143,000 unrecovered passenger cars are believed to have been stolen for export, with an estimated value of \$221 million to \$905 million.

However, the Customs Service has provided more recent estimates of vehicles stolen for export. They estimated that in 1995 as many as 375,000 (the FBI data indicates that 200,000 is a better estimate of unrecovered vehicles) cars may have been stolen and exported. Using the Customs Service value of recovered stolen cars in 1994 of \$13,100, the upper bound estimated value of stolen exported passenger cars could be as much as \$4.9 billion. The Customs Service also estimated that 200,000 passenger cars were stolen and exported in 1990 with a market value of \$800 million (at a reported average of \$4,000 per vehicle in 1990).

Exports of stolen vehicles are extremely difficult to estimate. In 1988 and 1989, Customs agents report seizing 1,292 stolen passenger cars, a fraction of the estimated total. The Customs Service has improved its ability to recoup stolen passenger cars and reported 1,700 recovered in 1992 and 2,300 recovered in 1994. However, no inferences can be drawn from the trend in recoveries to the number exported and not recovered. While 1992 and 1994 show an improvement in recoveries over 1988 and 1989, there are still tens of thousands of stolen vehicles being exported illegally out of this country. Because law enforcement officials believe most stolen vehicles and parts are exported in sealed containers or crates, two provisions of the Anti Car Theft Act of 1992 specifically address that issue. One provision allows for random customs inspections to detect stolen vehicles being exported, and the other authorizes a pilot study of a nondestructive inspection system.

The 1991 report estimates that almost 32 million passenger cars during 1988 had crash damage which cost an estimated \$28.6 billion in parts to repair. The used/rebuilt portion of the parts market in 1988 was thought to be 4 to 5 percent or \$1.6 billion at that time. That portion appears to have grown over time. A survey of repair shops in 1989 indicated that used parts were employed in making repairs about 10 percent of the time; a similar survey in 1996 indicates that used parts comprise 14 percent of the repair parts. Assuming that the same number of cars as in 1988 need repair today and using current dollars, the estimated portion for used/rebuilt repair parts is about \$5.3 billion. Stolen parts comprise a portion of that used parts market.

The lack of information for making good estimates on the motives for auto theft results in broad and sometimes overlapping ranges. Thus, in the remainder of this evaluation, vehicle thefts and recoveries are analyzed only in the aggregate, without identifying the motives.

Thefts, Theft Rates, and Recovery Rates, 1984-1995

The FBI's National Crime Information Center (NCIC), once again is the source of theft and recovery data for this report as it was for the 1991 report. Theft data from 1984 through 1995 were available. Because of differences in screening, vehicle definitions, and aggregating the data, totals shown for 1984 through 1988 are slightly different from the 1991 report. The NCIC information is considered the most accurate and precise available. Each record contains the make, line, theft and recovery dates of individual stolen motor vehicles. The summary information compiled from the Uniform Crime Reports (UCR), which are based on reports by local police agencies, is not presented here, as it had been in the 1991 report. Comparisons were made between the NCIC and UCR data bases in the 1991 report, and the NCIC data base was found to be more definitive for analysis purposes. The UCR data base includes attempted thefts as well as successful thefts.

Thefts: The principal finding of this evaluation is that the auto theft problem, which was growing during the mid 1980's, leveled off or even began to decline after 1989-90. In 1995, there were 1,179,856 motor vehicles stolen, a rise of 39 percent since 1984, but a decline of 7 percent since 1990. In 1995, passenger cars account for 71 percent of all motor vehicle thefts; light trucks - i.e., pickup trucks, vans and sport utility vehicles (SUV's) account for 24 percent. The remaining five percent are thefts of heavy trucks, buses and motorcycles. Total thefts increased steadily from 830,545 in 1984 to 1,234,088 in 1989, an 8 percent annual rate of increase. They leveled off in the early 1990's, with a reduction from 1,227,768 in 1994 to 1,179,856 in 1995. The sharp increase in thefts of pickup trucks, vans and SUV's throughout this period is proportionate to their increasing share of the vehicles on the road. Annual thefts of motor vehicles from 1984 through 1995 are shown in Table 1 and Figures 1A and 1B.

Theft rates (Thefts per 100,000 registered vehicles²) are shown in Table 2 and Figures 2A and 2B. The theft rate for all types of vehicles has the same trend as overall thefts. The theft rate increased from 543 in 1984 to 714 in 1990. It has declined to 597 by 1995. The rates for passenger cars and light trucks show a similar pattern. (Even though thefts of light trucks have increased, their registrations grew even more rapidly, so the theft rate declined after 1989.) Theft rates for heavy trucks, buses and motorcycles have experienced even larger reductions.

Recovery rates: The number of recoveries have kept pace with thefts over the years. The recovery rate (recoveries/thefts) has remained stable. Table 3 and Figures 3A and 3B indicate that overall recovery rates during 1984-95 have ranged from a low of 78 percent to a high of 87 percent but the trend has been neither increasing nor decreasing: the rate has been consistently close to 83 percent. NCIC recovery data for 1995 was still incomplete at the time of this study. The 1995 rates in Table 3 can be expected to increase if vehicles stolen in 1995 and recovered in 1996 (after the cutoff date for the file used in this study) were to be included.

Passenger cars have slightly higher recovery rates than pickup trucks/vans/SUV's or heavy trucks. Motorcycles have substantially lower recovery rates, and they have gotten worse. After 1990, recovery rates for all types of vehicles tend to be higher in the even years than the odd years. The reason for that pattern is unknown.

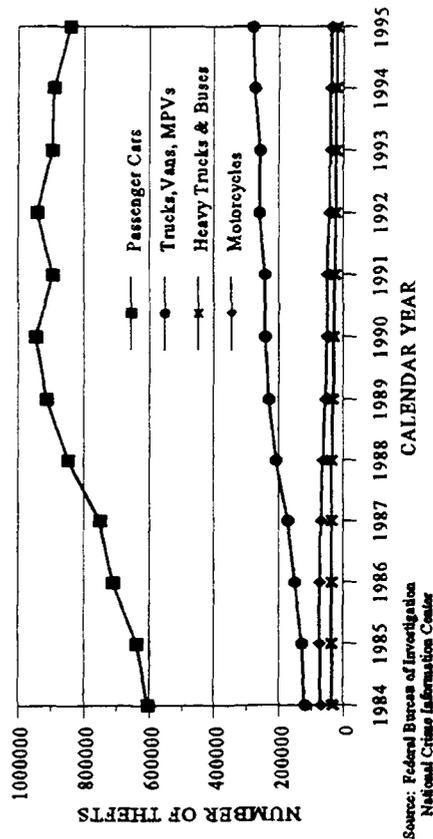
²Registered vehicles are the number of vehicles registered by the states and reflects the fleet of vehicles on the road. The data comes from the R. L. Polk Co. which compiles the information obtained from the states usually at the end of June which is the fiscal year for most states. Registered vehicle data is essential since it can be separated by model year.

TABLE 1. MOTOR VEHICLE THEFTS

Motor Vehicle Type	CALENDAR YEAR													
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995		
Passenger Cars	603,103	636,663	709,497	749,607	846,050	912,466	945,181	894,167	942,388	897,020	891,020	840,642		
Trucks, Vans, MPVs	119,117	130,498	150,378	172,614	207,741	230,985	242,621	242,260	260,856	258,879	274,729	279,894		
Heavy Trucks & Buses	38,630	37,222	37,182	37,066	36,398	33,441	30,439	25,975	24,420	22,766	21,708	20,875		
Motorcycles	69,695	73,765	74,338	70,050	64,251	57,196	51,543	50,993	44,213	41,213	39,754	38,445		
TOTAL THEFTS	830,545	878,148	971,395	1,029,337	1,154,440	1,234,088	1,269,784	1,213,395	1,271,877	1,219,878	1,227,211	1,179,856		

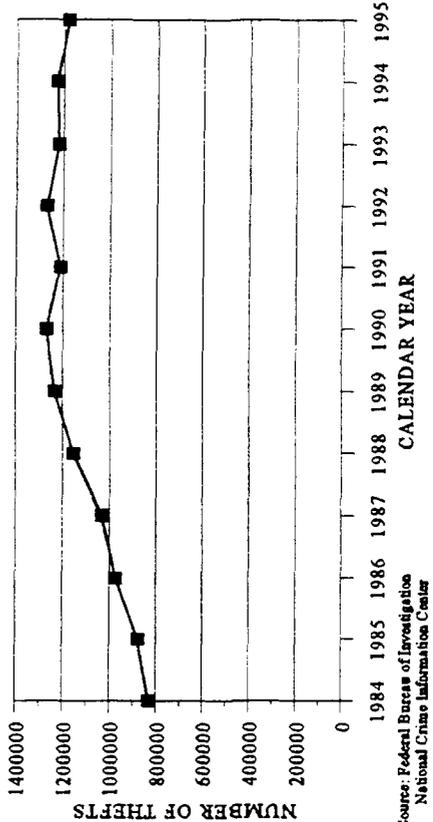
Source: Federal Bureau of Investigation, National Crime Information Center

FIGURE 1A. MOTOR VEHICLE THEFTS BY VEHICLE TYPE



Source: Federal Bureau of Investigation, National Crime Information Center

FIGURE 1B. TOTAL MOTOR VEHICLE THEFTS



Source: Federal Bureau of Investigation, National Crime Information Center

TABLE 2. MOTOR VEHICLE THEFT RATES BY VEHICLE TYPE

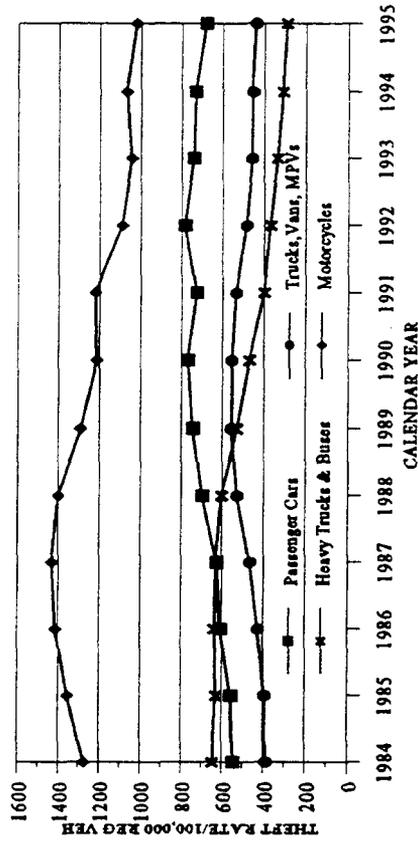
Motor Vehicle Type	CALENDAR YEAR												
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	
Passenger Cars	545	555	605	625	696	743	767	725	783	741	731	682	
Trucks, Vans, MPVs	387	393	426	465	527	557	533	535	485	458	455	441	
Heavy Trucks & Buses	645	628	636	628	602	529	469	400	369	336	311	293	
Motorcycles	1,272	1,355	1,413	1,434	1,402	1,290	1,210	1,210	1,088	1,042	1,069	1,021	
ALL VEHICLES	543	551	594	613	673	705	714	682	688	648	636	597	

Source: Number of thefts - Federal Bureau of Investigation, National Crime Information Center

Registration data - R.L. Polk & Co. Data, & Federal Highway Administration

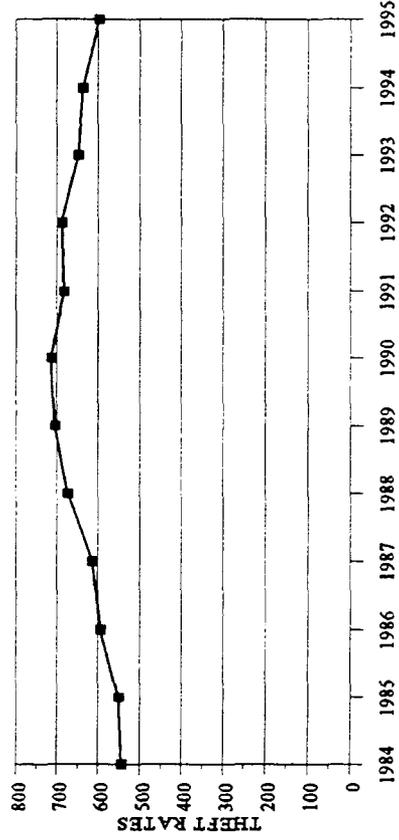
(Theft Rate = Thefts/100,000 Registered Vehicles)

FIGURE 2A. MOTOR VEHICLE THEFT RATES BY VEHICLE TYPE



Source: Federal Bureau of Investigation, National Crime Information Center, R.L. Polk, Federal Highway Administration

FIGURE 2B. THEFT RATES FOR ALL VEHICLES



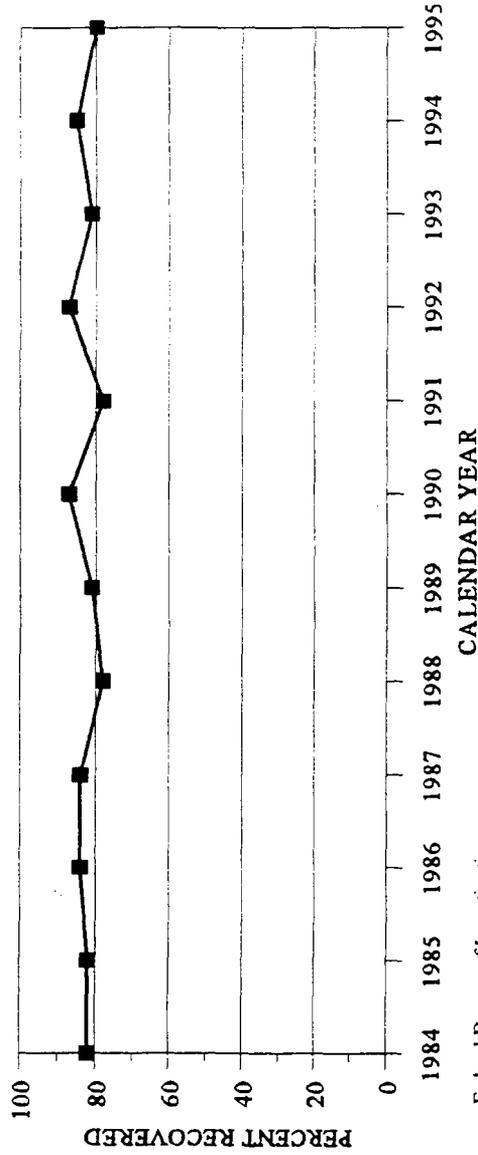
Source: Federal Bureau of Investigation, National Crime Information Center, R.L. Polk, Federal Highway Administration

TABLE 3. MOTOR VEHICLE RECOVERY RATES BY VEHICLE TYPE

Motor Vehicle Type	CALENDAR YEAR											
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
<i>Passenger Cars</i>												
Number Thefts	603,103	636,663	709,497	749,607	846,050	912,466	945,181	894,167	942,388	897,020	891,020	840,642
Number Recovered	511,167	547,765	620,291	655,595	684,903	761,930	838,779	723,412	840,634	750,696	778,984	697,565
Theft Rate	545	555	605	625	696	743	767	725	783	741	731	682
Recovery Rate	85%	86%	87%	*87%	81%	84%	89%	81%	89%	84%	87%	83%
<i>L. Trucks/Vans/SUVs</i>												
Number Thefts	119,117	130,498	150,378	172,614	207,741	230,985	242,621	242,260	260,856	258,879	274,729	279,894
Number Recovered	89,437	98,557	116,656	135,445	155,661	181,326	203,700	182,807	222,651	204,079	228,403	219,385
Theft Rate	387	393	426	465	527	557	553	535	485	458	455	441
Recovery Rate	75%	76%	78%	78%	75%	79%	84%	75%	85%	79%	83%	78%
<i>Heavy Trucks & Buses</i>												
Number Thefts	38,630	37,222	37,182	37,066	36,398	33,441	30,439	25,975	24,420	22,766	21,708	20,875
Number Recovered	32,626	30,987	30,845	30,203	27,213	25,645	24,692	18,650	20,130	16,938	17,395	15,441
Theft Rate	645	628	636	628	602	529	469	400	369	336	311	293
Recovery Rate	84%	84%	83%	81%	75%	77%	81%	72%	82%	74%	80%	74%
<i>Motorcycles</i>												
Number Thefts	69,695	73,765	74,338	70,050	64,251	57,196	51,543	50,993	44,213	41,213	39,754	38,445
Number Recovered	43,837	43,837	44,526	41,100	33,346	30,265	31,386	24,042	26,797	18,146	20,365	15,442
Theft Rate	1,272	1,355	1,413	1,434	1,402	1,290	1,210	1,210	1,088	1,042	1,069	1,021
Recovery Rate	63%	63%	60%	59%	52%	53%	61%	47%	61%	44%	51%	40%
TOTAL												
Number Thefts	830,545	878,148	971,395	1,029,337	1,154,440	1,234,088	1,269,784	1,213,395	1,271,877	1,220,111	1,227,768	1,179,856
Number Recovered	677,067	721,146	812,318	862,343	901,123	999,166	1,098,557	948,911	1,110,212	989,859	1,045,147	947,833
Recovery Rate	82%	82%	84%	84%	78%	81%	87%	78%	87%	81%	85%	80%

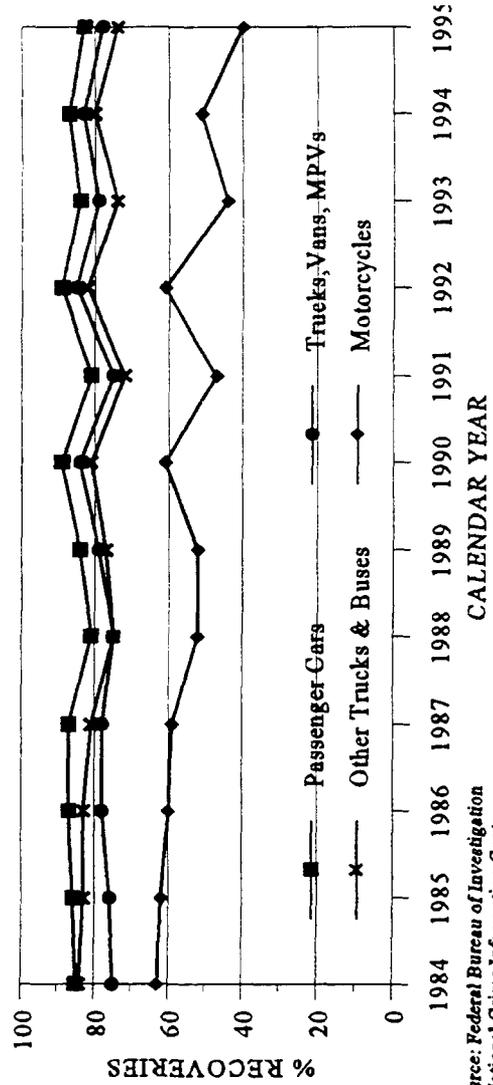
Source: Federal Bureau of Investigation, National Crime Information Center, R.L. Polk & Company data, Federal Highway Administration (Theft Rate = Thefts/100,000 Registered Vehicles)

FIGURE 3A. MOTOR VEHICLE RECOVERY RATES
ALL VEHICLES



Source: Federal Bureau of Investigation
National Crime Information Center

FIGURE 3B. MOTOR VEHICLE RECOVERY RATES
BY TYPE



Source: Federal Bureau of Investigation
National Crime Information Center

Effect of Parts Marking and Antitheft Devices on Theft and Recovery Rates

A key outcome of the Antitheft Act of 1984 was that a large number of model year 1987 passenger cars would get marked parts. A smaller number would get factory-installed antitheft devices in 1987, or a few years earlier or later. At the time of the 1991 Report to the Congress, a comprehensive evaluation was impossible simply because there were not yet enough data on cars with marked parts or antitheft devices. By now, those cars have been on the road for a much longer time. Their theft and recovery rates can be tracked for several years and compared to the corresponding rates for cars without either measure. Appendix A of this report presents the analyses that were performed to evaluate the effect of parts marking and antitheft devices. However, biases in the data obstructed the evaluation of parts marking and made it essentially impossible to attribute a specific percentage reduction in thefts or increase in recoveries to that remedy. Still, the analyses do suggest that parts marking quite possibly had **some** beneficial effects at times. The analyses produced quantitative effectiveness estimates for one type of antitheft device installed in domestic cars, but the data were insufficient for similar analyses of other types of antitheft devices. Here is a summary of the analysis objectives, data sources, findings and conclusions.

If parts marking or antitheft devices are effective, they ought to **reduce** theft rates **and/or** **increase** recovery rates. These goals would be accomplished through **direct** effects and **deterrent** effects. While there have been numerous cases where parts marking directly helped recover cars or convict thieves, it is probably safe to say that the deterrent effects are potentially far larger, in quantitative terms. The primary deterrent effect, of course, would be to dissuade professional car theft operations, especially chop-shop operations, from stealing cars with marked parts or antitheft devices. Thefts for joyriding, etc., are less likely to be deterred by parts marking. A significant reduction in the theft rate might be expected to start **in model year 1987** in the make-models that got marked parts that year. However, the effect might not trigger all at once (i.e., in model year 1987). It might have built up over time as thieves became more aware of parts marking, or as body shops gradually became more careful about the source of their parts, and it might even have spilled over onto earlier cars (thieves do not always have time to ascertain the exact model year, and might avoid stealing cars of the lines that got parts marking, even if they are slightly pre-1987). A **long-term** reduction of theft rates might be expected in the lines

that got parts marking or antitheft devices, relative to car lines that did not. Thus, it is appropriate to perform short-term (just before/after model year 1987) and long-term analyses of theft rates.

The deterrent effect might also impact the **recovery** rate. When cars are stolen for chop shops, the overall recovery rate is relatively low and many of the recoveries are only “in part” (as defined in “Collection and Dissemination of Theft and Recovery Information,” later in this report). When cars are stolen for joyriding, etc., the overall recovery rate is usually high, and most of the recoveries are “intact” or “in whole.” If parts marking deters thefts for chop shops but has little effect on joyriding, etc., it ought to increase the overall recovery rate and reduce the proportion of recoveries that are only “in part.”

The remedies should reduce the number of unrecovered stolen vehicles per million registered vehicles. To the extent that many of the vehicles stolen by professional thieves - for chop shops, salvage switch and retag, or export - are never recovered, this “**unrecovered theft rate**” may be considered as a sort of surrogate for the unknown “professional” theft rate. If the remedies change all three rates in the right direction, so much the better, but even if they change just one, especially the unrecovered theft rate, it might be good enough.

Only a small reduction in theft is needed to make parts marking cost effective. As discussed in “The Cost of Marking Parts,” later in this report, a relative reduction of two percent in the theft rate of 0-3 year old cars would already pay for parts marking.

The make-models slated for parts marking or antitheft devices in 1987 were not picked on a random basis, but were the ones that had **the highest theft rates in MY 1983-84**. Even without parts marking or antitheft devices, these make-models would inevitably have experienced a strong reduction in their theft rates, relative to other car lines, for a number of years after 1984 - a phenomenon called “regression to the mean.” As is explained in Appendix A, parts-marking effects on the order of, say, two percent cannot readily be discerned from the much stronger “regression to the mean” effect that went on at the same time. With this fundamental bias in the data, it becomes almost impossible to produce specific, quantitative effectiveness estimates. A closer look at “regression to the mean,” and an attempt to isolate its effect by statistical tools is

documented in Appendix B. However, even with statistical tools, it is difficult to distinguish one effect from another in the type of data furnished for this evaluation.

The principal data base for the analyses, assembled from NCIC and R.L. Polk data, enumerates how many cars were registered, stolen and recovered, by make-model, model year and calendar year. The data base covers calendar years 1984-95, and it includes cars from 0 to 15 years old. It is useful for studying the short-term and long-term trends in theft rates and overall recovery rates. Another data base, assembled by HLDI from theft and recovery records supplied by the NICB, enumerates how many cars were recovered "in part," "in whole," or "intact," by make-model, model year and calendar year. That data base is complete for calendar years 1986-91, and it includes cars from 0 to at least 2 years old. It is useful for studying short-term trends of the "in part" recovery rate.

As stated above, the analyses did not generate a reliable quantitative estimate of the reduction of thefts or enhancement of recoveries attributable to parts marking, and they did not lead to an unequivocal conclusion that parts marking has been effective. But the analyses were not totally inconclusive or neutral. They produced five concrete indications of benefits for parts marking, all hedged with caveats that made them fall short of firm deductions:

- (1) Short-term theft trends: Above all, there was a conspicuous shift in theft rates in 1986-87, coinciding with the introduction of parts marking. Thefts of 1987 make-models with marked parts were lower than expected, while thefts of the same make-models in 1986 (unmarked) and thefts of other 1987 make-models (unmarked) were both higher than expected. The net shift was on the order of 20 percent when the cars were less than a year old (see Figures A-9 and A-10 in Appendix A). However, the effect was already much weaker for one-year-old cars and it had vanished by the time the cars were two years old. Also, the effect was more of a shift in what cars were stolen than a reduction of overall theft rates.
- (2) Short-term recovery trends: Recovery rates for 1987 cars with parts marking were consistently higher than for the same make-models in 1986, the last year before parts

marking. Unlike the effect on theft rates, this benefit persisted as the model year 1987 cars got older. On the other hand, the 1986-87 favorable effect was followed by an unexplained but consistent deterioration, starting in model year 1988, in the recovery rates of cars with parts marking relative to other make-models without the markings.

- (3) Short-term unrecovered-theft trends: In calendar year 1987, the unrecovered-theft rate of model year 1987 cars with parts marking was 26 percent lower than expected. As the model year 1987 cars got older, this benefit diminished, but not to zero; it persisted at about 6 percent. That is the closest thing to a specific "effectiveness estimate" for parts marking. However, that observed benefit is within the "noise range" of possible biases in the data and it cannot be attributed to parts marking without considerable doubt.
- (4) Long-term trends: In the very long term (cars of the early 90's vs. cars of the late 70's), parts marking and antitheft devices appear to be associated with a reduction in theft rates (see Figures A-1 and A-2 in Appendix A). In other words, the make-models that were selected in 1983-84 to get parts marking or antitheft devices in 1987 historically had higher theft rates than other make-models, even as far back as model year 1976. But from model year 1991 onwards, their theft rates were slightly lower than other make models. Little can be said about the crucial intervening years, the 1980's. The nonrandom selection of high-theft lines for parts marking caused a "regression to the mean" situation that obscured all other trends. It is only possible to compare cars of the late 70's and early 90's, before and after the "regression to the mean" phenomenon. So many other factors could be affecting theft trends over a 20-year period that it would be foolhardy to attribute the observed long-term reduction to parts marking. Additionally, the unrecovered-theft rates did not experience a similar long-term improvement.
- (5) Short-term "in part" recovery trends: There was a strong reduction of "in part" vehicle recoveries, and a corresponding increase of "in whole" and "intact" recoveries in all make-models after parts marking was introduced in 1987, and especially in the make-models that got the markings. The reduction of "in part" vehicle recoveries could be an indication that chop shop operations and some other types of professional car theft are declining.

However, a closer examination of the data showed that the reduction did not begin immediately with the introduction of parts marking, but mostly came 1-3 years later, possibly as a result of factors unrelated to parts marking, such as, perhaps, changes in the way that recoveries were reported.

By contrast, for at least one type of factory-installed antitheft device, the available data provide unequivocal evidence of effectiveness. One domestic manufacturer installed a system as standard equipment in various car lines during 1989-94. This system was associated with an immediate - and persistent - 70 percent reduction in the theft rate and a 58 percent reduction in the unrecovered-theft rate. In other words, the devices appear to be quite effective in reducing all kinds of thefts, both the "professional" and the "casual" type.

Substantially fewer data were available on the antitheft devices installed by other manufacturers. Specific estimates were not obtained, but the available data suggest considerable variation in effectiveness. With some of the devices, little change was seen in theft rates; with others, there were reductions comparable to those for the domestic manufacturer.

On the whole, the analysis results seem to suggest that the approach of Chapter 331 of the Anti Car Theft Act, which views both parts-marking and factory-installed antitheft devices as effective deterrents to automobile theft, has had benefits. Only a small effect, such as a 2 percent reduction of unrecovered thefts is necessary for parts marking to be cost-effective. An effect of that magnitude would have been obscured in the data available for the analyses. However, the positive results described above hint that the effect of parts marking might have been greater than 2 percent, at least at certain times. Antitheft devices, at least those installed in certain vehicles, are many times more effective, but also many times higher in cost. Parts marking and antitheft devices are components of a larger program that has, on the whole, succeeded. As shown in Table 2 and Figure 2, theft rates have leveled off and even began to decline after 1989-90. When the team wins, each of the individual players gets some credit.

Two other issues tie in with the analysis results. (1) The nonrandom selection of high-theft make-models for parts marking impeded the evaluation, and (2) There is a hint that the initial effect of

parts marking may have waned in subsequent years. That's at best a tentative finding, given the uncertainties in all the analyses. However, it corresponds to the view that many professional thieves eventually learned how to obliterate the markings. If so, that encourages consideration of more permanent systems of parts marking: the high potential for benefits might well justify the higher cost.

Effect of Vehicle Age on Theft and Recovery Rates

A vehicle's age is a theft motive consideration. Chop shop operations involve removing parts from stolen vehicles for the purpose of providing repair parts for other vehicles that have either been damaged in collisions or because of wear. As vehicles age, the chance of needing repairs increases and the chance of being in a collision remains fairly constant. In contrast, vehicles that are stolen for either joyriding or for the purpose of retagging may more likely be newer vehicles that are attractive targets with higher market value. Unfortunately, there is no method for identifying theft motives by vehicle age.

Appendix C shows a detailed analysis of theft rates by vehicle age to determine if there is a relationship. Analysis of theft data in aggregate immediately suggested that there were two possible confounding factors: calendar year effects, and model year effects. In the first situation, vehicle thefts in any year can be influenced by such things as the weather or economic conditions, neither of which would have anything to do with vehicle age. For example, the blizzard conditions in the midwest this spring has meant that some states have virtually no vehicles on the road and few people out-of-doors. This would mean for that region and time period, vehicle thefts would be low. Model year influences include such things as major manufacturers making across the board design changes such as when they went from rear to front wheel drive. Again, if these changes are radical it can result in fewer vehicle thefts of that model year because parts are not interchangeable with other older vehicles or because the new model's appearance has less appeal. The analysis in Appendix C corrected for both calendar year and model year effects.

The result of the vehicle age analysis was that no relationship between vehicle age and theft rate was found. Current model year cars were just as likely to be stolen as eight year old models.

Also, there was no relationship between vehicle age and recovery rate. Thus, current model year vehicles had the same recovery chance as did eight year old models. What the analysis suggests is that theft motives, including those of professional thieves, that may change as vehicles age may have countervailing effects. Thus, as vehicle thefts for used parts may increase as vehicles age, thefts for retagging or joy riding may decrease with vehicle age in a proportionate manner.

The analysis was extended to light trucks with the same findings: no relationship was found between vehicle age and theft and recovery rates. The passenger car data was separated by marked, unmarked and those with antitheft devices with the same result - no vehicle age effect was found with respect to either theft rates or recovery rates.

What this suggests is that the risk of theft persists over the life of a car. This implies that parts markings ought to last essentially over the life of the car.

Collection and Dissemination of Theft and Recovery Information

National theft and recovery information is collected and compiled by the same organizations as discussed in the 1991 report: The Federal Bureau of Investigation is responsible for the Uniform Crime Reports (UCR) and the National Crime Information Center (NCIC); the insurance industry sponsors the Highway Loss Data Institute (HLDI), the Insurance Institute for Highway Safety (IIHS), and the National Insurance Crime Bureau (NICB), formerly the National Automobile Theft Bureau.

The 1991 report discussed the fact that these data sources provide substantial information on the number of thefts, the costs associated with auto theft, and the recovery of stolen vehicles and their condition. These systems do not reveal the motives for vehicle thefts. Thus it is not possible to directly measure changes in thefts so as to determine if the 1984 and 1992 Acts have had an impact on chop-shop operations and any of the other thefts for profit: retagging, insurance fraud, and export of stolen vehicles.

As in 1991, the UCR collects monthly information from local police agencies on reported vehicle thefts and attempted thefts, and arrests for these crimes. This information is published at least annually with the primary objective of providing reliable crime statistics for law enforcement use.

The NCIC has an online-computerized filing system of theft cases with all the key information for ready access to individual records of reported motor vehicle thefts. This system is used to obtain information on crimes under investigation. When a vehicle is located, the case is closed. The NCIC maintains historical information for four years before purging its files. Each case of a reported stolen vehicle includes the Vehicle Identification Number (VIN) and complete state registration data as well as the date of the theft, theft location and reporting agency.

The NICB is a clearinghouse for information on motor vehicle thefts reported by the insurance industry. The NICB provides assistance to law enforcement and other public agencies such as state motor vehicle administrations. The NICB is the organization designated by the U.S. Department of Transportation to collect information in a standard reporting system on vehicle recovery condition:

- “In part” One or more major parts missing. “Major” parts are the engine, transmission, fenders, doors, bumpers, quarter panels, hood, and decklid/tailgate/hatchback - i.e., the parts that would have been marked if the vehicle had parts marking.

- “In whole” No major parts missing; but there is damage to the vehicle such as being stripped of other than major parts and/or wrecked, burned, etc.

- “Intact” No major parts missing; no damage to the vehicle other than that caused when the thieves entered and operated the vehicle; ordinary wear and tear.

The NICB assists law enforcement agencies by matching reports of stolen vehicles with reports of vehicle recoveries, and impounded vehicles. The NICB also helps with investigative inquiries.

The IIHS and HLDI collect and compile the insurance industry annual report on theft experience and its effect on insurance premiums. This report is submitted to the Department of Transportation, as required by the 1984 Act. HLDI also compiles and disseminates insurance claim cost data and insurance theft losses and prepares industry reports annually.

The Anti Car Theft Act of 1992 calls for two new or expanded systems: the National Motor Vehicle Title Information System and the National Stolen Auto Part Information System. The Justice Department is setting up the first system after considering the recommendations of an expert advisory committee that prepared a report in 1994 for the President, Congress, and State Governors. A pilot project for the system is under development in Virginia, Florida, Indiana and Massachusetts. The American Association of Motor Vehicle Administrators is managing the project and the R.L. Polk Company is also participating. Three other states, Maryland, Delaware, and New York are expected to participate as well. The stolen auto parts system is an expansion of a NCIC system that existed before the 1992 Act. These two systems are either not completely in place or are so new that their effects on vehicle theft (on the prevention, recovery or apprehension of auto thieves) cannot be evaluated at this time.

Current data and views on what changes have taken place in collecting and disseminating motor vehicle theft information are based on a survey of state motor vehicle administrations and the annual insurance reporting information sent to the Department. All the state motor vehicle administrations in 1991 agreed that there had been no changes in information sharing practices between 1983-1986 (before the 1984 Act's provisions were implemented) and 1987-1988. By 1996, however, one-third had experienced gradual changes in the way information was shared due mainly to improvements in information-processing technology implemented since 1988. Nevertheless, the majority still felt that no changes occurred after 1988.

Databases became more complete and accessible to the agencies needing the information. In 1991, three-fourths of the state agencies recorded the recovered vehicle's condition, by 1996 this had grown to almost 90 percent. Almost 80 percent of the states surveyed in 1996 had made changes to procedures regarding the collection and recording of vehicle recovery information since 1986, as a direct result of the 1984 and 1992 Acts. New technology has provided for increased data collection and dissemination and resulted in changes in these processes. All states

surveyed participated with the NCIC and equivalent state-level organizations. Two-thirds indicated that state and local law enforcement agencies played a major role in collecting and recording vehicle theft and recovery information. In other words, although there have not been major changes in the type of information collected, technology improvements have made it easier to access and share the information.

Each year since 1986, the insurance industry has reported to the Department on collecting and disseminating motor vehicle theft and recovery data as well as effects on insurance premiums and other related matters. In 1986, there were 24 companies that reported, while in 1992 (the latest year of information available for this report), 19 companies reported.

Percent of insurance companies that:

	<u>1986</u>	<u>1992</u>
Reported thefts and recoveries to NICB	83	76
Notified local law enforcement agencies	20	60
Notified other insurance companies or state/federal agencies	33	33
Did not notify any outside organization	10	10

Insurance companies have made some progress in directly disseminating auto theft and recovery information, including a threefold increase of reporting to local law enforcement agencies. Nevertheless, it is clear that insurance companies still rely most heavily on the NICB as a clearinghouse for such information.

The Economic Cost of Auto Theft

The overall cost of motor vehicle thefts to the United States economy is difficult to estimate accurately, since not all thefts are reported, the precise value of stolen and recovered vehicles may be unknown, and ancillary costs such as insurance administration, police work, and loss of consumers' time are hard to gauge. Based on available data, four estimates were generated,

ranging from about \$4.0 to \$8.3 billion per year. The best guess is that the actual cost is near the middle, or somewhat below the middle of that range, i.e., about \$5 or \$6 billion per year.

The lowest estimate is derived from the Uniform Crime Report (UCR), as summarized in *Crime in the United States*; 1994 is the most recent year for which data were available. The total value of vehicles stolen in 1994, as reported to police agencies, was \$7.6 billion (based on *Crime in the United States*, 1994, p 50). While over 80 percent of the vehicles were eventually recovered, many of them are damaged or have parts missing; only 61.1 percent of the **value** of the stolen vehicles was recovered (ibid, p. 205). The other 38.9 percent of the value, \$2.957 billion was lost. To those direct losses, it is necessary to add the cost of insurance administration, police investigation, and time lost by victims (filling out reports, court appearances, acquiring substitute transportation, etc.): an estimated markup of 33.7 percent (taken from The Economic Cost of Motor Vehicle Crashes, 1994, DOT HS 808 425, p.7). Thus, the overall cost to the economy was an estimated \$3.954 billion in 1994. Based on the UCR data, the economic cost of motor vehicle theft escalated from \$2.4 billion in 1985 to \$4 billion in 1991, and it leveled off after 1991, consistent with the pattern of overall thefts in Table 1 and Figure 1.

A somewhat higher estimate is derived from NCIC data. In 1995, there were 1,179,856 stolen vehicles with an average value of \$7,350 (based on Crime in the United States). The total value of the stolen vehicles, according to NCIC, would have been \$8.672 billion. If 38.9 percent of that value is lost, as was estimated in the UCR data, the direct loss was \$3.373 billion. With a 33.7 percent markup, the net loss to the economy would have been \$4.510 billion.

A nearly identical estimate can be obtained by examining actual premiums paid for comprehensive insurance. The Insurance Information Institute reports that the comprehensive policies written for motor vehicles during 1995 amounted to 110.8 million insured vehicle years. The average premium was \$116.91 per year. Thus, consumers actually spent \$12.954 billion on comprehensive premiums. Very close to one-third of comprehensive premiums go to processing and paying theft claims: \$4.318 billion (the remainder goes to processing and paying claims for vandalism, fires, floods, etc.). When an 8.7 percent markup is added for police investigation and time lost by victims, the cost to the economy is \$4.694 billion.

The preceding estimate may be considered low because many stolen vehicles are not insured by comprehensive policies. For an upper bound, let it be assumed that all of the 196.6 million vehicles on the road in 1995 had comprehensive insurance, at the same \$116.91 premium as above. In that case, the total cost of premiums would have been \$22.985 billion, the portion used for processing and paying theft claims \$7.662 billion, and the cost to the economy, after the 8.7 percent markup, \$8.329 billion. However, this is undoubtedly an overestimate. It is primarily older vehicles that do not have comprehensive policies, and since their value has substantially depreciated, their average premiums, if they had such policies, would have been less than \$116.91.

The Cost of Marking Parts

To comply with the standard, up to 14 parts have to be marked. These include the engine and transmission, which historically had already been marked with the entire VIN or a VIN derivative of eight to nine digits. If manufacturers had been using the VIN derivative on or before October 24, 1984, they were permitted to continue using it. The other parts that were marked were the front fenders (2), doors (2 or 4), bumpers (2), rear quarter panels (2), hood and decklid/tailgate/hatchback.

When labels are used, the 17 digit VIN must be printed indelibly, and the label permanently affixed to the part. If the label is removed it must self-destruct by tearing or making the VIN illegible. Removing the label must also alter the appearance of the area where it was affixed so that evidence remains that a label was originally there. Any attempts to alter the number on a label must leave traces of the original number. Standards also apply to new replacement parts: they do not have a VIN but instead have the DOT logo and the letter "R" to indicate that they are new replacement parts.

Since the beginning of parts marking, manufacturers have met the requirements with adhesive backed labels made by a variety of suppliers. In accordance with Section 604(b)(1) of the 1984 Theft Act, the cost of marking engines and transmissions was not taken into account in estimating

the cost of parts marking since these parts have historically been marked with the VIN or VIN derivative.

The 1984 Theft Act limited the cost to manufacturers to \$15 per car (in 1984 dollars) or less. In 1995 dollars, the maximum cost per car would be \$22 (based on the Consumer Price Index for all items, United States city average). Using a detailed production analysis process and factors to estimate the consumer cost, the 1991 report to Congress showed that actual costs were well within the permissible amount. The highest cost to a manufacturer among the make-models analyzed was \$3.35 per passenger car and the highest cost to purchasers was \$5.49 per car. The average cost per car was \$4.14. These estimates were in 1988 dollars. There is no evidence to suggest that the cost of labels and the cost of the manufacturing assembly process have changed. Thus the average cost to the purchaser, per car, in 1995 dollars is estimated to be \$4.92.

A two percent reduction in thefts among 0-3 year old cars would generate a consumer benefit that would more than pay for the cost of the labels. The cost-benefit analysis is as follows: in 1995, when 3.2 million cars with marked parts were sold, the cost to consumers for parts marking was \$15.7 million. Also in 1995, thieves stole 50,131 model year 1992-95 cars with marked parts (i.e., 0-3 years old). The average market value in 1995 of these new or partially depreciated cars was \$14,833 (Source: Average New Car Prices 1993-1996 Automotive News Market Data Books and the Used Car Book). The types of theft most likely to be deterred by parts marking (chop shop operations, retag) typically result in a total or near-total loss of the vehicle (\$14,833); after adding the cost of insurance administration, police investigation and victims' lost time, the cost to the economy is \$19,832. Given the \$15.7 million cost of parts marking, thefts of 0-3 year old passenger cars would have to drop by about 792 (i.e., \$15,700,000/\$19,832) to have the benefit in terms of auto thefts avoided equal to the cost of parts marking. That amounts to approximately 1.6 percent of the 50,131 thefts of 0-3 year old cars with marked parts.

In the 1991 report to Congress, the subject of removal of labels was discussed. It was found at that time that it was possible to completely remove the label and its adhesive and even any traces that the parts was originally labeled. A national survey of auto theft investigators conducted for the Justice Department in 1996 found that the most serious obstacle to making effective use of labels is their ease of removal. Once the label is removed and its trace wiped out, it is, of course,

of no value for proving the parts are stolen because the owner cannot be traced. A more permanent system of parts marking could help overcome that obstacle.

Arrest and Prosecution

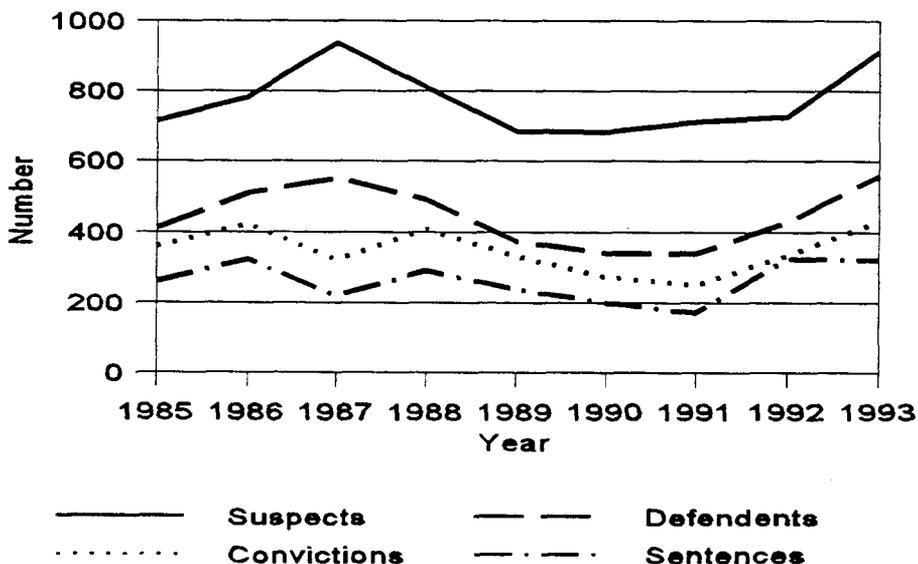
The 1991 report to Congress discussed the dramatic rise in the number of persons arrested for auto theft during the years immediately following the Theft Act of 1984: there were 133,900 arrests in 1985 and 208,400 in 1988, the latest year of data available for that report. Subsequently, arrests peaked at 228,500 in 1989, but have leveled off since then. In 1994, an estimated 200,200 people were arrested for auto theft or attempted theft in the United States.

In 1991, no national prosecution data were available on cases involving the parts marking standard. The 1991 report to Congress estimated 35,000 convicted auto theft cases involving 50,000 convicted defendants. The 1991 report indicated that the odds of being arrested and serving time in prison (more than one year) were one in 100.

The 1991 report to Congress also discussed Federal cases prosecuted under the new sections of the 1984 Act: 180 cases involving 258 defendants and resulting in 114 convictions and 159 convicted defendants. During 1985-89, over 1,100 other cases were filed under U.S. laws in existence before the 1984 Act, primarily brought to the courts after FBI investigations.

The Justice Department reported the following Federal court activity in motor vehicle theft from 1985 through 1993 (Figure 4):

FIGURE 4. FEDERAL COURT MOTOR VEHICLE THEFT STATISTICS



The Federal statistics seem to indicate that court activity peaked in 1987 and again in 1993. The actual number of cases is so small that no conclusions can be drawn from these data.

The 1991 report to Congress did not include any statistical analyses of parts marking in apprehending, arresting, and prosecuting car thieves because of insufficient data, but it contained summaries of individual cases where parts marking helped accomplish those goals. The report concluded that auto theft investigators were able to use labels to their advantage in chop shop cases, inspections of salvage yards, steal-to-order operations, and insurance fraud.

Surveys of District Attorneys

For both the 1991 report to Congress and this report, surveys were conducted of state district attorneys, motor vehicle administrations and law enforcement agencies to determine the effects of the 1984 and 1992 Acts on apprehending, arresting, prosecuting, convicting, and sentencing chop shop owners and "professional" auto thieves as well as chop shop operations and monitoring body shops. The second survey showed a moderate increase in the number of prosecutions under the 1984 and 1992 Acts and an even larger increase in the level of effort that could be directed to each prosecution. In 1991, very few of the district attorneys reported that the 1984 Act made prosecution of professional auto thieves and chop shop operators easier. Similarly, only four percent reported an increase in the number of prosecuted cases as a result of the 1984 Act and none of the district attorneys had increased their efforts to prosecute auto theft cases. By 1996, over 20 percent had seen an increase in the number of prosecuted cases in their jurisdictions and 10 percent saw a decrease in the auto theft rates as a result of the 1984 and 1992 Acts, although two-thirds of the district attorneys reported that the number of prosecuted cases had not changed as a result of the 1984 and 1992 Acts. In 1996, two-thirds of the district attorneys did increase their efforts on a case-by-case basis in prosecuting these cases. Half of them indicated that the 1984 and 1992 Acts were responsible for this increase and the other half indicated that increased motor vehicle thefts and administrative changes were the cause of their increased efforts.

In 1991, an overwhelming 96 percent of the district attorneys reported that convictions were not affected by the 1984 Act. There were no changes in sentencing (most said that first offenders got

suspended sentences and/or fines and subsequent offenders were put in jail/prison). In contrast, by 1996, almost half of the district attorneys reported an increase in convictions and most of them attributed this to the 1984 and 1992 Acts. District attorneys reported stiffer sentencing in 45 percent of the convictions, including a 75 percent increase in jail sentences. This could have been even higher but prison overcrowding in one jurisdiction necessitated automatic probation for thefts valued under \$20,000. Other benefits of the 1984 and 1992 Acts include: district attorneys working more closely with law enforcement agencies; auto theft prevention authorities being established to prevent, arrest, and prosecute auto theft cases; and greater success in catching violators.

Surveys of Law Enforcement Agencies

The surveys of law enforcement agencies done in 1991 and 1996 did not reveal dramatic changes in their attitudes about the deterrent effect of parts marking. In 1991, most auto theft investigators at law enforcement agencies anticipated no effect in reduction of auto thefts for chop shop operations. They felt that if there was a demand for a part, even if marked, thieves would steal the part. Nevertheless, about 45 percent of the investigators felt that parts marking might make professional thieves more cautious or even completely deter them. Another one-third of the investigators thought that auto thieves looked upon parts marking as an inconvenience. All investigators thought that parts marking had no effect on amateur thieves. The 1996 survey was also split. Half the investigators felt that parts marking did deter professional auto thieves and the other half did not. Those who thought parts marking was beneficial felt that it had the greatest effect on chop shop operators because it did increase the cost of "doing business".

However, the surveys showed that the agencies had even more positive attitudes about parts marking as a tool for arresting and prosecuting thieves in 1996 than in 1991. In 1991, while most law enforcement officers said there was no effect on thefts, arrests, and prosecution of auto thieves as a result of the 1984 Act, most of them did feel that parts marking did assist in identifying and recovering stolen parts and vehicles. There were no cases reported that were prosecuted under the sections of the 1984 Act. By 1996, arrests and prosecutions had changed dramatically. About three fourths of the law enforcement agencies in the big cities surveyed (31

of 32 of the largest cities in the U.S. were surveyed) said that parts marking helped in arresting both chop shop owners and professional auto thieves for these reasons:

- Labels make it possible to detect stolen parts/vehicles
- Missing, damaged, counterfeit, miss-matched VIN's on parts is sufficient evidence for officers to seize parts as evidence and make subsequent arrests.
- Without labels serving as "red-flags", investigators would have no reason to suspect cars or parts are stolen.
- In many inspections of restored salvage vehicles, labels have led to evidence of stolen parts or the total vehicle.

Surveys of Motor Vehicle Administrations

Surveys for the 1991 report to Congress and again in 1996 show that since 1983 to the present there has been little or no change in monitoring body shops. Lack of funds for inspectors is the primary cause for this even though the 1984 and 1992 Acts have given more methods for inspectors to detect stolen parts being used by body shops.

Motor vehicle administrations have continuously increased their investigative efforts. In 1991, one fourth reported increased effort as a result of the 1984 Act. By 1996, almost 45 percent of reporting administrations indicated increased investigative effort.

From the surveys of district attorneys, auto theft investigators, and motor vehicle administrations, advances in apprehending, arresting, prosecuting, convicting, and sentencing as a result of the 1984 and 1992 Acts seem evident.

Insurance Premiums

Motor vehicle thefts are covered under the comprehensive portion of insurance policies. Comprehensive also includes coverage for floods, fires and vandalism - events not related to collisions. At the time of the 1991 report, based on information from insurers, thefts represented

about 40 percent of the cost of comprehensive claims. By 1995, according to the Insurance Information Institute, this proportion had dropped to one-third of the cost of those claims. As stated in the preceding section on "The Economic Cost of Auto Theft," comprehensive premiums amounted to \$12.954 billion in the United States in 1995. Thus, \$4.318 billion of those premiums were used to process and pay theft claims.

The 1984 Theft Act specifies insurer reporting requirements including an explanation of the basis for setting comprehensive insurance premiums and premium penalties for motor vehicles considered as most likely to be stolen. The following is a summary of the insurer's explanations.

Many insurers establish comprehensive rates on a statewide basis using total comprehensive loss experience -- the theft component is not identified. This is done because the insurers' theft loss experience is insufficient for rate setting. In fact, some insurers' total loss experience is inadequate to serve as a basis for comprehensive rates. These insurers rely on the aggregate of many companies, compiled by a rating organization such as the Insurance Services Office, Inc. (ISO).

Statewide rates are established by individual makes and models based on rating symbols. These designations reflect the new vehicle price and its damageability/repairability. The individual rating symbols may be adjusted up or down for the state, based on combining collision losses with all losses covered by comprehensive insurance. Since the bulk of the total cost experience comes from physical damage arising from collisions, adjusted rating symbols correlate more closely to collision experience rather than theft experience. Rates are further adjusted for: the location where the vehicle is driven, the vehicle age, and driver and vehicle use characteristics. Other elements for premium rates and penalties include vehicle size, design, performance, sportiness and production levels.

In addition to the aforementioned factors for rate setting, some states require that rates be submitted for information only; others approve rates before they can be used, and in a few states the insurance commissions actually set the premium rates. Before establishing the premium rates for comprehensive coverage, most insurance companies determine how much is needed statewide

to cover their anticipated claims, expenses and profit. Then they adjust for the difference between what they collect currently and what they need to collect from policies in the state.

While theft losses amount to 33 percent of comprehensive claim payments and only six percent of all auto insurance claims, they do constitute an implicit basis for setting rates. Insurance claim payments were analyzed for the 1991 report to the Congress. No significant difference was found between marked cars and unmarked cars. That analysis was based on 1983 through 1988 claim payment data for marked and unmarked cars. The Highway Loss Data Institute (HLDI), a part of the Insurance Institute for Highway Safety, was the source of the claim data. This data base is not available to NHTSA beyond 1989, and the analysis in the 1991 report has not been updated.

Insurance Claim Payments for Recovered Vehicles Before and After Inception of Parts Marking

Highway Loss Data Institute (HLDI) collects information from insurance companies on the number of thefts, the number of insurance claims, and the average dollar amount paid by the insurance company for unmarked and marked vehicle lines or vehicles with factory installed anti-theft devices. Data on recovery condition is available after 1989 but the average claim data were not reported after that year. However, the data available for 1990-1992 are not comparable to previous data and were not included in the analyses.

Average theft claims paid for recovered cars were compared for cars without marked parts, cars with marked parts, and for cars with factory installed anti-theft devices and their predecessors. Table 4 presents the average claim amounts in 1995 dollars and number of claims paid for the three categories of passenger cars for the period prior to parts marking (1983-1986) and the period after parts marking took effect (1987-1989).

For parts marking to be successful in reducing the proportion of thefts by professional thieves, it would be expected that the average theft claim cost for recovered marked vehicles would drop. One might expect the same result for vehicles with factory installed anti-theft devices. While the average theft claim costs for current model year marked vehicles did decrease by 4.8 percent for the three year period after the marking program began, claim costs for unmarked vehicles for the

same time period were reduced even further by 7 percent. Claim payments for the vehicles with factory installed anti-theft devices rose by 3.6 percent for the same time period.

For parts marking to have resulted in a decrease in claim payments, marked vehicles would have to have experienced a larger drop in payments than the unmarked vehicles. This is based on the assumption that thieves are aware of the vehicle lines that were covered by the marking standard. However, average claim payments for unmarked vehicles dropped even further than those for the marked vehicles. There was a reduction in claim payments after implementation of the standard, but it is not clear that parts marking was the cause of the reduction for both marked and unmarked vehicles. If thieves were not aware of which lines had marked parts and simply reacted to the standard, then parts marking may have been responsible for the overall drop in claim payments after implementation of the standard.

Claim payments for vehicles with factory installed anti-theft devices increased at about the same percent as the other two dropped. It is possible that the vehicle lines with factory installed anti-theft devices are recognized more easily. Thieves may be finding it easier to bypass the devices and are stealing them more than other vehicles.

TABLE 4. AVERAGE THEFT CLAIM PAYMENTS & NUMBER OF CLAIMS FOR CMY MARKED & UNMARKED AND ANTI-THEFT PASSENGER CARS

CALENDAR YEAR - CURRENT MODEL YEAR VEHICLES										
Reported In 1995 Dollars	1983 - 1986 Pre-Standard		1987 - 1988 Post-Standard		1989 Post-Standard		1987 - 1989 All Post-Standard Yrs		Difference in Avg. Amt. Pd. 1983-1986 vs 1987-1989	
	Avg Amt Paid	Number of Claims	Avg Amt Paid	Number of Claims	Avg Amt Paid	Number of Claims	Avg Amt Paid	Number of Claims	Dollar Difference	Percent Change
Unmarked	\$12,175	2,026	\$11,262	1,300	\$11,370	951	\$11,316	2,551	-\$859	-7.1%
Marked	\$15,625	4,250	\$14,456	3,269	\$15,288	775	\$14,872	4,044	-\$753	-4.8%
Anti-Theft	\$19,873	559	\$19,485	2,787	\$21,677	66	\$20,581	2,853	+\$708	+3.6%

The absolute number of claims declined for marked cars, but increased for unmarked and anti-theft cars when comparing the four prestandard years to the three post standard years of claims.

Used Replacement Parts

The 1984 Act requires the insurance industry to respond to the Department of Transportation's questions on their used part policies. Their responses since the enactment of the 1984 and 1992 Acts have shown little change regarding their policies on used replacement parts. These are their responses from 1986 through 1992:

- Between 69 and 87 percent of those reporting encourage the use of used parts for auto crash repairs.
- One-half to two-thirds of the insurance companies rely on repair shops to obtain parts from reputable sources.
- Less than one percent of the reporting insurers have any actual policy regarding checking used parts for VIN markings and/or checking with the NICB or law enforcement agencies if the VIN shows up in theft records.
- In 1986 and 1987, one percent of the responding insurance companies required documentation of the source of used parts -- name, address, etc. In 1989 and 1990, this had increased to 17 percent, but returned to less than one percent in 1991 and 1992. The 1989 and 1990 increase in companies requiring documentation may be a reporting variation, because in those years, twice the number of companies submitted reports as compared to the other two time periods.

Insurance companies seem to favor having repair shops fix vehicles with used parts, but do not seem to have incurred the added expense of having a system to verify that the used parts are obtained legitimately.

The Condition of Recovered Vehicles

Parts Marking and Insurance Claims. The 1984 and 1992 Theft Acts require major motor vehicle parts be marked with the VIN. If the program is effective in deterring theft of major parts, there

should be fewer stolen marked vehicles that are recovered with these parts missing. If the program is even more effective, there might be a spill over for unmarked stolen vehicles being recovered. These vehicles would also have less major parts missing. With this in mind, the 1984 Act required the collection of data on recovered stolen vehicles in three categories: intact (no parts missing but with damage from unauthorized entry), in-part (major parts, which for marked vehicles would have VIN markings, missing), and in-whole (other motor vehicle parts that are not required to be marked are missing).

If the parts marking program aids in reducing the number of vehicles stolen for their parts, then the percent of marked vehicles which were recovered in-part (i.e., major parts missing) should decrease after parts marking began. Highway Loss Data Institute (HLDI), with vehicle condition from the NICB, provides insurance data which includes the number of claims and average payment for vehicles recovered: in-part (i.e., vehicle recovered with one or more major parts missing at the time of recovery); intact (i.e., vehicle recovered with no major parts missing at the time of recovery); or in-whole (i.e., vehicle recovered with no major parts missing but may have other parts missing at the time of the recovery or with damage in addition to that sustained during unauthorized entry and operation).

Insurance data were compared for pre- (1986) vs. post- standard (1987 - 1989) years. Table 5 shows the intact, in-part, and in-whole percent of claims and average payment for marked and unmarked vehicles. The pre-standard year (1986) is compared to the post-standard years (1987-1989). Only one additional year of claim payment data by recovery condition (1989) was available since the 1991 report to Congress. That year is compared to the 1987-1988 data to determine any continuing or changing trends. Data on recovery condition for insurance claims but without claim payment amount was collected after 1989, but this data is not comparable to the 1986 through 1989 data for several reasons: samples were collected from different insurance companies, the coding identifiers for vehicle condition had been changed and it doesn't appear that they were consistently applied, motor vehicles were incorrectly placed in vehicle classes. Therefore, the analysis of recovered stolen vehicle condition had to be based on 1986 through 1989 data.

Percent of Claims. In-part claims have dropped from the pre- standard year 1986 through the post-standard years 1987-1989. The percent of in-part claims for marked vehicles decreased 46 percent from the pre- vs. the two post-standard years (i.e., 1986 vs. 1987-1988). The trend continued and dropped another 33 percent from 1987-1988 to 1989. In-part claims accounted for 15 percent of claims in 1987-1988 and 10 percent in 1989. At the same time, in-part claims for unmarked vehicles experienced an overall drop of 52 percent for the pre- vs. the three post-standard years. This trend included drops from 22 percent in 1986 to 11 percent in 1987-1988 and to 10 percent in 1987-1988.

In comparison, the number of in-whole claims have increased by 32 percent for marked and 27 percent for unmarked vehicles during the pre- to three year post-standard time frame. The increase also continued in 1987-1988 vs. 1989 post-standard time frames from 76 to 80 percent for marked and 77 to 80 percent for unmarked vehicles. This represents a 5.3 percent increase for marked vehicles and a 3.9 percent increase for unmarked vehicles.

The claims also dropped for both marked (27 percent) and unmarked (31 percent) vehicles for that same pre- and post-period time period. Overall intact claims for marked vehicles dropped from 13 percent in 1986 to 9.5 percent in 1987-1989 and for unmarked vehicles from 16 percent to 11 percent for that same time period. From 1987-1988 to 1989, intact claims for marked vehicles increased slightly from 9 to 10 percent and intact claims for unmarked vehicles decreased from 12 to 10 percent.

Claim Payments. Average claim payments from insurance companies have dropped for all but the in-whole marked vehicles. The average claim payments for in-part marked vehicles dropped 2.3 percent while the in-whole payments for unmarked vehicles rose 12.6 percent from the 1986 pre- to the 1987-1989 post-standard years. Unmarked vehicle claim payments dropped 2.6 percent of in-part, 8.8 percent for in-whole and 13.6 percent for intact payments.

Summary. The data show that in-part claims for both marked and unmarked vehicles dropped initially after parts marking was introduced and continued to drop from the post-standard 1987-1988 to 1989 years. Intact claims have also dropped during that period. In comparison, the

number of in-whole claims for both marked and unmarked vehicles has increased over the same time period.

Average payments for all claims except in-whole marked vehicle thefts have also dropped from the pre- to post-standard time period. It would appear that the marking standard has provided a deterrent effect to thieves. These trends suggest the possibility that thieves are less willing to steal major parts from vehicles which may require marking. Instead they are stealing other vehicle parts which are not covered by the marking standard.

TABLE 5. PERCENT OF CLAIMS AND AVERAGE PAYMENTS FOR IN-PART, INTACT, AND IN-WHOLE INSURANCE CLAIMS

Model & Recovery Status	1986 CMY Pre-Standard		1987-1988 CMY Post-Standard		1989 CMY		1987-1989 CMY Post-Standard		Difference 1987-1988 vs 1989		Difference 1986 vs 1987-1989	
	Pct. of Claims	Avg. Payment	Pct. of Claims	Avg. Payment	Pct. of Claims	Avg. Payment	Pct. of Claims	Avg. Payment	Pct. Of Claims	Avg. Payment	Pct. Of Claims	Avg. Payment
IN 1995 DOLLARS												
Marked												
In-Part	28%	\$15,635	15%	\$15,610	10%	\$14,927	12.5%	\$15,269	33.3% ↓	4.4% ↓	55% ↓	2.3% ↓
Intact	13%	\$10,570	9%	\$ 8,329	10%	\$12,858	9.5%	\$10,594	11.1% ↓	54.4% ↓	27% ↓	0.2% ↓
In-whole	59%	\$ 9,922	76%	\$ 9,638	80%	\$12,702	78%	\$11,170	5.3% ↓	31.8% ↓	32% ↓	12.6% ↓
Unmarked												
In-Part	22%	\$12,593	11%	\$12,509	10%	\$12,028	10.5%	\$12,268	9.1% ↓	3.8% ↓	52% ↓	2.6% ↓
Intact	16%	\$ 8,578	12%	\$ 7,162	10%	\$ 7,664	11.0%	\$ 7,413	16.7% ↓	7.0% ↓	31% ↓	13.6% ↓
In-whole	62%	\$ 8,868	77%	\$ 7,883	80%	\$ 8,298	78.5%	\$ 8,091	3.9% ↓	5.3% ↓	27% ↓	8.8% ↓

Source: HLDI, NICB data

Adequacy of Theft Laws

In the 1991 report to Congress, it was too early to make a definitive statement about the adequacy and effectiveness of the Federal and State laws designed to prevent the distribution of used parts removed from stolen motor vehicles. While effectiveness still cannot be proved with statistical confidence, the laws do seem to have led to an improvement in prosecuting and convicting auto thieves. Comparisons of surveys of district attorneys in 1991 and 1996 show that the 1984 and 1992 Federal Acts increased prosecutions and, especially, convictions. Since the number of cases that are prosecuted is influenced by the total court caseload, it is not surprising that the number of prosecuted theft cases may not have grown as rapidly as might be expected. However, once a theft case is prosecuted, the probability of conviction has been greater since passage of the two Federal Acts. Undoubtedly the Acts have helped by providing prosecutors with better evidence (marked parts) and because they made trafficking in stolen vehicle parts or tampering with VIN marking Federal offenses. Once a thief is convicted, there is a strong likelihood that the sentence will be greater, with increased fines and jail time.

Most of the states surveyed in 1996 made legislative changes between 1993 and 1994 in response to the Federal Acts. For example, the sentencing guidelines were changed and the severity and length of penalties were increased. The survey done for the 1991 report to the Congress did not find any changes in state legislation.

It also is still true, as it was for the 1991 report, that the efforts by various state and local government associations, privately funded organizations, legislators, police agencies, insurance companies and others in the private sector have been instrumental in creating and sponsoring laws and statutes dealing with titling, inspections and licensing of vehicle and parts businesses. It is anticipated that the Motor Vehicle Titling, Registration and Salvage Advisory Committee report of 1994, as its recommendations are implemented, will also help achieve better and more uniform statutes dealing with these subjects. The end result will be to make it more difficult for thieves and forgers to traffic in stolen vehicles and parts.

The Adequacy of Tracking Systems for Theft Investigators

Motor vehicle theft investigators were surveyed for both the 1991 report to Congress and this report. In 1991, law enforcement officials said that professional thieves appeared to be more cautious when deciding which vehicles to steal, but that they stole cars with marked parts and took measures to make it difficult for law enforcement to find the stolen car or its parts. The parts marking standard had not been in effect long enough to be a deterrent to thieves stealing cars.

By 1996, about half the auto theft investigators interviewed felt that parts marking was effective in deterring thieves. Professional thieves know which cars have marked parts and won't steal a vehicle unless there is a safe and sure place to sell/dispose of the vehicle or its parts. Labels won't deter some thieves but some body shops won't purchase parts with missing labels and they demand paperwork documenting the parts' source.

A 1996 survey of repair facilities indicated similar benefits for parts marking. Salvage yards are reluctant to accept or keep parts without labels. Chop shops now do things differently because there is an increased threat of being inspected and they can be caught for having parts with missing labels. Legitimate body shops keep records of who brought in parts and honest businesses very frequently report suspicious parts. They know that they can go to jail if their business receives stolen unlabelled parts, so there is an incentive for thieves to avoid selling stolen parts to these businesses.

While some investigators surveyed at seaports felt that labelling deterred crating and exporting stolen vehicles, others reported that the labels had no impact on exports. None of the reporting cities included in the survey, however, were located near the borders with Mexico or Canada.

Several investigators volunteered that, even if labels do not have a deterrent effect on auto theft, they do increase the "cost of doing business" to thieves. Stolen parts have to have their labels removed. That takes time and money and increases the risk of arrest. The extra time thieves need to select cars without labels also complicates their operations.

Labels also reduce the investigative burden. If the VIN's on the labels match the VIN on the dash, this can reduce the checking process. This saved time may enable investigators to devote more time to catching thieves. All surveyed investigators found that the labels resulted in more productive labor on their part.

Benefits of Parts Marking to Other Classes of Motor Vehicles

The statistical analyses of the effectiveness of parts marking in the "high theft" passenger car lines did not produce specific quantitative estimates of their effect in deterring thieves, but the data seem to suggest that parts marking has had benefits, quite possibly beyond the break-even point with the cost of producing the labels and putting them on the designated parts. Because of the timing of this report and the rulemaking process, data were not available for "low theft" car lines and multipurpose vehicles that have been marked beginning with the 1997 model year.

Surveys confirm the benefits of parts marking as an important component of the 1984 and 1992 Acts. Auto theft investigators report that labels on parts have saved them investigative time so they can be more productive. Prosecutors are getting more convictions because of better evidence with marked parts and additional statutes for charging criminals. Convicted auto thieves are getting longer jail sentences, thus keeping them off the streets and acting as a better deterrent to auto theft. All these are benefits of the parts marking system, but they are difficult to measure in quantitative terms.

One shortcoming of current markings is that they can be obliterated. More permanent methods of marking parts might substantially improve effectiveness. Since current markings cost less than \$5 per car and the Act allows a cost up to \$22 per car (in 1995 dollars), there is considerable room for developing more effective markings, even if they carry some additional cost. Any improvement in the permanence of marking parts would have to result in better effectiveness in deterring thefts or increasing recoveries. At the maximum allowed cost per car of \$22, parts marking with more permanence would have an upper effectiveness bound of seven percent to pay for additional cost of marking.

Given that parts marking appears to be effective in the passenger car lines currently marked, there is little reason to doubt that it could also have benefits for other passenger vehicles: currently unmarked car lines, light duty pickup trucks and multipurpose passenger vehicles (MPV's), since those vehicles are stolen for similar reasons, including chop shop operations. Parts marking is less likely to be effective for heavy trucks, buses and motorcycles, vehicle types that generally do not pass through chop shops.

In 1984, passenger cars represented 73 percent of stolen motor vehicles. Light trucks (pickup trucks, vans and SUV's) were 14 percent of the stolen vehicles in 1984 followed by motorcycles at 8 percent and heavy trucks at 5 percent. In 1995, passenger cars still represented 71 percent of stolen vehicles but light trucks had increased to 24 percent, with motorcycles shrinking to 3 percent and heavy trucks to 2 percent. Obviously, light trucks, because of their growing market share, account for a growing proportion of motor vehicle thefts. Although theft rates for both passenger cars and light trucks have dropped since 1989-90, they have nevertheless increased from 1984 to 1995 by 25 percent and 14 percent respectively. In the other two vehicle categories, heavy trucks and motorcycles, theft rates have decreased over 50 percent and 20 percent respectively. Since cars and light trucks account for an increasing proportion of thefts, they are more in need of countermeasures than heavy trucks and motorcycles.

APPENDIX A

EFFECT OF PARTS MARKING AND ANTITHEFT DEVICES ON THEFT AND RECOVERY RATES

A key requirement of the Antitheft Act of 1984 was that a large number of model year 1987 passenger cars would have marked parts or antitheft devices. By now, these cars have been on the road for a long time. Their theft and recovery rates can be tracked for several years and compared to the corresponding rates for cars without marked parts or factory-installed antitheft devices - potentially allowing an evaluation of the effectiveness of those remedies. At the time of the 1991 Report to the Congress, a comprehensive evaluation was impossible simply because there were not enough data on cars with marked parts or antitheft devices. Now there are many data, but biases in the data still obstruct the evaluation. The analyses described herein cannot go so far as to attribute a specific percentage reduction in thefts or increase in recoveries to parts marking or a single effectiveness number for antitheft devices. Nevertheless, they do suggest that parts marking quite possibly had **some** effects at times. They also demonstrate that at least one group of antitheft devices has been highly effective in reducing thefts. Since even a small benefit of parts marking would be sufficient to justify its low cost, these fragmentary analysis results can be viewed positively - especially in the context of the all-encompassing finding of this report: overall theft rates, which grew in the earlier 1980's, leveled off in the late 1980's and declined in the mid 1990's. Parts marking and antitheft devices are elements of the 1984-92 battery of measures to deter theft. They are components of a process that has, on the whole, experienced success.

Potential Effects of Parts Marking or Antitheft Devices

Before proceeding with the analyses, it is appropriate to consider what sorts of effects might be expected for parts marking and antitheft devices, how large those effects might possibly be, and how that magnitude compares to the effectiveness level needed for those remedies to have societal benefits commensurate with their costs. Fundamentally, if the remedies are effective, they ought to **reduce** theft rates **and/or increase** recovery rates. They should reduce the number of unrecovered stolen vehicles per million registered vehicles. To the extent that many of the vehicles stolen by professional thieves - for chop shops, salvage switch and retag, or export - are never recovered, this

"**unrecovered theft rate**" may be considered as a sort of surrogate for the unknown "professional" theft rate. (The data do not and usually cannot describe why a car was stolen, but if that car is not recovered, it was quite probably stolen by a professional thief.) If the remedies change all three rates in the right direction, so much the better, but even if they change just one, especially the unrecovered theft rate, it might be good enough.

These goals would be accomplished through **direct** effects and **deterrent** effects. A direct effect of marked parts or antitheft devices would be to allow identification or location of a stolen car (or parts of a car), thus assisting the prompt recovery of the car - i.e., an increase in the recovery rate. Above all, certain types of antitheft devices might make it hard to steal a car at all - i.e., a reduction in theft rates. A direct consequence of parts marking would be evidence to help convict the people involved in stealing the cars and put them out of the theft business. While there have been numerous cases where parts marking helped recover cars or convict thieves, it is probably safe to say that the deterrent effects are potentially far larger, in quantitative terms, than the direct ones.

The deterrent effect would be to dissuade thieves from stealing cars with marked parts (and possibly other cars). But many types of thieves are unlikely to be deterred by marked parts. People who steal a car for joyriding, or to commit another crime, and intend to abandon it, intact, after a few hours or days, have little to fear from parts marking: the marked parts merely duplicate the VIN that can readily be seen on the intact VIN plate. In fact, many of them might not even know that parts marking exists, let alone what models have it. The activities most likely to be deterred by parts marking are chop shops and fraud that involves a change in the reported VIN (salvage switch and retag for resale). Here, parts marking could reveal the true source of the parts, or the original VIN of the retagged vehicle. However, the 1991 report suggests that these activities account for only about 20-30 percent of all car thefts. Thus, even if parts marking were a highly successful deterrent, it could not reasonably be expected to reduce overall theft rates by more than 20-30 percent and, in all probability, only a fraction of that reduction can reasonably be expected.

On the other hand, only a small reduction in theft is needed to make parts marking cost effective. As discussed in the main report in "The Cost of Marking Parts," a relative reduction in the overall theft rate of just 2 percent would already pay for parts marking.

Antitheft devices, whose costs exceed parts marking by an order of magnitude, would need to show substantially higher benefits. On what vehicles would the deterrent effect apply? Most immediately, on the specific cars that actually had marked parts. In particular, on the make-models that got parts marking in 1987, there should be a reduction in the model year (MY) 1987 theft rate, relative to the MY 1986 theft rate for the same models (when they did not yet have marked parts). In other words, thieves who steal for chop shops might have been instructed to avoid the specific cars with marked parts. The statistical analysis of the theft data would be easy if this were the only place where an effect could be expected.

However, there could likely be other deterrent effects, possibly exceeding in magnitude the narrowly focused MY 86-87 effect described above. There might be fewer thefts in those make-models that got parts marking even in the model years before the parts were marked. A car thief does not always have time to inspect the VIN plate carefully and find the exact model year. It might be expedient to avoid stealing cars of the lines that got parts marking, even if their model years are somewhat earlier than 1987. Conversely, there might be a delayed effect, for example, as body shops gradually become more careful about the source of their used parts.

As a consequence, there might be a dual impact on theft rates in the make-models that got parts marking in MY 1987: a discernable one-time reduction in the theft rate for MY 1987 (with parts marking) vs. MY 1986 (without parts marking) and, perhaps, a more diffuse, gradual reduction in the model years slightly before and after 1987, both resulting in a permanent reduction of the theft rate during the 1980's model years.

Furthermore, the effect is not necessarily limited to the make-models that got parts marking, but could spill over to the lines that were never marked - and it is not clear if the spillover would be positive or negative. On the one hand, parts marking, along with other measures of the 1984 and 1992 laws, might discourage professional car thefts of all types, resulting in a long-term reduction

of theft rates in all makes and models. On the other hand, parts marking on selected make-models could motivate discriminating thieves to concentrate their activities on the unmarked lines, with little change in overall theft rates.

The deterrent effect might impact the recovery rate as well as the theft rate. If parts marking deters thefts for chop shops (where the recovery rate is relatively low), but has little effect on joyriding, etc., (where it's usually high), the overall recovery rate might be expected to rise after parts marking.

The Confounding Effect of "Regression to the Mean"

The analysis of the effectiveness of parts marking and antitheft devices would have been easier if the make-models slated for parts marking in 1987 had been picked on a random basis. In that case, prior to 1987, the make-models slated for parts marking would have had the same average theft rate as other make-models. Any theft reduction in the marked make-make models during or after MY 1987, relative to the rates in the make-models that never got the remedy, could reasonably be attributed to the parts marking. Unfortunately for the analyst, the models were not selected on a random basis. Instead, the make-models that had the highest theft rates in **MY 1983-84** were slated to get parts marking in **MY 1987**.

It is a basic characteristic of any population that "what goes up must come at least part of the way down." For example, in a population of 1000 people, the 100 who are the heaviest today will almost certainly not be the 100 heaviest a year from today. For example, some of those 100 might have a condition that makes them heavy this year, but will soon return to their normal weight. These 100 will probably still be heavier next year, on the average, than the other 900, but they will not be the 100 heaviest individuals. With each passing year, that original group of 100 will have an average weight closer to the average for the other 900. This tendency is called "regression to the mean." Now, if these original 100 had been given some kind of diet treatment, even if that treatment had been worthless, they still would have exhibited a steady weight loss relative to the other 900, because of the "regression to the mean" phenomenon.

The same thing happens with theft rates. The make-models slated for parts marking in MY 1987 were the ones with the highest theft rates in 1983-84. They included some make-models with

chronically high theft rates, but other make-models that, for whatever reason, were highly desirable to thieves in 1983-84 but soon lost that special attraction. Times change, tastes change, even in car thefts. Even if parts marking had never been implemented, these make-models would undoubtedly have experienced a reduction in theft rates (relative to the trend in theft rates for other make-models) as early as 1985, and would have continued to experience reductions in 1986, 1987, 1988... However, just as it is difficult to predict how quickly tastes change, it is difficult to predict how quickly the theft rates for the 1983-84 high-theft models ought to regress to the mean, or even to predict that the regression will be steady from year to year.

Under these circumstances, it will be difficult to discern the specific effect of parts-marking from the general, uneven regression-to-the-mean trend, unless the former is large relative to the latter. If parts marking has reduced thefts by, say, 2 or 3 percent (which would make it highly cost-beneficial), that effect could hardly be distinguished from kinks and bends in the regression-to-the-mean trend. In short, with these fundamentally biased data, even if none of the analyses were to show an effect for parts marking, it could still not be concluded that the measure was ineffective, or that it was not cost-beneficial.

Preview of the Analyses

The choice of analyses is influenced by the manner in which parts marking and factory-installed antitheft devices were implemented in the passenger car fleet and by the types of theft, recovery and registration data that are available.

The principal introduction of parts marking took place in model year 1987. Based on theft rates in 1983-84, a group of make-models with high theft rates, accounting for about 40 percent of passenger car registrations, was slated for parts marking from 1987 onwards. A few high-theft make-models, fewer than 5 percent of car registrations, were exempted from parts marking and slated to receive factory-installed antitheft devices no later than 1987 (and in some cases they got the devices earlier than 1987). The remaining, low-theft make-models, over 55 percent of registrations, would get neither countermeasure.

In 1988 and subsequent years, a small number of additional make-models got parts marking or antitheft devices. Most of them were new make-models, introduced at that time, and never produced without the countermeasure. However, during 1989-92 several groups of domestic make-models, accounting for about 10 percent of car sales in the United States, received antitheft devices in place of, or in addition to parts marking. Finally, during 1993-95, generally too late to provide data for these statistical analyses, there were some additional introductions or shifts to parts marking or antitheft devices.

The principal data base was assembled by NHTSA's contractor from the theft and recovery records of the National Crime Information Center (NCIC) and vehicle registration files of R.L. Polk. It enumerates how many cars were registered, stolen and recovered, by make-model, model year and calendar year. The data base covers calendar years 1984-95, and it includes cars from 0 to 15 years old. The following analyses will be performed on the NCIC/Polk data base:

- (1) Long-term trends in theft rates, MY 1976-95, make-models that got parts marking or antitheft devices in 1987 vs. those that were never marked
- (2) Long-term trends in recovery rates and unrecovered theft rates
- (3) MY 1984-89 trends in theft rates, focusing on changes from MY 86 to 87, make-models that got parts marking in 1987 vs. those that were never marked
- (4) MY 1984-89 trends in recovery rates and unrecovered theft rates: parts marking in 1987 vs. never marked
- (5) MY 1986-94 trends in theft rates, domestic make-models that switched from parts marking to antitheft devices in 1989-92 vs. control-group make-models
- (6) MY 1986-94 trends in recovery rates and unrecovered theft rates, domestic make-models that switched from parts marking to antitheft devices in 1989-92 vs. control-group make-models

- (7) Trends in the theft rates of other make-models that got antitheft devices before 1995

Another file was boiled down from data assembled by the Highway Loss Data Institute (HLDI) from theft and recovery records supplied by the National Insurance Crime Bureau (NICB). It enumerates how many cars were stolen and recovered, by make-model, model year and calendar year, and it enumerates how many of the recoveries were "in part," "in whole," or "intact." Registration data are not included. The data base is complete only for calendar years 1986-91, and in most of those years it only includes cars from 0 to 2 years old. The following analysis will be performed on the HLDI-NICB data base:

- (8) MY 1984-89 trends of "in-part" recoveries vs. other types of recoveries, focusing on changes from MY 86 to 87, make-models that got parts marking or antitheft devices in 1987 vs. those that were never marked

Long-Term Theft and Recovery Rates (Model Years 1976-95)

Figure A-1 compares the theft rates, by model year, of two groups of passenger cars. The "0" data points are the theft rates for make-models that existed in 1984 and did **not** get parts marking or antitheft devices at any time. The "1" data points are the theft rates for make-models that existed in 1984 and were selected to get parts marking or antitheft devices **starting in 1987** (and possibly switched from one to the other in a subsequent year).

The "theft rate" is the logarithm of (thefts/registration years). Cars up to 10 years old are included in the rates (e.g., the 1984 data point comprises the theft rate of MY 1984 cars throughout CY 1984-94). The theft rates are derived from the NCIC-Polk file, which was available for calendar years 1984-95 (thus, for example, information on MY 1980 cars is only available from CY 1984 onwards, i.e., from age 4 onwards). However, for vehicles of the current year (MY = CY), the Polk registration count is multiplied by 1.495, as recommended by the contractor who developed the data base; the purpose of this "annualization factor" is to make the Polk data for current-year cars (which only includes cars registered during the first half of the year) compatible with the NCIC data, which include any car stolen during the year, regardless when it was registered.

FIGURE A-1

PASSENGER CAR THEFT RATES BY MODEL YEAR, 1976-95

make-models that existed from 1984 or earlier until 1989 or later; 0-10 year old cars

"1" = make-models that got parts marking or antitheft devices in 1987

"0" = make-models that did not get parts marking or antitheft devices at any time

log(thefts/registrations)

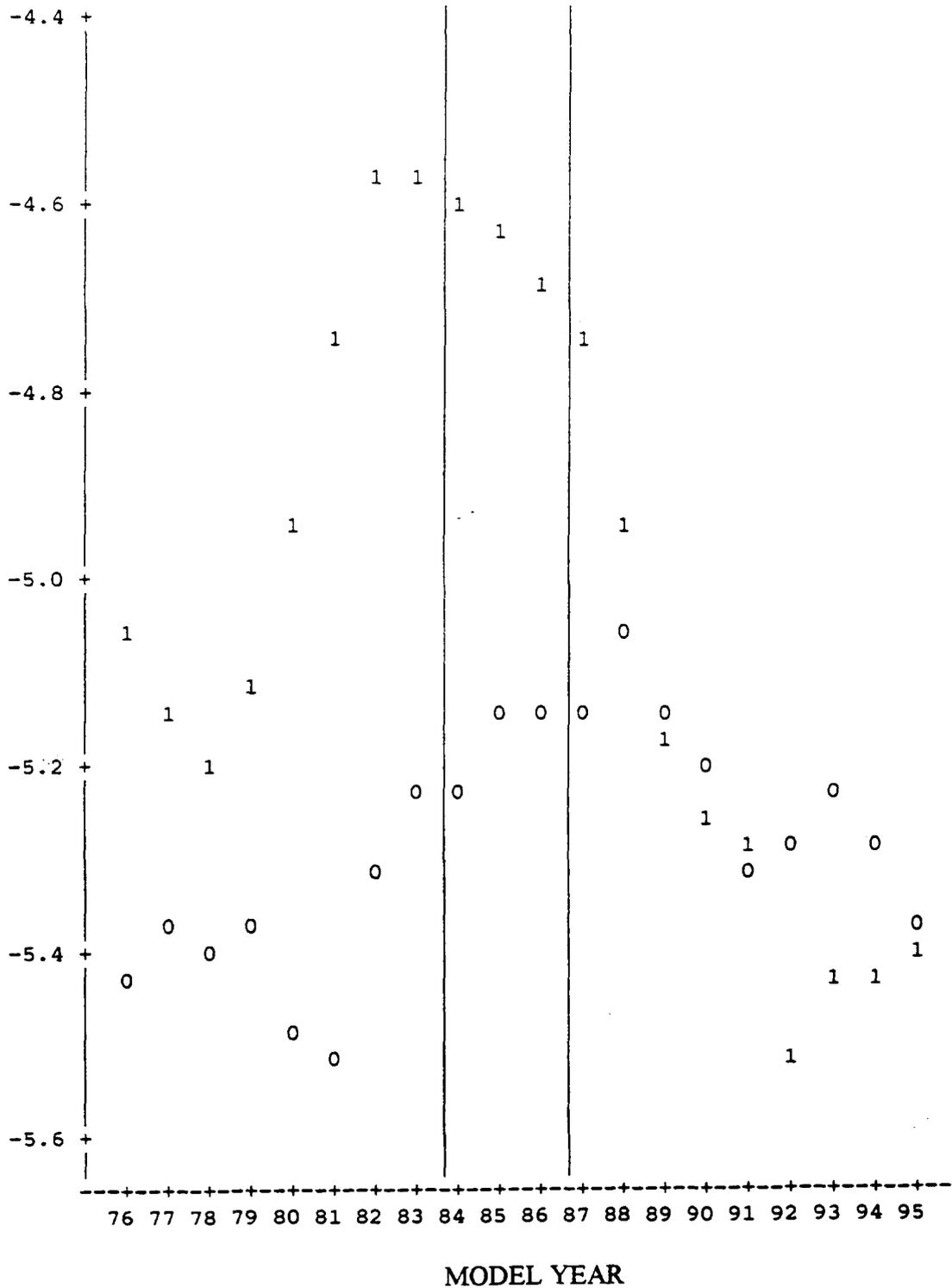


Figure A-1 includes only those make-models that were in production throughout MY 1984-89, plus any earlier or later model years that those make-models existed. Included, for example, are:

- Chevrolet Caprice, MY 1976-95, no parts marking or antitheft devices
- Ford Mustang, unmarked 1976-86, marked 1987-95
- Pontiac Firebird, unmarked 1976-86, marked 1987-89, antitheft 1989-95
- Dodge Aries, unmarked 1981-86, marked 1987-89 (produced only in 1981-89)
- Nissan Sentra, produced 1982-95 and never marked, etc.

Figure A-1 **excludes** make-models that first got parts marking/antitheft devices in 1986, 1988, 1989 or 1990 (most of those were models that did not exist prior to 1987). It also excludes make-models that were not produced in all the "core" years 1984-89. Excluded, for example, are:

- Oldsmobile Cutlass Supreme: first got parts marking in 1988
- Ford Taurus: first produced in 1986 (but not in 1984 or 1985)
- VW Scirocco: last produced in 1988 (but not in 1989)
- Dodge Caravan: not a passenger car

Two vertical lines are drawn on Figure A-1: one between 1983 and 1984, when the selection was made as to what models would get parts marking or antitheft devices, and one just before 1987, when the models actually got those remedies.

Figure A-1 shows some very strong patterns, but not necessarily anything to establish the effectiveness of parts marking. The theft rate for the make-models that got parts marking or antitheft devices (the 1's) reaches a majestic peak in MY 1983-84. That is hardly surprising: the countermeasures were specifically applied to the make-models that had the highest theft rates in 1983-84. Their theft rate immediately begins to drop off in 1985-86, even **before** parts marking, exhibiting "regression to the mean," and continues to drop sharply in 1987-89, after parts marking/antitheft devices. Their theft rates in 1979-83 are practically the mirror image of the pattern for 1985-89: the steep increase is unrelated to parts marking (which did not exist before 1987) but an exhibit of "digression from the mean," as it were. The theft rate for these make-models is relatively stable in 1976-79 and 1991-95.

By contrast, the theft rates for the make-models that never got parts marking (the 0's) are low during 1976-79, rise steadily during 1980-89 until they meet the 1's, and are slightly higher than the 1's during 1990-95.

Figure A-2 graphs the **difference** in the theft rates for the models that eventually got parts marking or antitheft devices and those that didn't (the 1's and the 0's in Figure A-1). It contains some principal findings of the long-term analysis. The difference reaches a peak around 1981 and begins to drop steadily in 1982, five years before the actual implementation of parts marking. It continues to drop until 1990, when it levels off slightly below zero (i.e., the cars with parts marking or antitheft devices have **lower** theft rates than the models that did not get either remedy). Similarly, the difference drops off as you work backwards from 1984, and it levels off at about 0.3 in 1976-79. Thus, the main effect in Figure A-2 is regression to and from the mean, and most of it (1980-86) occurred during years when no cars had parts marking.

Nevertheless, there is another pattern visible in Figure A-2. The average difference for the four years 1976-79 was +.27, but it was -.12 for 1991-95. **In the long term**, the models that got parts marking or antitheft devices ended up with lower theft rates (**relative** to the cars that never got either) than they had before the whole process started. Quantitatively, the relative reduction is

$$1 - \exp(-.12 - .27) = 32 \text{ percent}$$

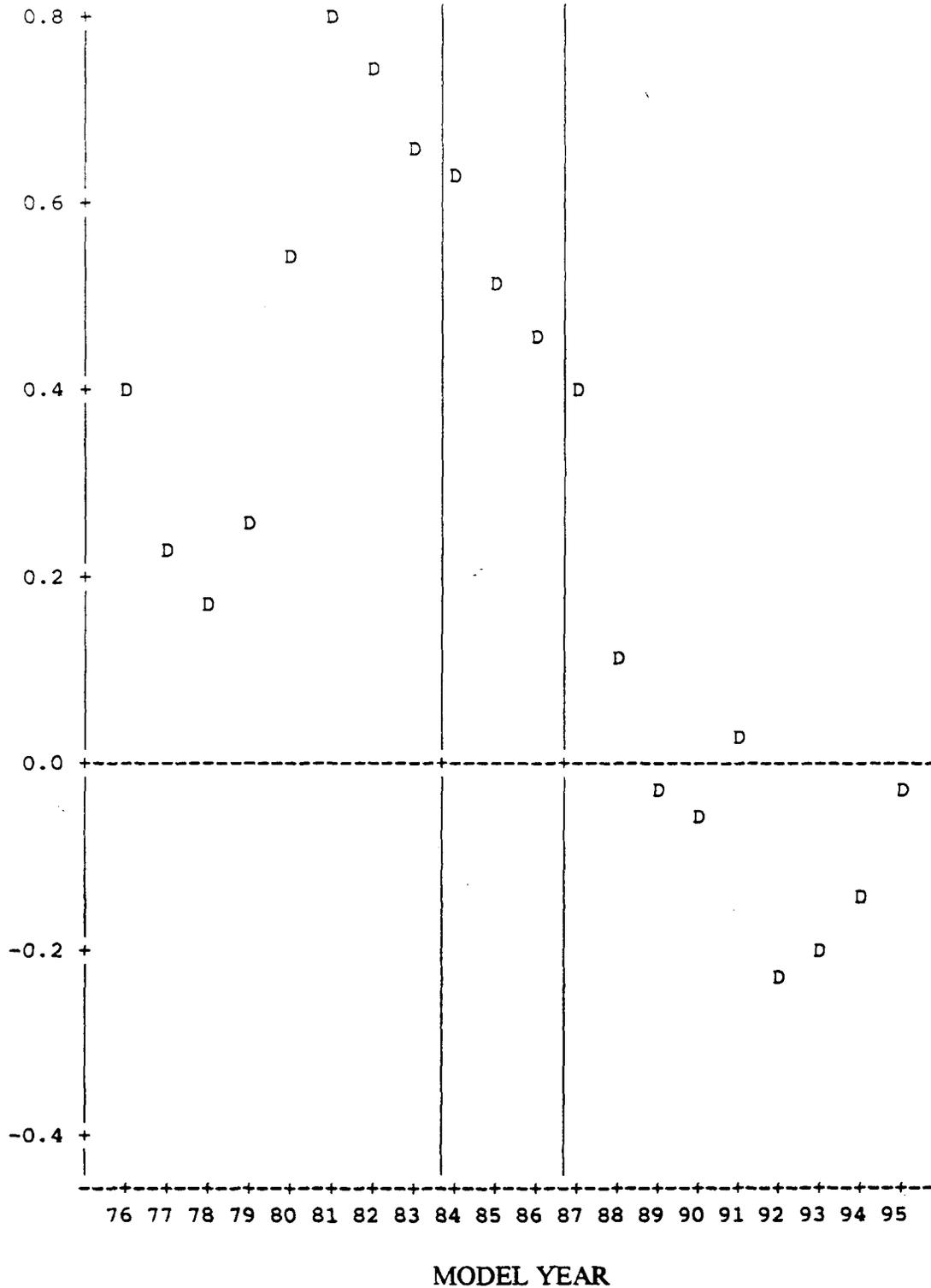
The result is "in the right direction" for the hypothesis that parts marking and antitheft devices deterred thefts, or at least shifted the thefts from the marked to the unmarked models. However, it would be foolhardy, without additional analysis, to attribute all or even part of this 32 percent long-term reduction to parts marking or antitheft devices. There are simply too many other factors that could be affecting theft rates. Although the make-models in the analysis had the same names throughout 1976-95, most of them changed a good deal during that period. There is no reason that a model with high appeal for thieves in the 1970's would necessarily have the same appeal in the 1990's.

Although the principal hypothesis was that parts marking or antitheft devices would reduce theft rates, another hypothesis was that recovery rates could **increase** if parts marking makes it possible to track down the stolen vehicle or if it **deters** the types of thefts that are least likely to

FIGURE A-2: THEFT RATE DIFFERENTIAL, MY 1976-95
 MAKE-MODELS THAT GOT PARTS MARKING OR ANTITHEFT DEVICES IN 1987
 VERSUS MAKE-MODELS THAT NEVER HAD THEM AT ANY TIME

make-models that existed from 1984 or earlier until 1989 or later; 0-10 year old cars

log of the theft rate for models that got parts marking or antitheft devices minus
 log of the theft rate for models that didn't



be recovered while having little effect on other thefts (e.g., joyriding). This hypothesis would not necessarily be valid for antitheft devices; in fact, they may be especially useful in deterring the non-professional thefts that are easiest to recover.

Figure A-3 shows the recovery rates [$\log(\text{recoveries}/\text{thefts})$] during MY 1976-95 for make-models that had parts marking or antitheft devices from MY 1987 onwards (1's) vs. make-models that never had either (0's). The selection of make-models is the same as in Figures A-1 and A-2. Here, however, low rates are "bad" and high rates are "good." Figure A-3 does not exhibit the "regression to the mean" pattern of Figure A-1. Since make-models were selected for parts-marking based on their theft rates in 1983-84, not their recovery rates, there is no *a priori* reason that the one group should have higher recovery rates than the other. Indeed, throughout MY 1976-84, both groups have quite similar recovery rates, both rising gradually during those years. However, during MY 1985-95, the recovery rate for the cars without marked parts stays almost unchanged, while the rate for cars that got parts marking or antitheft devices decreases rather sharply.

Figure A-4, which graphs the difference in the recovery rates for the models that got marked parts or antitheft devices and the models that didn't, confirms the negative trend, especially from MY 88 onwards, while the difference was close to zero up through MY 87. Given the hypothesis that recovery rates could increase with parts marking, this long-term result does not appear favorable for parts marking. Nevertheless, there is little basis for attributing the unfavorable effect to parts marking. No substantial change is visible from MY 86 to 87, when the cars first got marked parts. The subsequent trends may be associated, to some extent, with antitheft devices that are especially effective in reducing the most easily recovered thefts, or they may be due to other factors unrelated to parts marking or antitheft devices.

A better impression of the long-term trend in professional thefts can be gained by studying the "unrecovered theft rate," - i.e., the logarithm of $[(\text{thefts}-\text{recoveries})/\text{registration years}]$. It is a sort of composite of the theft rate and the recovery rate. Figure A-5 shows that the rate was practically constant during model years 1976-95 for the make-models that did not get marked parts or antitheft devices (the 0's). The make-models that got either of those devices in 1987 had a strong peak in 1981-85, with a sharp drop on either side of the peak (regression to the mean). Before and after this

peak, in 1976-79 and 1991-95, the 1's are moderately higher than the 0's. Figure A-6 graphs the difference in the unrecovered theft rates. Basically, the relative risk ends up where it started. The average difference for 1976-79 was +.304, and for 1991-95 it was +.307. In the long term, the unrecovered theft rates of the models that got parts marking or antitheft devices did not change relative to the cars that never got either.

Parts Marking and Theft Rates Just Before and After Model Year 1987

Figure A-2 showed that the difference in the theft rates for cars that got parts marking or antitheft devices and the rates for never-marked cars shrank rather steadily from its peak value in MY 1981 to zero in MY 1989, largely due to "regression to the mean" but also, perhaps, as a consequence of the remedies. The next analyses concentrate on those crucial model years, 1984-89, to see if the shrinkage was really steady. Specifically, was there a larger-than-usual effect from MY 1986 to MY 1987, when parts marking was actually introduced in the cars, than in the other years?

Figure A-7, as it were, cuts out and enlarges the MY 1984-89 section of Figure A-1. The 1's are the theft rates [$\log(\text{thefts}/\text{registration years})$] of make-models that got parts marking in 1987 and the 0's are the theft rates of models that never got parts marking or antitheft devices. The vertical line down the middle of Figure A-7 separates MY 1984-86, when neither group of make-models had parts marking, from MY 1987-89, when the 1's had parts marking and the 0's did not. To limit biases in the analysis as much as possible, the following restrictions were imposed on the data used to generate Figure A-7, although not necessarily Figure A-1:

- Just as in Figure A-1, each of the make-models included in the analysis had to be produced throughout 1984-89. However, since Figure A-7 only looks at theft rates in MY 1984-89, the effect of this restriction is that **exactly** the same make-models are used to calculate each of the 1's in Figure A-7, (and the same is true of the 0's).
- As in Figure A-1, the relatively few make-models that first got parts marking in 1988 or 1989, rather than 1987, are excluded from the analysis. Most of these were new make-models that did not exist during 1984-87.

FIGURE A-3

PASSENGER CAR RECOVERY RATES BY MODEL YEAR, 1976-95

make-models that existed from 1984 or earlier until 1989 or later; 0-10 year old cars

"1" = make-models that got parts marking or antitheft devices in 1987

"0" = make-models that did not get parts marking or antitheft devices at any time

log(recoveries/thefts)

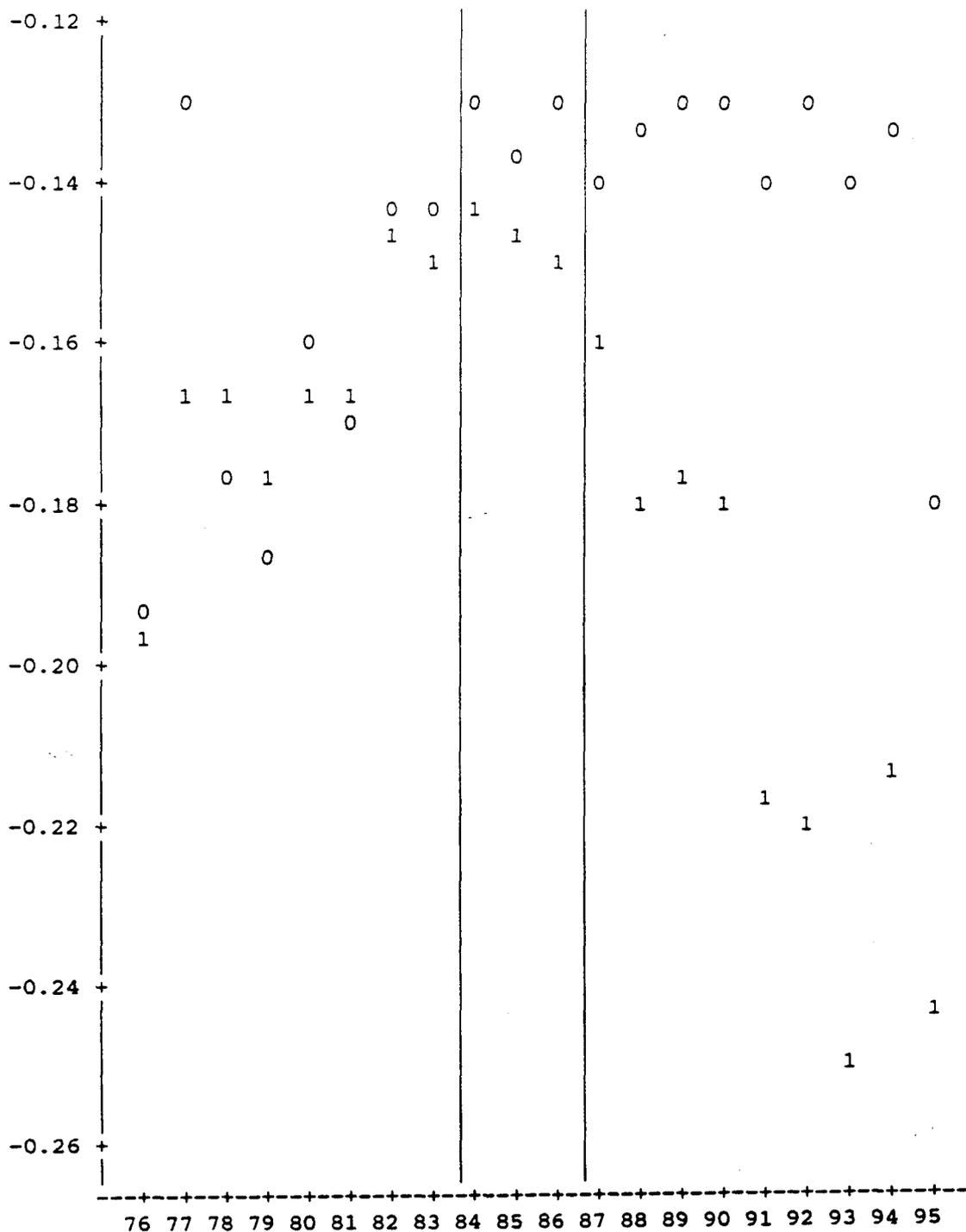


FIGURE A-4. RECOVERY RATE DIFFERENTIAL, MY 1976-95
 MAKE-MODELS THAT GOT PARTS MARKING OR ANTITHEFT DEVICES IN 1987
 VERSUS MAKE-MODELS THAT NEVER HAD THEM AT ANY TIME

make-models that existed from 1984 or earlier until 1989 or later; 0-10 year old cars

log of the recovery rate for models that got
 parts marking or antitheft devices minus
 log of the recovery rate for models that didn't

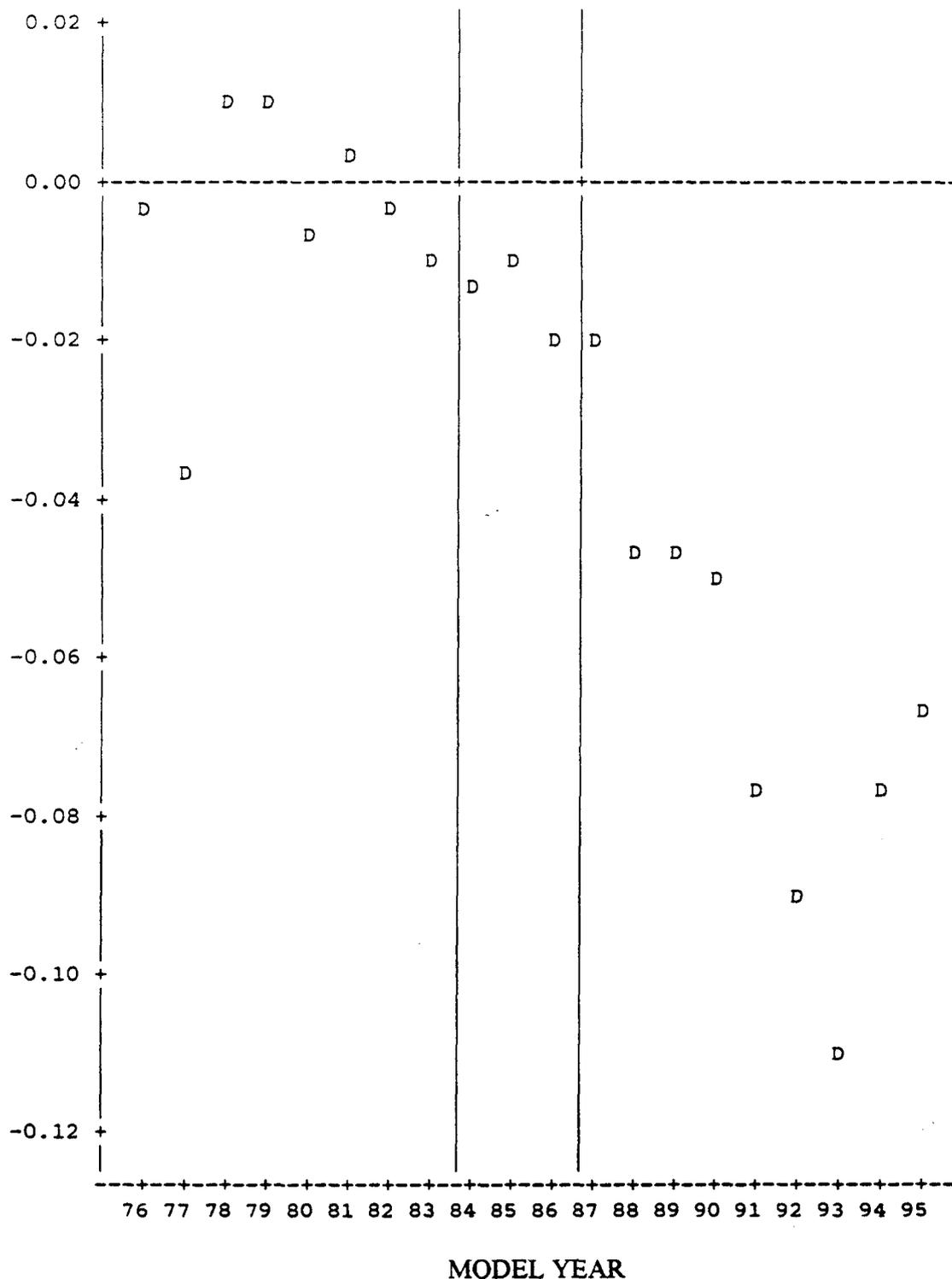


FIGURE A-5

UNRECOVERED THEFT RATES BY MODEL YEAR, 1976-95

make-models that existed from 1984 or earlier until 1989 or later; 0-10 year old passenger cars

"1" = make-models that got parts marking or antitheft devices in 1987

"0" = make-models that did not get parts marking or antitheft devices at any time

$\log([\text{thefts-recoveries}]/\text{registrations})$

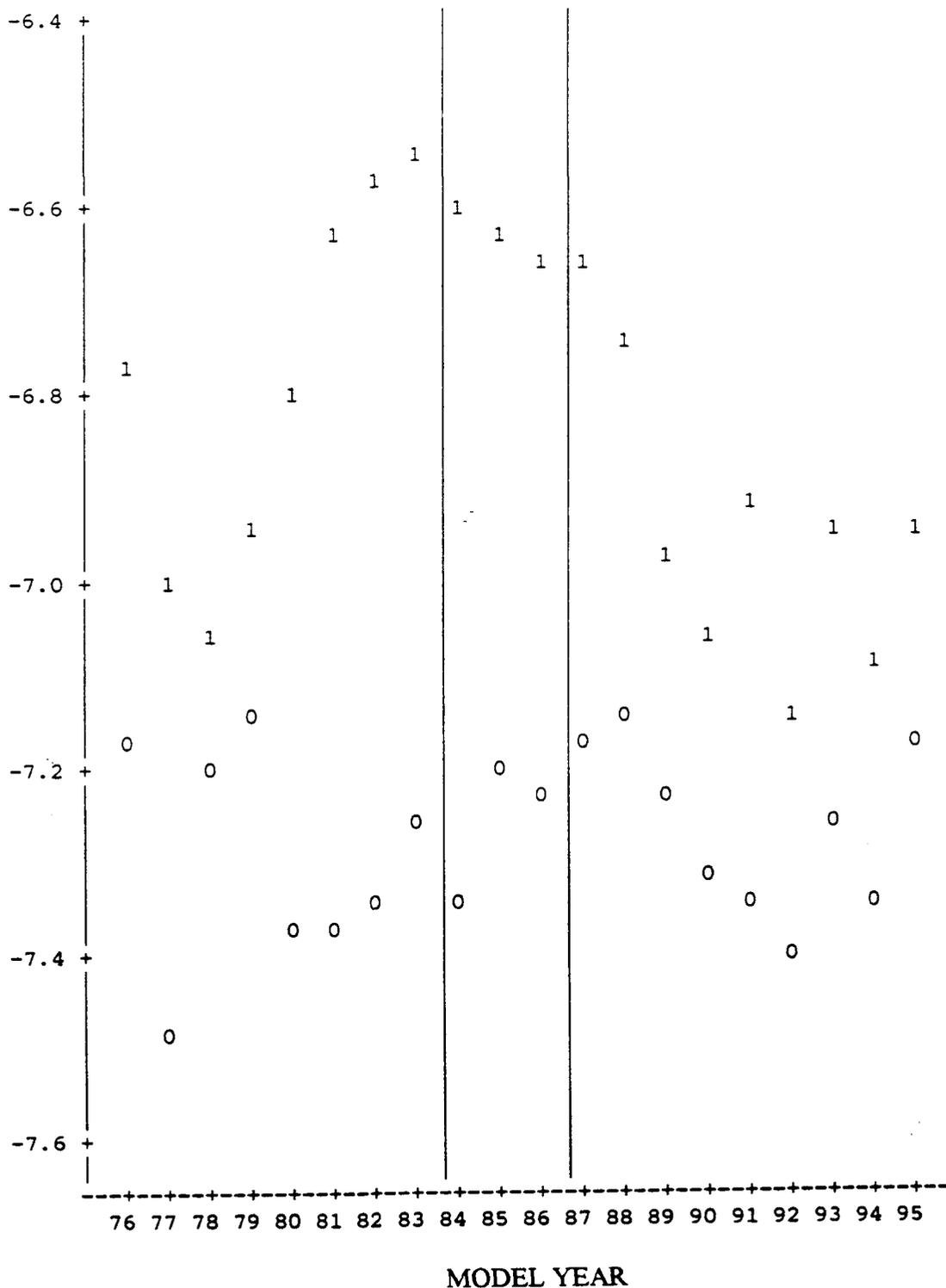
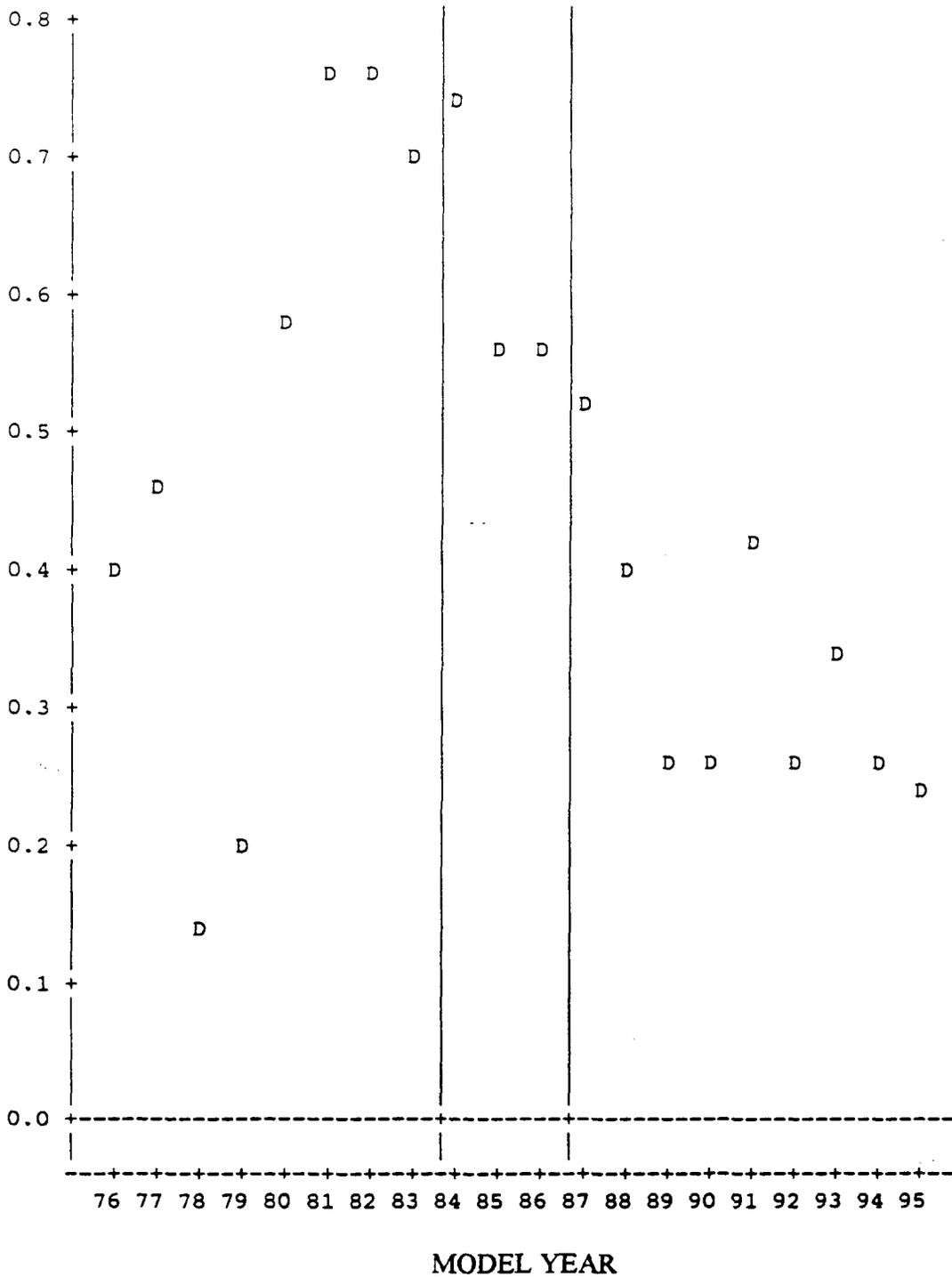


FIGURE A-6 UNRECOVERED THEFT RATE DIFFERENTIAL, MY 1976-95
 MAKE-MODELS THAT GOT PARTS MARKING OR ANTITHEFT DEVICES IN 1987
 VERSUS MAKE-MODELS THAT NEVER HAD THEM AT ANY TIME

make-models that existed from 1984 or earlier until 1989 or later; 0-10 year old cars

log of the unrecovered theft rate for models that got
 parts marking or antitheft devices minus
 log of the unrecovered theft rate for models that didn't



- Make-models that got antitheft devices at any time during 1984-89 are not included in the 1's of Figure A-7 (although many were included in Figure A-1). Figure A-7 is **purely** an analysis of parts marking.
- Since relatively new cars account for a disproportionate share of the consumer losses associated with auto theft, Figure A-7 is limited to cars **0-3 years old**. CY 1984-92 NCIC/Polk files, together, provide data for this age range for every MY from 1984 to 1989. (Figure A-1 had to include cars up to 10 years old, or there would have no theft rates for pre-1981 cars, given that the NCIC data only were available from CY 1984. Even so, no data are available for the pre-1984 cars when they were brand new, etc.)
- Since theft rates for imported cars are more variable than those of domestic cars (more discussion below), and to avoid biases due to market shifts from domestic to imported cars, or vice-versa, Figure A-7 is limited to **domestic** cars (including "captive imports").

The make-models included in Figure A-7 that did **not** get parts marking or antitheft devices during 1984-89 are the following:

Buick Century	Buick Skyhawk	Chevrolet Caprice/Impala
Chevrolet Cavalier	Chevrolet Celebrity	Chrysler New Yorker
Dodge Colt	Dodge Colt Vista	Dodge Omni
Ford Crown Victoria	Ford Escort	Ford EXP
Ford Tempo	Mercury Grand Marquis	Mercury Topaz
Oldsmobile Ciera	Plymouth Colt	Plymouth Colt Vista
Plymouth Horizon	Pontiac 6000	Pontiac J2000/Sunbird

The make-models included in Figure A-7 that got parts marking in 1987 and did not get antitheft devices in 1984-89 are the following:

Buick Electra	Buick LeSabre	Buick Riviera
Cadillac DeVille	Chevrolet Monte Carlo	Chrysler Lebaron
Dodge Aries	Dodge Daytona	Dodge Diplomat
Ford Mustang	Ford Thunderbird	Lincoln Continental
Lincoln Mark 7	Lincoln Town Car	Mercury Cougar
Oldsmobile Delta 88	Oldsmobile 98	Oldsmobile Toronado
Plymouth Gran Fury	Plymouth Reliant	Pontiac Bonneville

Figure A-7 shows that the theft rate for make-models that got parts marking (the 1's) remained fairly constant during MY 1984-89. The theft rate for make-models that did not get parts marking or antitheft devices (the 0's) climbed steadily during MY 1984-88 and leveled off in 1989.

Figure A-8 tracks the difference between the 1's and the 0's in Figure A-7. It is a "close-up" of the 1984-89 trend in the log-theft-rate difference between the models that got parts marking and those that didn't. That difference shrinks from 0.66 in 1984 to 0.2 in 1988-89. In MY 1984, theft rates of the make-models that were selected to get parts marking was nearly twice as high as the rate for make-models that wouldn't get it; by MY 1989, the theft rate of the models that had gotten parts marking was only 20 percent higher than those that hadn't gotten it. Of course, the principal reason for the dramatic shrinkage in the observed difference is the regression-to-the-mean effect, very strong during 1984-89, as a consequence of the completely nonrandom basis for selecting the make-models that would get parts marking.

FIGURE A-7

PASSENGER CAR THEFT RATES BY MODEL YEAR, 1984-89

domestic make-models that existed from 1984 or earlier until 1989 or later; 0-3 year old cars

"1" = make-models that got parts marking in 1987 (no antitheft devices)

"0" = make-models that did not get parts marking or antitheft devices during 1984-89

log(thefts/registrations)

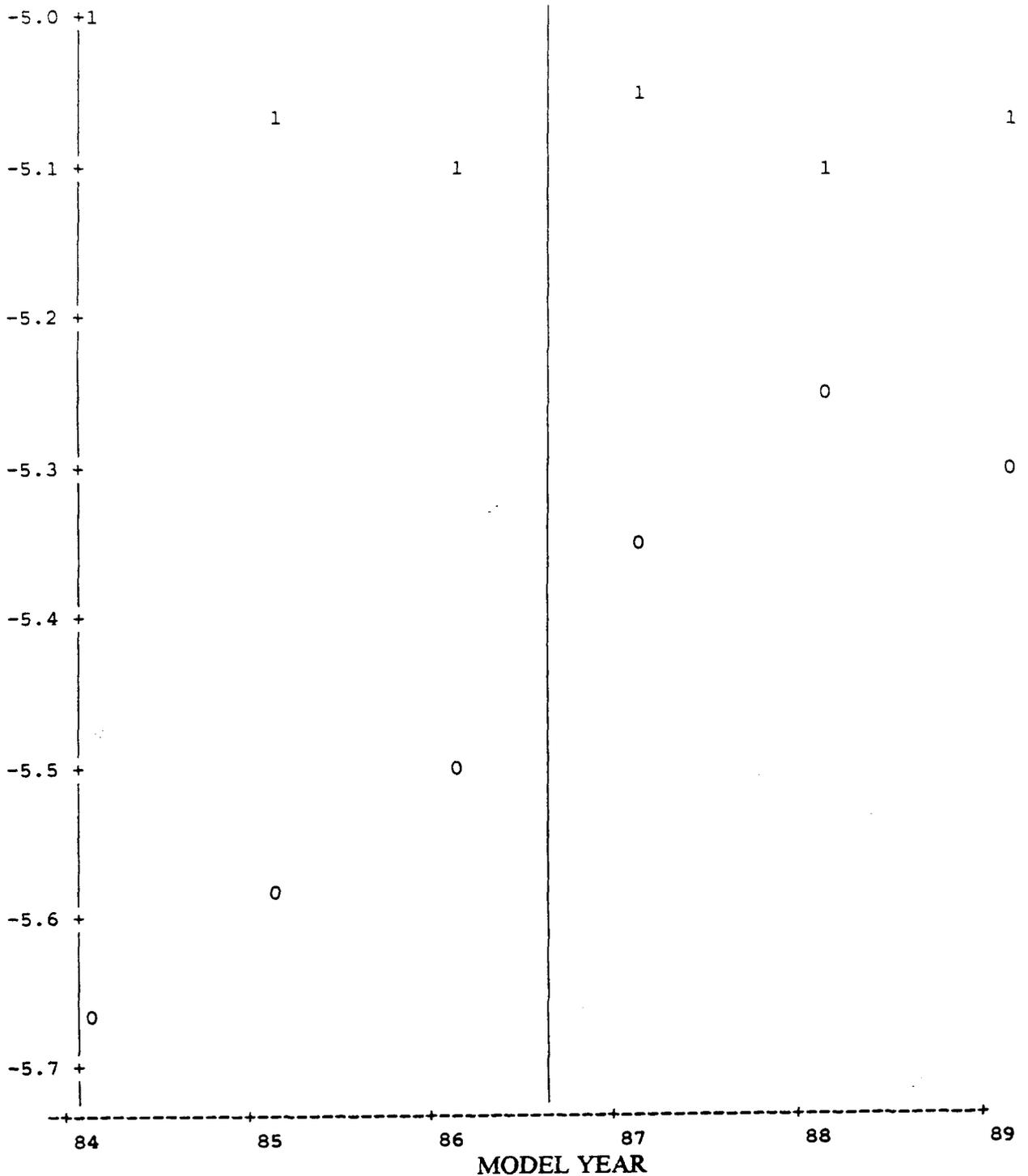
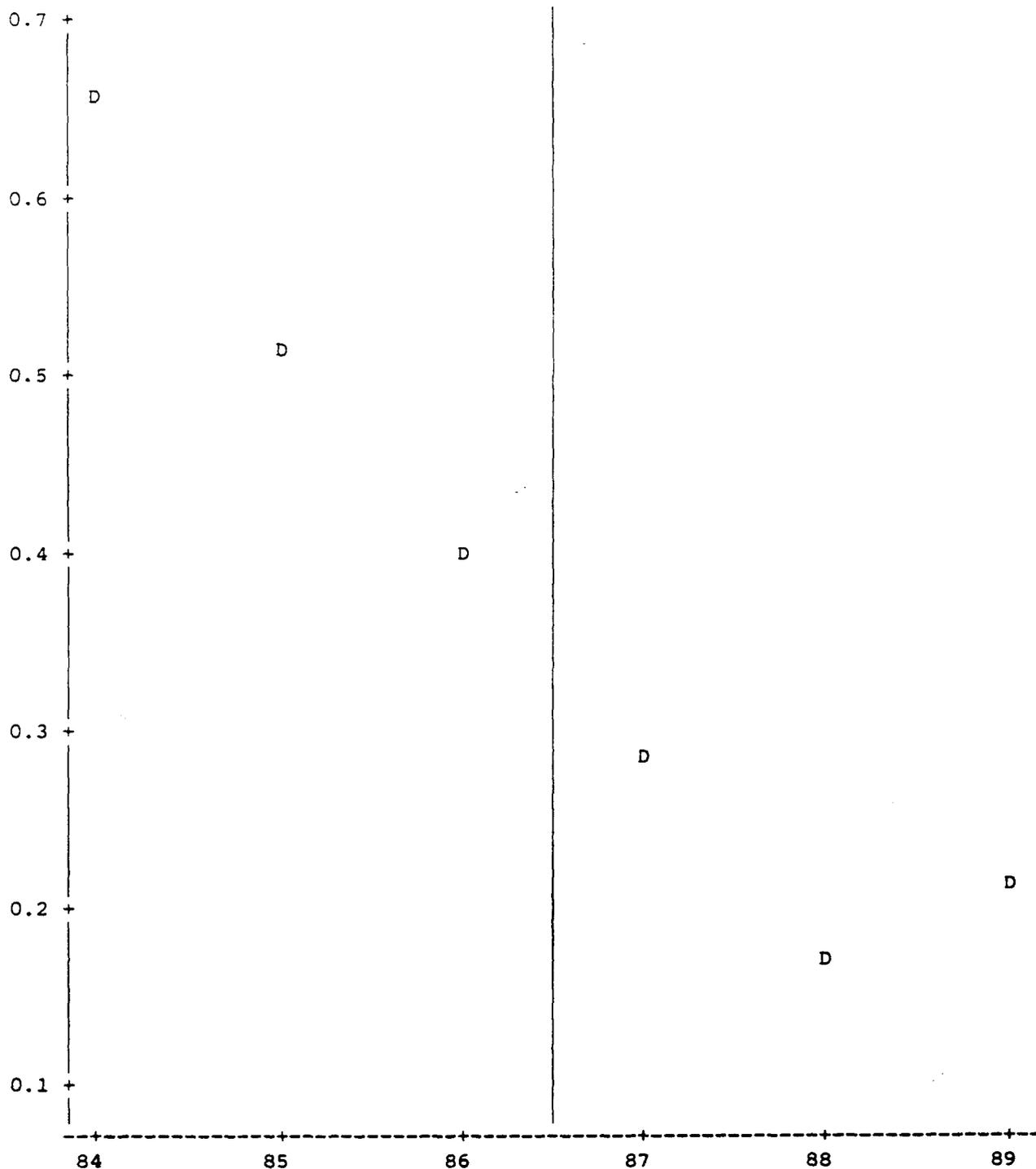


FIGURE A-8

THEFT RATE DIFFERENTIAL, MY 1984-89
MAKE-MODELS THAT GOT PARTS MARKING IN 1987 VERSUS
MAKE-MODELS WITHOUT PARTS MARKING OR ANTITHEFT DEVICES IN 1984-89
domestic make-models that existed from 1984 or earlier until 1989 or later; 0-3 year old cars

log of the theft rate for models that got parts marking
minus log of the theft rate for models that didn't



MODEL YEAR

The question is whether any additional effect due specifically to parts marking can be measured within that overall trend. The measurement procedure entails two assumptions:

- (A) The regression-to-the-mean effect ought to be linear - i.e., the D's in Figure A-8 ought to drop by equal amounts from year to year.
- (B) The effect of parts marking ought to be concentrated on the MY 1986-87 change, because parts marking was introduced in MY 1987 (if it was introduced at all), in the make-models included in this analysis.

In other words, the drop in the D's from 1986 to 1987 is measured and compared to the average drop in the other years, when the parts marking status of the various make models did not change: 1984-85, 1985-86, 1987-88, 1988-89.

An inspection of Figure A-8 reveals that the 1986-87 drop is **not conspicuously larger** than the reductions in the other years. On the contrary, the 1987 data point is nearly collinear with the 1984-86 and 1988 data points. Nevertheless, the slight 1988-89 increase will pull down the average drop for the other years. The arithmetic for the shrinkage in theft rate differentials works out as follows:

	Shrinkage
1984-85	.147
1985-86	.123
1986-87	.102
1987-88	.126
1988-89	- .055
Average excluding 1986-87	.085
Excess of 1986-87 over average drop	.017

In other words, given the preceding assumptions, the data suggest that the shrinkage in the theft rate differential from MY 1986 to 1987 was 1.7 percent beyond the "average" annual regression to the mean. That looks like a nice, plausible result: a 1.7 percent reduction in thefts with parts marking, approximately equal to the amount needed for the measure to be cost-beneficial.

Unfortunately, this estimate cannot be accepted for three crucial reasons. (1) It relies on two assumptions that are quite probably untrue, and possibly not even close to the truth. (2) The estimate is not robust. (3) The shrinkage in the theft rate differential need not represent a "pure" reduction of thefts of marked cars, but might just be a shift of thefts from marked cars to unmarked cars. These issues will now be examined in turn.

The assumption that the regression to the mean "ought to" take place at a constant rate, equal from year to year, might make sense if the data included a large number of make-models (e.g., hundreds), each having relatively small sales. Instead, there are only 42 distinct domestic make-models in the analysis, differing widely in sales. A significant redesign or sales shift for a few of the really high-sales models in a particular year could change theft rates substantially more (or less) than usual that year. An unsteady "regression to the mean" trend can intuitively be expected.

The assumption that the effect of parts marking ought to be concentrated in the 1986-87 change is also questionable. Unlike a static crashworthiness device, such as a high-penetration-resistant windshield, which accomplished its effect as soon as it was installed (in MY 1966 cars and all subsequent years) and obviously had no effect when it was not installed (MY 1965 and earlier), a measure such as parts marking mostly works indirectly by creating a deterrent effect in the minds of thieves, and this effect could be diffused over several model years, as was discussed above. The analyst's frustration with the data in Figure A-8 is that any "diffuse" effect of parts marking is undoubtedly lost within the "regression to the mean" effect, and even the "concentrated" 1986-87 effect of parts marking could be obscured by any "lumpiness" in the "regression to the mean effect."

One of the best defenses of the validity of an analytic model is that the results are robust - e.g., that similar trends and effects are seen in various subgroups of the data as in the entire data set. Unfortunately, the procedure described above is as robust as gelled desserts and quaking aspens.

Prima facie, if the 1988-89 change had not been included in the preceding calculations, the 1986-87 shrinkage would have been less than any of the others, and the effect attributed to parts marking would have been negative.

Additionally, the procedure was run separately on five manufacturer groups of cars: GM, Ford, Chrysler, Japanese, European. The results differed greatly (far more than would be expected by chance, given the sample sizes), both in the average year-to-year regression to the mean and in the specific 1986-87 change. The only consistent pattern was that GM, Ford and Chrysler had fairly similar, close to 0.1, average year-to-year regression to the mean (which is another reason why the analysis in Figures A-7 and A-8 was limited to domestic cars). The incremental 1986-87 effect did not converge on .017 at all, but ranged from quite positive to quite negative.

Another important finding was that, even among the domestic cars, the effect "attributed" to parts marking varied according to the age of the car. If the data used in Figures A-7 and A-8 are subdivided into cohorts of new cars, 1-year-old cars, etc. (and additional data are obtained for cars up to 6 years old), the analysis procedure yields the following results:

Vehicle Age	Gross 1986-87 Shrinkage	Avg. Regression to the Mean (Excl. 1986-87)	Net 1986-87 Shrinkage
0	.249	.054	.195
1	.167	.095	.072
2	.009	.100	-.091
3	-.010	.090	-.100
4	-.049	.084	-.133
5	-.042	.075	-.117
6	-.065	.065	-.130

The results are nearly identical for cars age 2-6 and quite different for brand-new cars and, to a lesser extent, 1-year-old cars. Moreover, even within each manufacturer group, nearly the same vehicle-age trend was seen (even though the net 1986-87 shrinkage had different starting points for different manufacturers, it kept getting worse up to age 2 and then leveled off). Thus, there is a robust pattern in a mass of results that are, on the whole, not robust.

The data suggest that parts marking had a quite strong effect in model year 1987 cars when they were less than a year old, a much less strong effect when they were one year old, and negative effects after that. The observed effect for the brand new cars is so strong that it can hardly be due to chance, or even an artifact of the "lumpiness" in the year-to-year regression-to-the-mean. In each model year, about 15,000 brand-new cars were stolen among the models that got parts marking, and another 15,000 among those that didn't. Thus, the "gross 1986-87 shrinkage" is a statistic derived from a ratio of ratios of rates, involving four rates, each based on about 15,000 thefts. The coefficient of variation of each of the four rates is less than 1 percent, and for the ratio of ratios, less than 2 percent. In other words, the confidence bounds on the net effect in brand new cars is about ± 4 percent; the observed effect of 20 percent is highly significant, deserving a detailed examination.

Figure A-9 is identical to Figure A-8, except that it is limited to cars of **vehicle age 0**, i.e., the CY of the theft is the same as the MY of the car (whereas Figure A-8 included 0-3 year old cars). The naked eye can clearly detect that the drop in the theft differential from MY 1986 to 1987 is about 0.25, while all the other year-to-year changes (except 1984-85) are negligible. At first glance, the MY 1986-87 effect of parts marking is far stronger than the "regression to the mean" trend.

More insight is gained by looking separately at the theft rates in the models that got parts marking and those that didn't. Figure A-10 is identical to Figure A-7, except that it is limited to cars of age 0. The four theft rates that explain the 1986-87 effect are the two 1's and the two 0's on either side of the vertical line. The MY 1987 cars with marked parts clearly had a lower theft rate than might be expected from the trend in the 1's. However, these same make models in their last year before parts marking (1986) had a slightly higher-than-expected theft rate. Conversely, the modes that never got marked parts had just slightly more thefts than expected in 1987 and slightly fewer than expected in 1986. With all four of these numbers going in the "right" direction, the 1986-87 change in the relative difference is substantial.

FIGURE A-9

THEFT RATE DIFFERENTIAL, MY 1984-89, **BRAND-NEW CARS**
MAKE-MODELS THAT GOT PARTS MARKING IN 1987 VERSUS
MAKE-MODELS WITHOUT PARTS MARKING OR ANTITHEFT DEVICES IN 1984-89

domestic make-models that existed from 1984 or earlier until 1989 or later; **MY=CY**

log of the theft rate for models that got parts marking
minus log of the theft rate for models that didn't

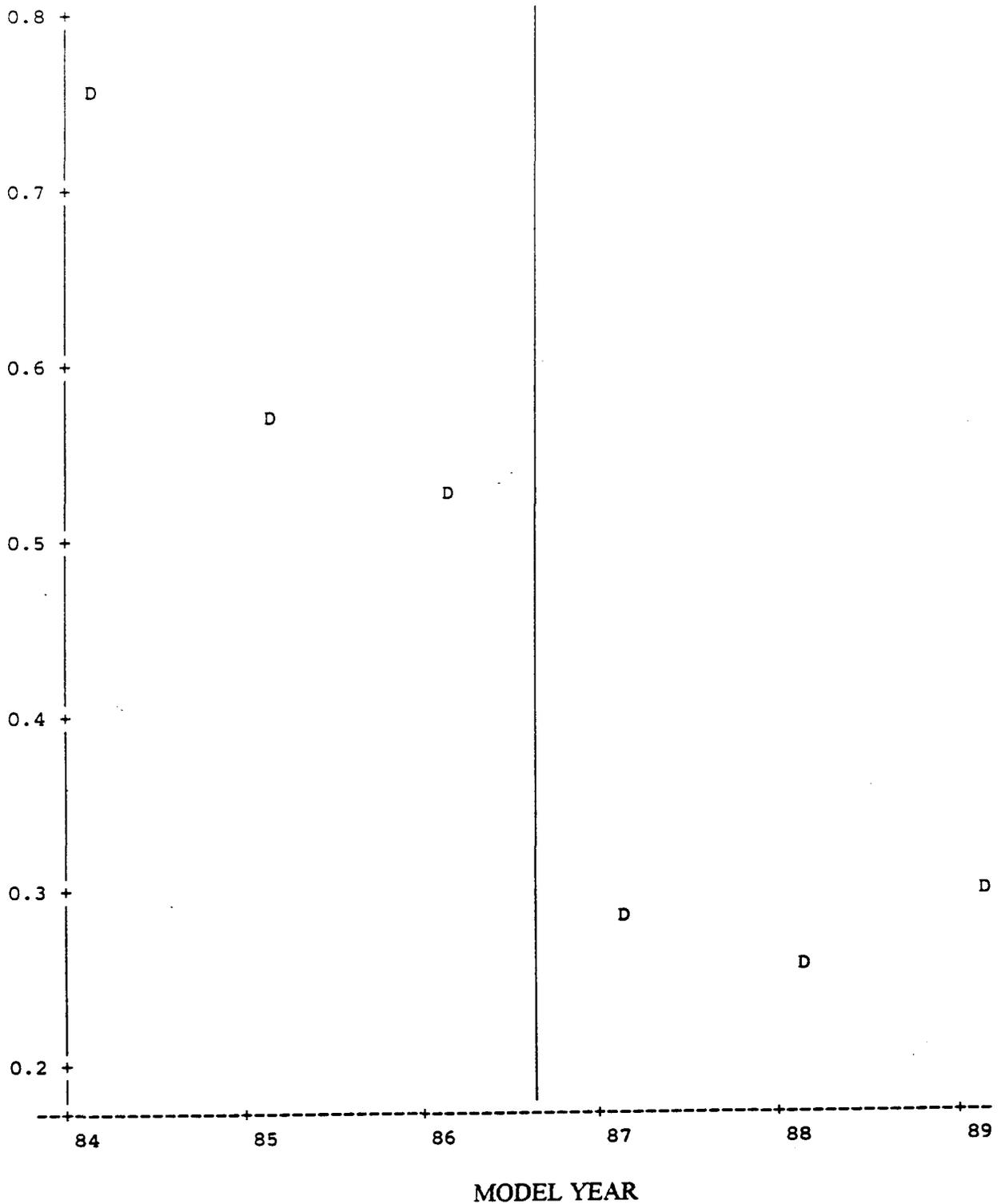


FIGURE A-10

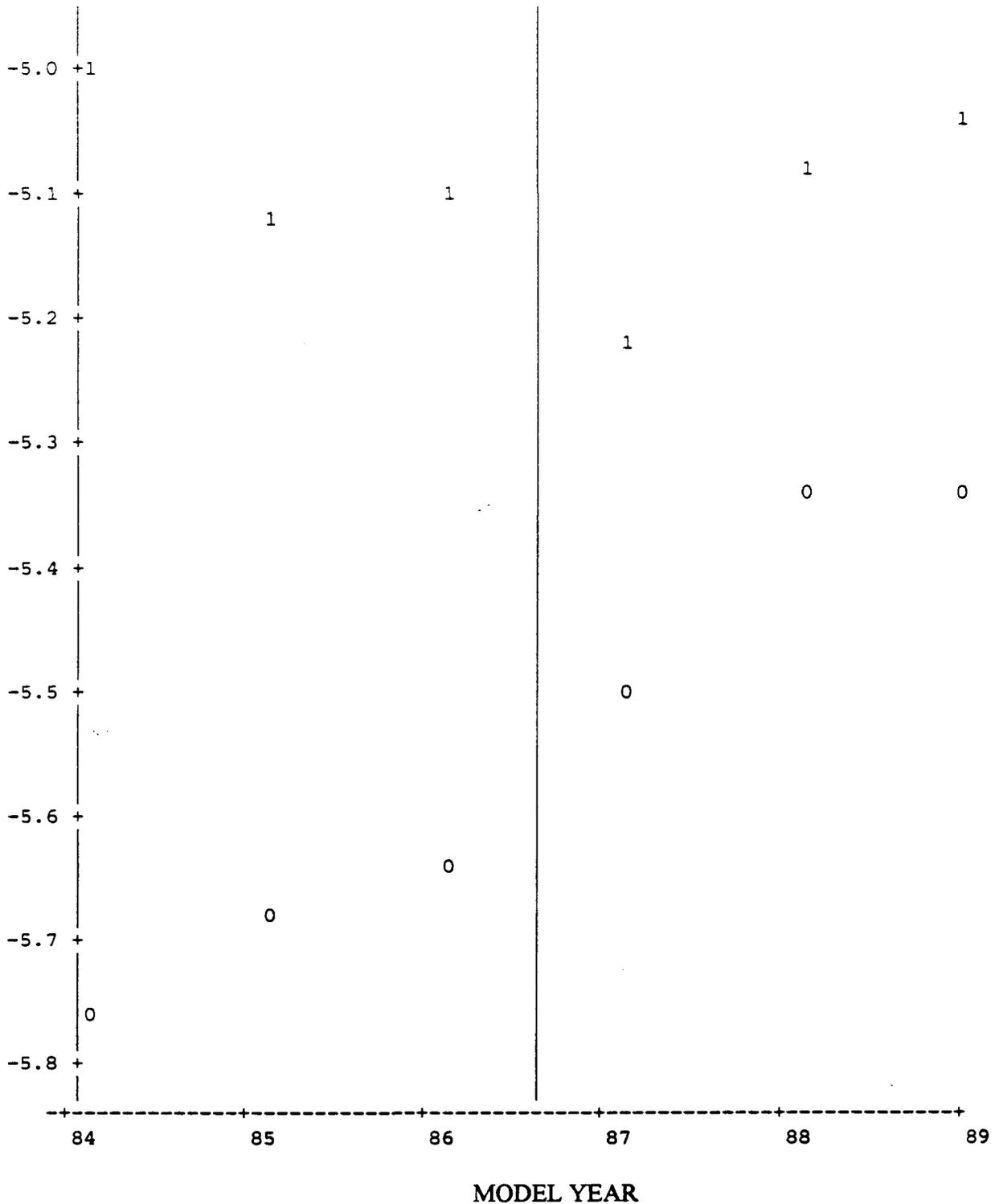
BRAND-NEW PASSENGER CAR THEFT RATES BY MODEL YEAR, 1984-89

domestic make-models that existed from 1984 or earlier until 1989 or later; **MY=CY**

"1" = make-models that got parts marking in 1987

"0" = make-models that did not get parts marking or antitheft devices during 1984-89

log(thefts/registrations)



In other words, in 1987, thieves stole fewer of the models with parts marking and shifted their attention to the models with unmarked parts. By contrast, in 1986, they stole some extra cars of the makes and models that were slated to get parts marking in 1987, but did not yet have it in 1986. They were, so to speak, "stockpiling" parts from these car lines during the last year when it was "safe" to steal them. (Of course, all of this is just statistical evidence. From the rates themselves, it is impossible to determine whether thieves **consciously and deliberately** "stockpiled" 1986 parts or shifted their 1987 theft choices. It can only be concluded that the actual theft patterns shifted in those directions.)

If the effect was so strong for brand-new cars, why did it drop off so quickly as the cars became older. Several possible explanations can be suggested: (1) The unique opportunity to "stockpile" parts at a time when **no** car on the road yet had parts marking was available only in calendar year 1986. In subsequent years, even though the MY 1986 cars were still unmarked, it became harder to tell them apart from later, marked cars of the same make-models. (2) As cars get older, they become of considerably less interest to professional thieves; more of them are stolen by nonprofessional thieves, unlikely to be deterred by parts marking. (3) As time passed, the deterrent effect of parts marking became more diffuse and less concentrated on MY 1987 vs. 1986 cars; the statistical procedure used above would be less likely to detect an effect. (4) If professional thieves learned how to defeat parts marking, or at least became less worried about getting caught as a result of parts marking, they were not as reluctant to steal cars with marked parts. Only explanation (4) suggests that parts marking became less effective; the other explanations merely suggest that effects of parts marking subsequently escaped detection by the statistical procedure used here.

It has been mentioned several times that the shrinkage in the theft rate differential need not represent a "pure" reduction of thefts of marked cars, but might just be a shift of thefts from marked cars to unmarked cars. Figure A-11 presents the combined, overall theft rate for the 42 domestic make models listed above, by model year, when the cars were brand new. It shows thefts of MY 1984 cars in CY 1984, MY 1985 in CY 1985, etc. This composite theft rate rose every year from 1985 to

1989, by an average of about 6 percent a year - commensurate with the annual increases in thefts of cars of all ages in the United States during the mid-1980's (see the main report). The increase from MY 1986 to 1987, 4 percent, is about par for the course. Clearly, the 20 percent shrinkage in the theft rate differential between marked and unmarked cars was caused by a shift of thefts from marked to unmarked models, rather than an absolute reduction in thefts. However, that is not necessarily an unfavorable sign; if **all** cars on the road had been marked, thieves would have been unable to shift from marked to unmarked cars, and it is conceivable that thefts would have declined in absolute terms.

Parts Marking, Recovery Rates and Unrecovered-Theft Rates Before/After MY 1987

The same data base that was used to analyze possible interactions between parts marking and theft rates can also be used to study recovery rates. The two major differences are (1) the "good" outcome is an increase in recovery rates (whereas for theft rates, a drop was desirable); (2) there is no overwhelming "regression to the mean" after 1984, since the models that got parts marking were selected because of their high theft rates, not low recovery rates (compare Figures A-1 and A-3).

Figure A-12 displays the recovery rates of 0-3 year old domestic cars during MY 1984-89. As above, it is based on make-models that were produced throughout 1984-89. The 1's are the recovery rates [$\log(\text{recoveries}/\text{thefts})$] of make-models that got parts marking in 1987 and the 0's are the recovery rates of models that never got parts marking or antitheft devices. The vertical line down the middle of Figure A-12 separates MY 1984-86, when neither group of make-models had parts marking, from MY 1987-89, when the 1's had parts marking and the 0's did not.

Figure A-12 shows slightly higher recovery rates throughout 1984-89 for the unmarked models than for the make-models that got parts marking. Both groups' recovery rates had a slight downward drift during those years. Obviously there is no dramatic change in the relation of the 1's to the 0's in 1987; nevertheless the gap between 0 and 1 is slightly smaller

in 1987 than in the preceding or the following year (an indication of a result in the “right” direction).

Figure A-13 tracks the difference between the 1's and the 0's in Figure A-12. Since the 1's were always lower than the 0's, the difference is consistently negative. If parts marking increases recovery rates, the difference ought to be less negative in MY 1987 than in MY 1986 - the data point for MY 1987 should be higher than the one for MY 1986 - and indeed it is. The climb from 1986 to 1987 is in the opposite direction of a somewhat inconsistent but generally downward trend.

If, as in the preceding section, the change in the D's from 1986 to 1987 is measured and compared to the average change in the other years, when the parts marking status of the various make models did not change, the arithmetic for the changes in recovery rate differentials works out as follows:

	Change
1984-85	+ .0027
1985-86	- .0078
1986-87	+ .0036
1987-88	- .0221
1988-89	+ .0069
Average excluding 1986-87	- .0051
<i>Departure of 1986-87 from prevailing trend</i>	+ .0087

In other words, given the assumption of a constant trend in the recovery rate differential, the data suggest that the implementation of parts marking in MY 1987 was associated with a 0.9 percent increase in the recovery rate, relative to the trend line.

FIGURE A-11

BRAND-NEW PASSENGER CAR OVERALL THEFT RATES BY MODEL YEAR, 1984-89

includes: unmarked cars + marked cars
excludes: models with antitheft devices at any time in 1984-89
domestic make-models that existed from 1984 or earlier until 1989 or later; **MY=CY**

log(thefts/registrations)

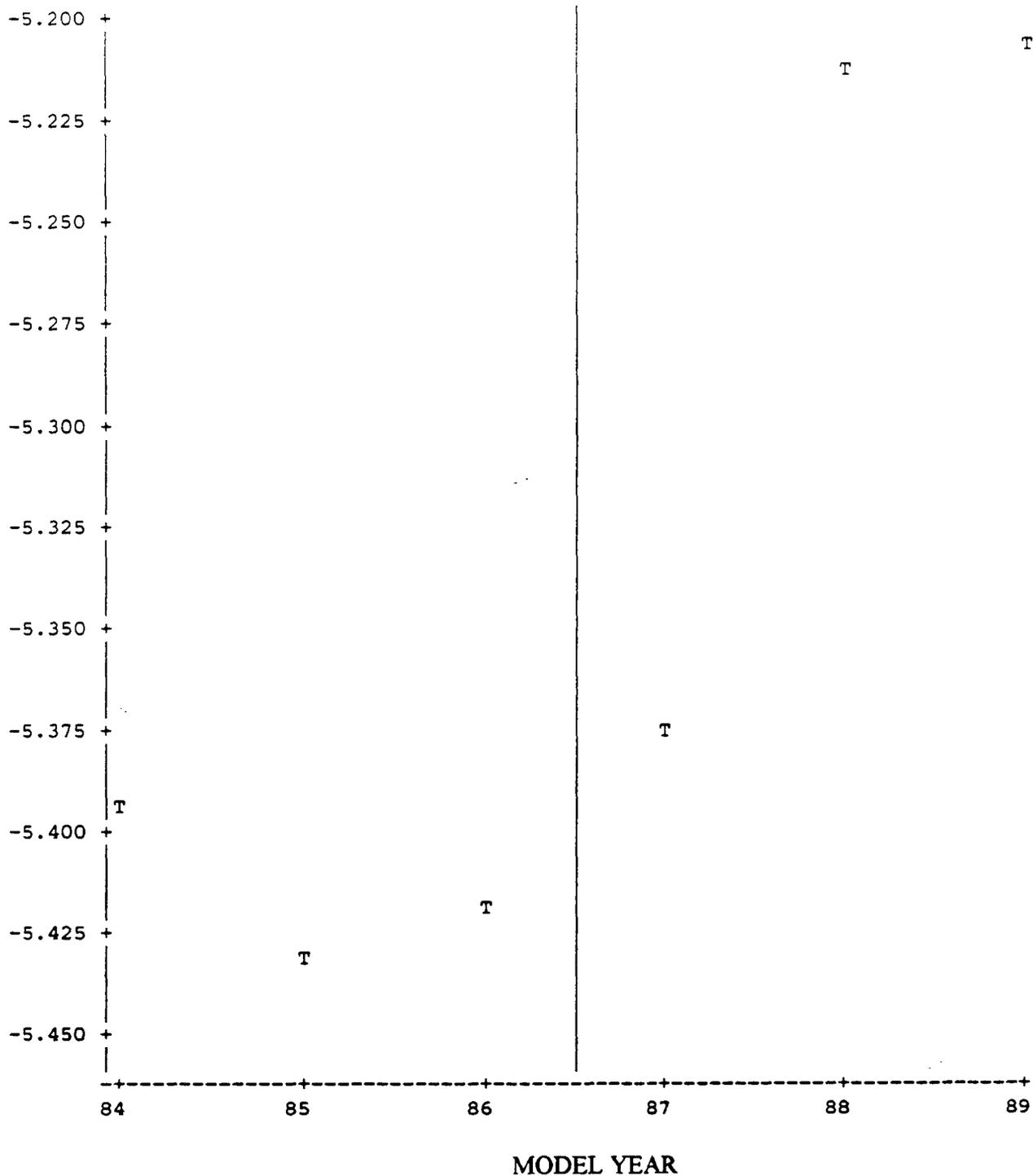


FIGURE A-12

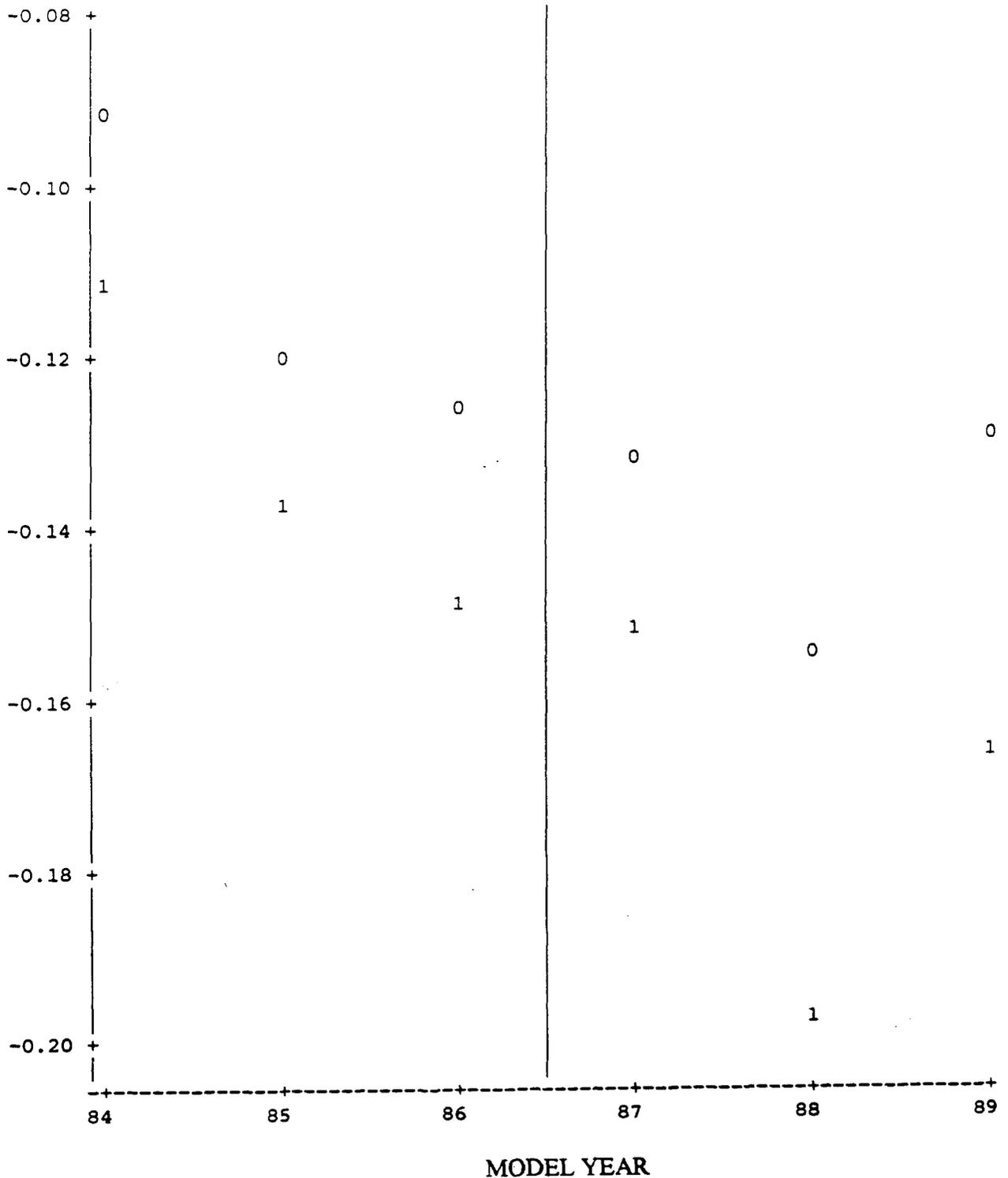
PASSENGER CAR RECOVERY RATES BY MODEL YEAR, 1984-89

domestic make-models that existed from 1984 or earlier until 1989 or later; 0-3 year old cars

"1" = make-models that got parts marking in 1987

"0" = make-models that did not get parts marking or antitheft devices during 1984-89

log(recoveries/thefts)



Unlike the 1986-87 effect on theft rates, which was strong only for brand new cars and disappeared after the cars were 2 years old, the observed effect on recovery rates remains uniformly favorable, even for vehicles as old as 6 years:

Brand new	+ .010
1 year old	+ .006
2 years old	+ .002
3 years old	+ .019
4 years old	+ .047
5 years old	+ .027
6 years old	+ .034

In summary, the results on recovery rates are mixed. On the one hand, Figures A-4 and A-13 show that, in the long term, the recovery rates of models with parts marking have steadily gotten worse than those of the models that never got parts marking. On the other hand, in 1987, the specific year that parts marking was introduced, those models had an increase in the recovery rate, contrary to the long-term trend. There does not appear to be any satisfactory explanation for the adverse long-term trend. Of course, if it has any causal relationship to parts marking, it far outweighs the one-time 1986-87 improvement. But if the long-term trend is not causally related to parts marking - e.g., if it is an artifact of the specific make-models that were selected for parts marking, and it would have occurred even if those models had never been marked - then the positive effect in 1986-87 might stand as a benefit for parts marking. Once again, the analysis is frustrated because make-models were selected for parts marking on a highly nonrandom basis, and there could be all sorts of trends unrelated to parts marking.

To the extent that many of the vehicles stolen by professional thieves - for chop shops, salvage switch and retag, or export - are never recovered, the **unrecovered theft rate**, defined as

$$\log [(thefts - recoveries)/registration\ years]$$

is a sort of surrogate for the “professional” theft rate, and it is a primary goal of parts marking to lower this rate. Obviously, when the theft rate goes down and the recovery rate goes up, the unrecovered-theft rate decreases. However, even small increases in the recovery rate, such as those attributed to parts marking in the preceding analysis, can have substantial effects on the unrecovered-theft rate: e.g., if the recovery rate increases from 90 to 91 percent, unrecovered thefts are reduced by 10 percent.

Figure A-14 tracks the differential in the unrecovered-theft rates of 0-3 year old domestic cars that got parts marking in MY 1987 and those that did not. In general, the models that got parts marking had initially higher unrecovered-theft rates, but the difference shrank throughout 1984-89 (regression to the mean). The differential was 0.85 in MY 84 and 0.45 in MY 89. The drop from 1986 to 1987, although not dramatically larger than the reductions in the other years, is nevertheless greater than average (and it is exceeded in magnitude only by the 1984-85 drop). That suggests a positive effect for parts marking; the arithmetic works out as follows:

	Shrinkage
1984-85	.207
1985-86	.077
1986-87	.133
1987-88	.039
1988-89	- .057
Average excluding 1986-87	.067
Excess of 1986-87 over average drop	.066

In other words, given the preceding assumptions, the data suggest a

$$1 - \exp(-.066) = 6.4 \text{ percent}$$

reduction of unrecovered thefts with parts marking. At first glance this reduction seems large in comparison to the amount needed for parts marking to be cost-beneficial. However, the result falls short of being conclusive, given the fragility of the assumptions and the rather tentative effect demonstrated in Figure A-14.

In one sense, however, the results on unrecovered thefts are more robust than the findings on the theft rate: the positive effect does not vanish as the cars get older:

Vehicle Age	Reduction Attributed to Parts Marking (%)
Brand new	25.8
1 year old	23.0
2 years old	- 14.8
3 years old	- .9
4 years old	20.9
5 years old	4.
6 years old	8.8

Initially, the effect is strong because thefts are down and recoveries are up. The observed benefit disappears when the cars are 2-3 years old, but subsequently returns to the positive, because the improvement in the recovery rate overshadows the observed negative effects on the theft rate. Figure A-15 illustrates the substantial benefit of parts marking on the unrecovered-theft rates of **brand-new** cars in MY 1987.

Effects of Antitheft Devices Introduced in My 1989-92 Domestic Cars

One domestic manufacturer gradually introduced factory-installed antitheft devices as standard equipment in a substantial number of make-models during 1986-94. In most of the vehicles, the equipment included a specially designed ignition key. A computer in the vehicle reads an encoded capsule embedded in the key and compares it to a microchip within the computer. The ignition system is shut down if the codes do not match, or it is attempted

to "hot-wire" the car. A partial list of make-models that have received these devices includes:

- 1986 Chevrolet Corvette (system upgraded in 1990)
- 1989 Chevrolet Camaro, Pontiac Firebird, Cadillac Eldorado, Cadillac Seville
- 1990 Cadillac DeVille, Buick Riviera, Oldsmobile Toronado
- 1991 Buick Park Avenue, Oldsmobile 98
- 1992 Buick LeSabre, Oldsmobile 88, Pontiac Bonneville
- 1994 Chevrolet Caprice (partial phase-in began in 1993)

The effects of the antitheft devices on theft, recovery and unrecovered-theft rates will be studied for the preceding list of make-models with 1989-92 introductions. The Corvette and Caprice are not included because their analysis is complicated by the two-stage introduction of the devices, as well as an insufficient amount of data. It is noteworthy that the antitheft device was not necessarily introduced in the same year that the Government granted these vehicles an exemption from parts marking; as a result, some cars have parts marking **and** antitheft devices in some model years.

As in the three preceding sections, rates for the make-models that got antitheft devices will be compared to rates for control groups of domestic make-models of a similar market class, produced in the same model years, that did not get antitheft devices in those years, and did not change their parts-marking status after 1987. The five cohorts of cars with antitheft devices, and their control groups are:

Antitheft Cars

Camaro, Firebird
Eldorado, Seville
DeVille, Riviera, Toronado
Park Avenue, Olds 98
LeSabre, 88, Bonneville

Control Group Cars

Mustang, Daytona, Thunderbird, Cougar
Lincoln Mark, Continental
Town Car, Mark, Continental
Crown Victoria, Grand Marquis
Taurus, Sable

Figure A-16 compares the theft rates of 0-3 year old LeSabres, Olds 88s and Bonneville to the rate for Taurus and Sables during MY 1988-95. It is based on the same NCIC-Polk data

files that were used in the preceding section (data up through CY 1995). The 2's denote the aggregate theft rate [$\log(\text{thefts}/\text{registrations})$] for LeSabre, 88 and Bonneville, which received antitheft devices in 1992 (and had parts marking in 1987-91; LeSabre and 88 also in 1992). The 0's denote the combined theft rate for Taurus and Sable, which did not have parts marking or antitheft devices during 1988-95.

Figure A-16 leaves no room for doubt about the effectiveness of the antitheft devices. The log of the theft rate for the GM cars (the 2's) is reasonably close to -5.25 in MY 1988-91; it drops to about -7 in 1992, when the devices were introduced, and it stays there in later model years. A drop of 1.75 on the logarithmic scale suggests a very substantial reduction in the actual theft rate, as will be confirmed below. The theft rate for the control group cars (Taurus and Sable) shows a comparatively modest decreasing trend in 1988-91 and a modest increase in 1992-95. Interestingly, the theft rate for the GM cars shows a similar decrease from 1988 to 1991, and a similar, modest increase from 1992 to 1995, but, of course, a very large drop from 1991 to 1992.

Figure A-17 tracks the theft rate differential - the difference between the 2's and the 0's in Figure A-16. This differential is relatively constant and close to 1.00 during MY 1988-91, and it drops abruptly to a relatively constant -0.75 in MY 1992-95. The drop clearly coincides with the introduction of antitheft devices in the GM cars. Figure A-17 should be contrasted with Figure A-8, a corresponding analysis of the effect of parts marking. In Figure A-8, the small effect of parts marking (if any) is obscured by a steady downward trend throughout 1984-89 (regression to the mean). In Figure A-17, the effect of antitheft devices is so large as to completely overshadow any other trends, such as regression to the mean.

If the procedure for calculating effectiveness that was employed in the analyses of parts marking is applied to the data in Figure A-17, the results are:

	Shrinkage
1989-90	- .074
1990-91	.076
1991-92	1.780
1992-93	- .027
1993-94	.205

Average excluding 1991-92	.045
Excess of 1991-92 over average drop	1.735

In other words, the data suggest a

$$1 - \exp(-1.735) = 82 \text{ percent}$$

reduction of the theft rate by the antitheft devices in LeSabre, Olds 88 and Bonneville.

Figure A-18 tracks the recovery rate differential for these same groups of cars. For recovery rates, the “right” direction is the opposite of theft rates: we want them to go up. Thus, the results in Figure A-18 are definitely in the wrong direction, since the differential drops from about .10 to zero with antitheft devices. This finding, however, should not come as a surprise. Unlike parts marking, which is primarily intended to deter the professional thief and probably has little effect on “casual” thefts such as joyriding, a successful antitheft device should reduce all types of theft substantially. But it will probably have the greatest impact on the casual thefts, the types that are most easily recovered. Thus, even though thefts are greatly reduced, the ratio of recoveries to thefts (the recovery rate) may actually decrease rather than rise.

Nevertheless, the decrease in the recovery rate is negligible relative to the decrease in the theft rate. Even though the number of unrecovered cars grows in proportion to the number of thefts, it will drop relative to vehicle registrations. The differential in the unrecovered theft rate, defined as

$$\log [(\text{thefts} - \text{recoveries}) / \text{registration years}]$$

is graphed in Figure A-19. It shows a strong reduction with antitheft devices, from about 0.2 in 1988-91 to about -0.8 in 1992-95. By the computation method used throughout this

appendix, the data in Figure A-19 correspond to a 58 percent reduction in the unrecovered-theft rate.

The trends in theft and recovery rates, relative to their respective control groups, are quite similar for the other four cohorts of domestic make-models that got antitheft devices at some time between 1989 and 1991. (The results for the Eldorado-Seville cohort are based on substantially fewer data than the others and subject to correspondingly higher uncertainty.) The effectiveness estimates for the antitheft devices in each group of cars are as follows:

Percentage Reduction by Antitheft Devices

	Theft Rate	Unrecovered Theft Rate
Camaro, Firebird	68	50
Eldorado, Seville	11	36
DeVille, Riviera, Toronado	47	58
Park Avenue, Olds 98	78	66
LeSabre, Olds 88, Bonneville	82	58

A “best estimate” for the effectiveness of these antitheft devices can be obtained by combining the data for the five make-model groups. The rates are not graphed by absolute model years, but by the model year relative to the implementation date for antitheft devices. For example, in Camaro and Firebird, year “0” is model year 1989, when those cars got the devices. MY 1988 becomes year “-1” and MY 1990 becomes year “1.” Thus, also, for their control group of Mustang, Daytona, etc. But in LeSabre, Olds 88 and Bonneville (and for their control group cars, Taurus and Sable), MY 1992 becomes year “0,” MY 1993 is year “1,” etc.

Figure A-20 tracks the theft rate differential for the five make-model groups combined.- the difference between the GM cars and the control group cars. This differential is .75 or larger during the four model years prior to the installation of antitheft devices in the GM cars (i.e., the control group models originally had a lower theft rate). It drops abruptly to a relatively constant -.5 in the year that the GM cars got the antitheft devices, and it stays there (i.e., from that point on, the GM cars have the lower theft rate). Figure A-21 shows a similarly strong effect of antitheft devices in lowering the unrecovered theft rate. Here are the calculations of effectiveness based on the data in Figures A-20 and A-21:

	Shrinkage in the Rate Differential	
	All Thefts	Unrecovered Thefts
3rd MY before to 2nd MY before antitheft	.138	.346
2nd MY before to last MY before antitheft	.309	.146
Last MY before to first MY with antitheft	1.342	.974
First MY with to 2nd MY with antitheft	.138	.201
2nd MY with to 3rd MY with antitheft	-.097	-.261
Average excluding year of transition	.122	.108
Excess of transition drop over average drop	1.220	.866

In other words, the data attribute to these antitheft devices:

- $1 - \exp(-1.220) = 70$ percent reduction of the theft rate
- $1 - \exp(-0.866) = 58$ percent reduction of the unrecovered-theft rate

Although these antitheft devices may be especially beneficial in reducing "casual" thefts for purposes such as joyriding or temporary transportation, they also appear to be highly effective in reducing "professional" thefts. To the extent that the unrecovered-theft rate can serve as a surrogate for professional thefts, these antitheft devices are far more effective than parts marking (which was associated with perhaps a 6 percent reduction of the unrecovered theft rate). Of course, when comparing effectiveness, it should not be forgotten that the antitheft devices cost far more. Also, the roles of antitheft devices and parts marking are complementary, not redundant. The former makes it hard to steal a car; the latter acts as a deterrent because it aids in the apprehension and conviction of thieves.

The reductions in thefts persist as the cars get older, and they persist in later model years. For example, in Camaro and Firebird (the first high-sales make-models to get antitheft devices), theft rates are low for every model year from 1989 to 1995. Rates have remained low for the MY 1989 cars even in calendar year 1995, when they were six years old.

Effects of Factory-Installed Antitheft Devices in Other Cars

Since 1984 a number of other manufacturers have introduced factory-installed antitheft devices as standard equipment in selected make-models. Since the devices vary considerably in design and function, it is not unreasonable to expect a corresponding variation in their effectiveness. However, since none of these devices were introduced in numbers anywhere near as large as the system analyzed in the preceding section, it is difficult to estimate their effectiveness accurately. The analysis in this section will be limited to inspecting the general trends in the theft rates of 0-5 year old cars of some of those models. (Even the accuracy of these "general trends" cannot always be assured, since the data base may have been incomplete for some of the low-sales, imported make-models.)

FIGURE A-13

RECOVERY RATE DIFFERENTIAL, MY 1984-89
MAKE-MODELS THAT GOT PARTS MARKING IN 1987 VERSUS
MAKE-MODELS WITHOUT PARTS MARKING OR ANTITHEFT DEVICES IN 1984-89

domestic make-models that existed from 1984 or earlier until 1989 or later; 0-3 year old cars

log of the recovery rate for models that got parts marking
minus log of the recovery rate for models that didn't

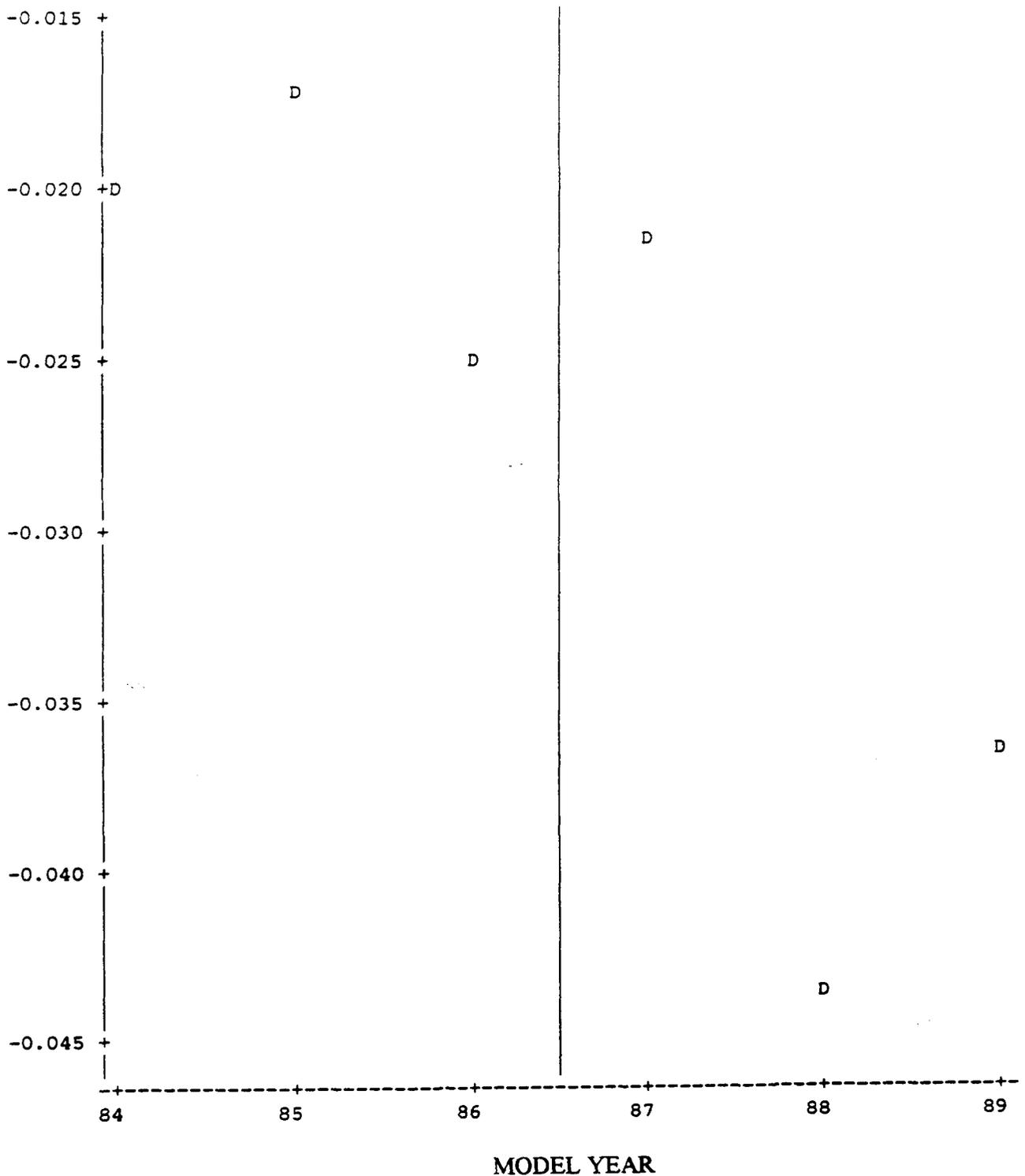


FIGURE A-14

UNRECOVERED THEFT RATE DIFFERENTIAL, MY 1984-89
MAKE-MODELS THAT GOT PARTS MARKING IN 1987 VERSUS
MAKE-MODELS WITHOUT PARTS MARKING OR ANTITHEFT DEVICES IN 1984-89

domestic make-models that existed from 1984 or earlier until 1989 or later; 0-3 year old cars

log of the unrecovered theft rate for models that got parts marking
minus log of the unrecovered theft rate for models that didn't

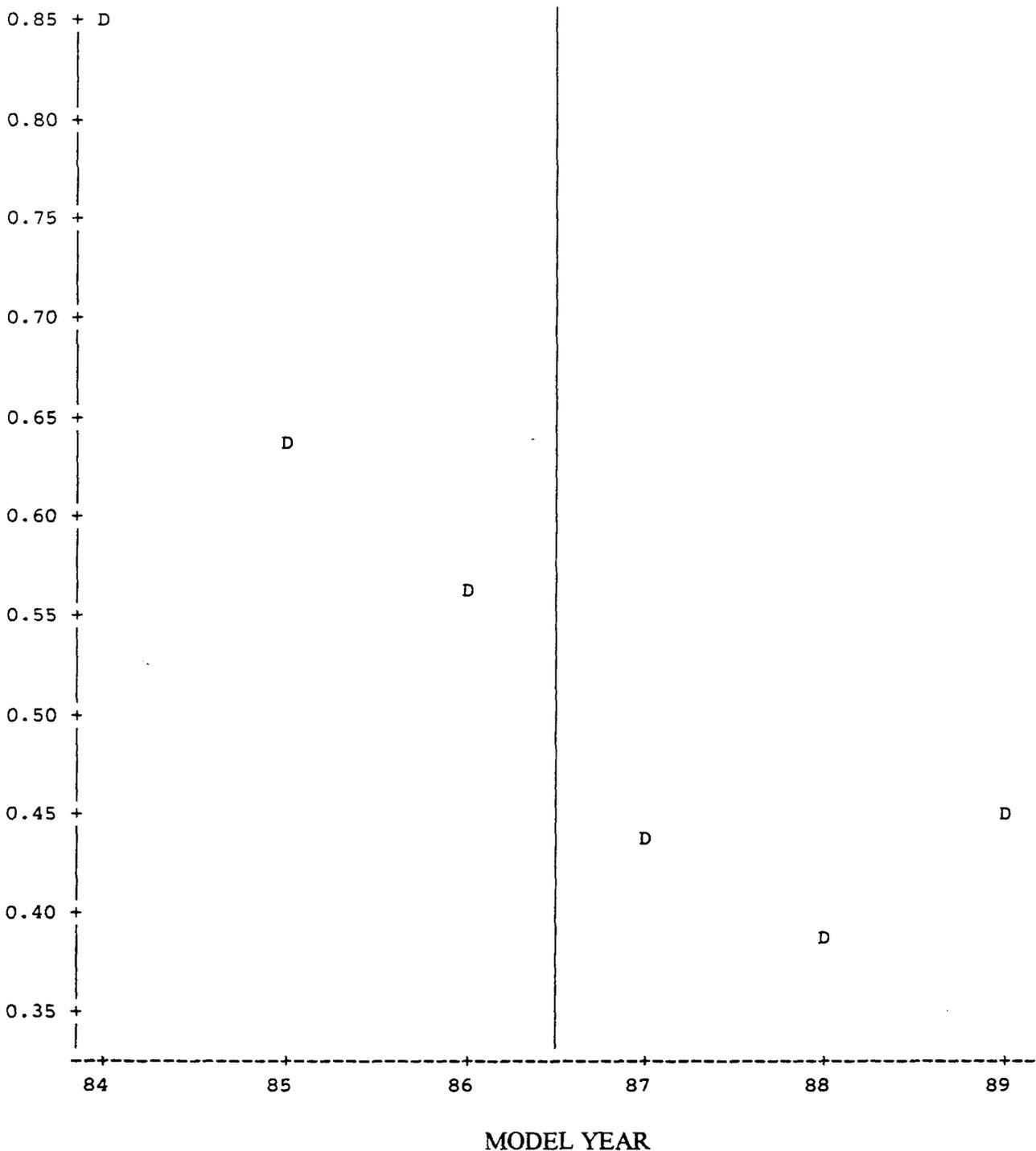
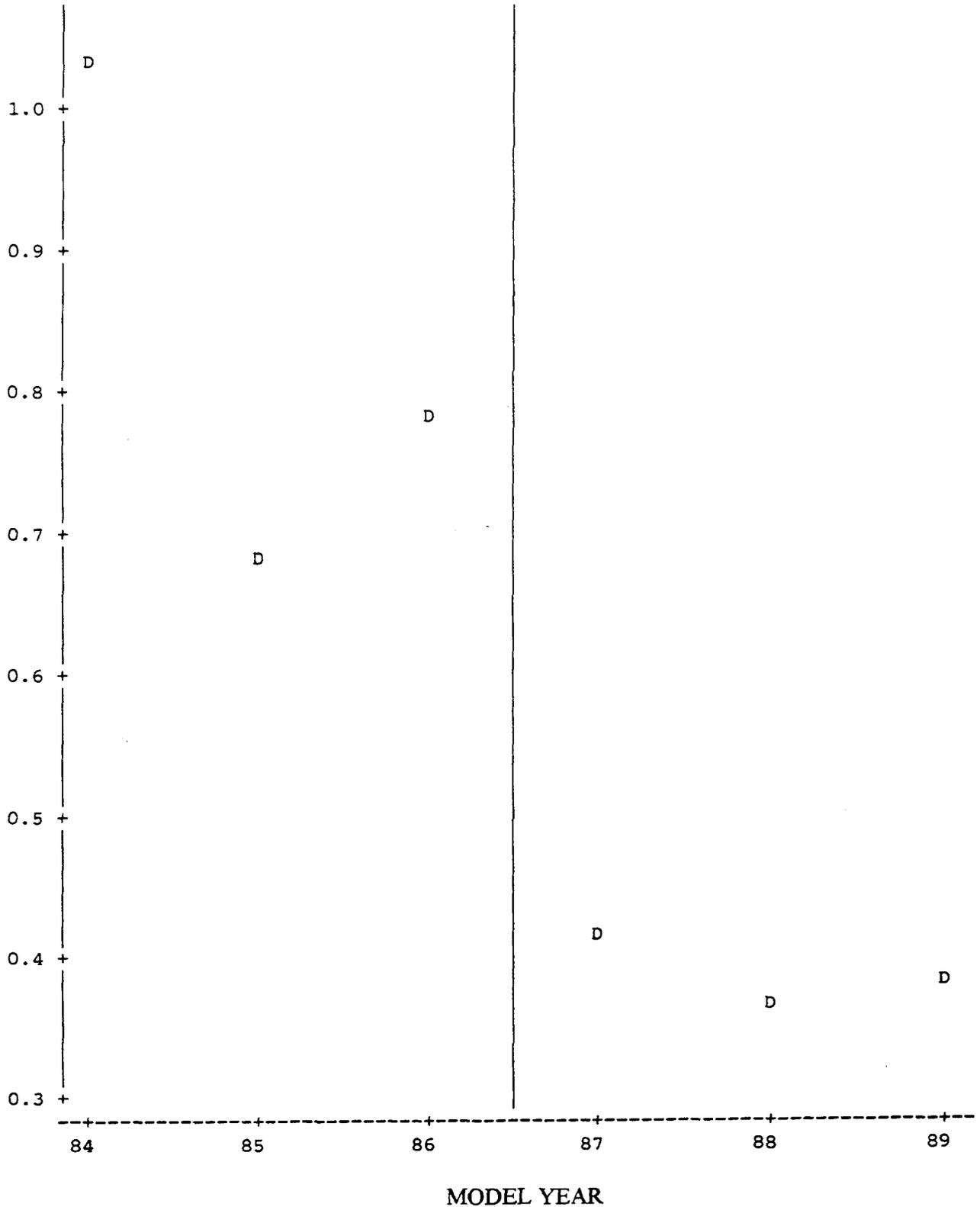


FIGURE A-15: UNRECOVERED THEFT RATE DIFFERENTIAL, MY 1984-89,
BRAND-NEW CARS, MAKE-MODELS THAT GOT PARTS MARKING IN 1987 VERSUS
MAKE-MODELS WITHOUT PARTS MARKING OR ANTITHEFT DEVICES IN 1984-89
 domestic make-models that existed from 1984 or earlier until 1989 or later; **MY=CY**

log of the unrecovered theft rate for models that got parts marking
 minus log of the unrecovered theft rate for models that didn't



According to NHTSA's *Auto Theft-Resistance Study*, a report to the Congress dated April 1992, the Nissan 300ZX received antitheft devices in 1984 and the Maxima in 1985. The device disables the starting mechanism and sounds an alarm when somebody attempts to enter the car without a key. An inspection of the theft rates for these make-models indicates a 25-35 percent reduction in MY 1984-85. In subsequent years, however, the theft rate climbed back to the pre-1984 level.

BMW passenger cars received a system in 1985 consisting of a key-activated alarm and an optional code pad requiring the driver to key in a sequence of numbers. Later, the 7-series cars also received a device to disable the starter mechanism. Theft rates showed a decrease of about 10-20 percent in MY 1985 and 1986; by 1987-90, theft rates had largely returned to pre-1985 levels

BMW passenger cars received a system in 1985 consisting of a key-activated alarm and an optional code pad requiring the driver to key in a sequence of numbers. Later, the 7-series cars also received a device to disable the starter mechanism. Theft rates showed a decrease of about 10-20 percent in MY 1985 and 1986; by 1987-90, theft rates had largely returned to pre-1985 levels.

Toyota Supra and Cressida received antitheft devices in 1985 with functions similar to the BMW systems. Later (by 1987?) they received devices to disable the starter mechanism. Theft rates for these relatively low-sales vehicles do not follow clear trends; nevertheless, there appears to be a substantial reduction in the Supra (55 percent) and a smaller reduction in the Cressida (10-20 percent). In subsequent years, theft rates stayed at the lower levels.

Starting in 1987, certain make-models were exempted from the parts marking requirement if they carried antitheft devices that, as a minimum, included a mechanism to disable the starter and trigger an audio or visual alarm after unauthorized entry. Whereas this device may have been installed in a model year earlier than the effective date of the exemption (e.g., in the domestic cars analyzed in the preceding section), it was, at the latest, installed during the exemption year.

Chrysler Conquest and Mitsubishi Starion, two make-models of similar design, received exemptions from parts marking in 1987. Their theft rates increased steadily throughout the model years that they were produced (1983-89). Unless the antitheft devices were already present in the first year that

these models were produced, it may be concluded that they had no obvious beneficial effect on the theft rate.

Audi 5000S/100/200, Mitsubishi Galant and Isuzu Impulse received exemptions in 1987, and Saab 9000 received one in 1989. Each of these make-models shows steady, gradual reductions in the theft rate during the model years after the exemption. Typically, the cumulative reduction in the theft rate was about 50 percent over a 5-year period. Since there was no concentrated drop in a specific year, it is difficult to judge if the long-term reductions were due to the antitheft devices or to other factors that may have made these models less enticing to thieves.

Acura Legend received an exemption in 1991. Theft rates, however, steadily increased throughout the years this model was produced (1986-94). Unless the antitheft devices were already present in 1986, it may be concluded that they had no obvious beneficial effect on the theft rate.

Volkswagen Jetta gained an exemption in 1994. At that time, or shortly earlier, they received an antitheft system rather similar to the one in the domestic cars analyzed in the preceding section. There was a dramatic 63 percent reduction in the theft rate from MY 1992 to 1994.

While the above discussion of theft rates does not pretend to have generated specific estimates of the effectiveness of antitheft devices in any of the individual make-models, it is safe to draw one conclusion from the great variation of the results from model to model: the mere presence of an "antitheft device" does not guarantee an immediate, spectacular reduction of the theft rate. It all depends on the type of antitheft device.

FIGURE A-16

PASSENGER CAR THEFT RATES BY MODEL YEAR, 1988-95

make-models that got **antitheft devices in 1992** vs. control group; 0-3 year old cars

"2" = LeSabre, 88, Bonneville: antitheft devices in 1992-95

"0" = Taurus, Sable: no parts marking or antitheft devices in 1988-95

log(thefts/registrations)

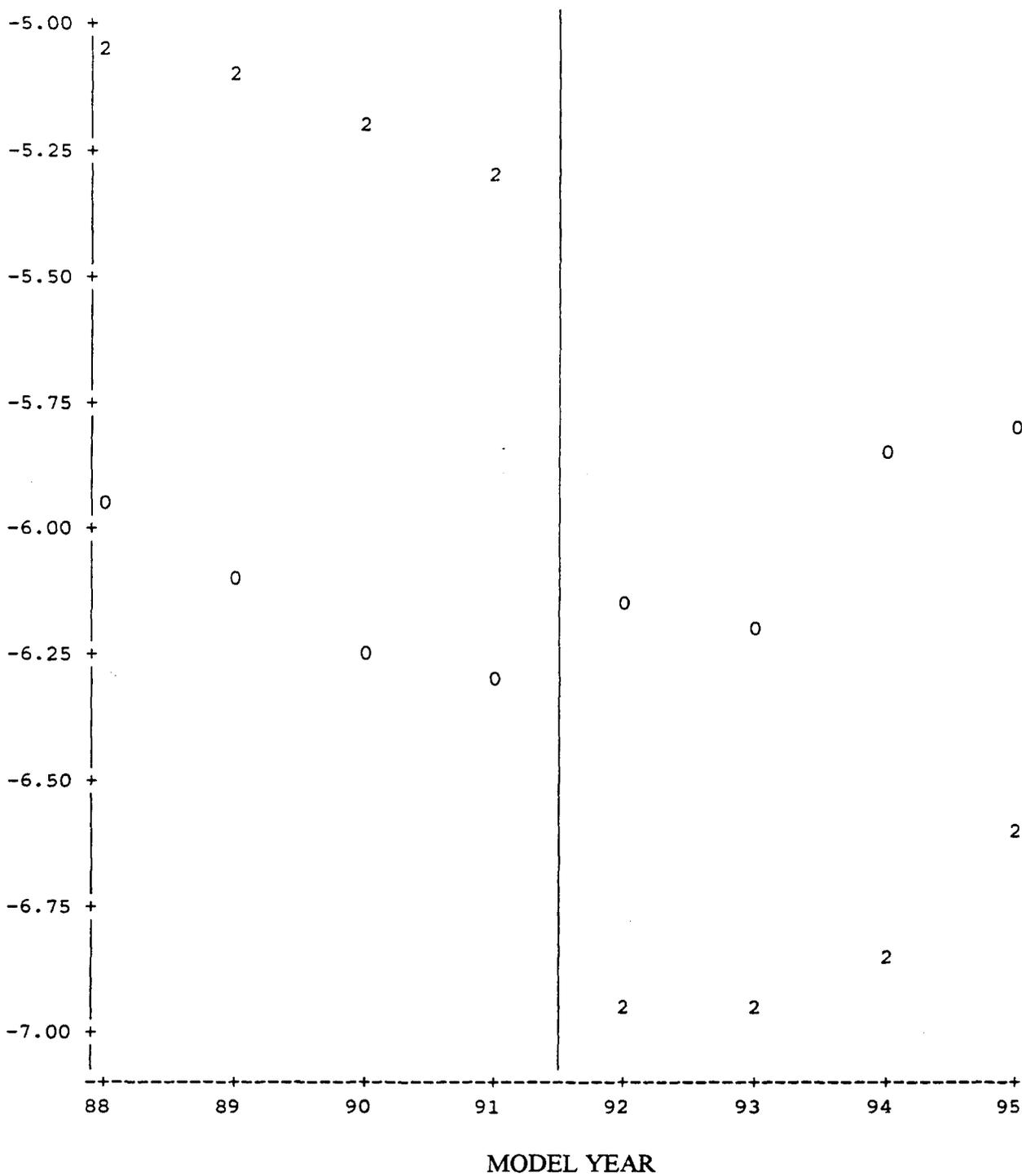


FIGURE A-17: THEFT RATE DIFFERENTIAL, MY 1988-95
 LeSABRE + 88 + BONNEVILLE (ANTITHEFT DEVICES IN 1992-95) VERSUS
 TAURUS + SABLE (NO PARTS MARKING OR ANTITHEFT DEVICES IN 1988-95)
 0-3 year old cars

log of the theft rate for models that got antitheft devices
 minus log of the theft rate for models that didn't

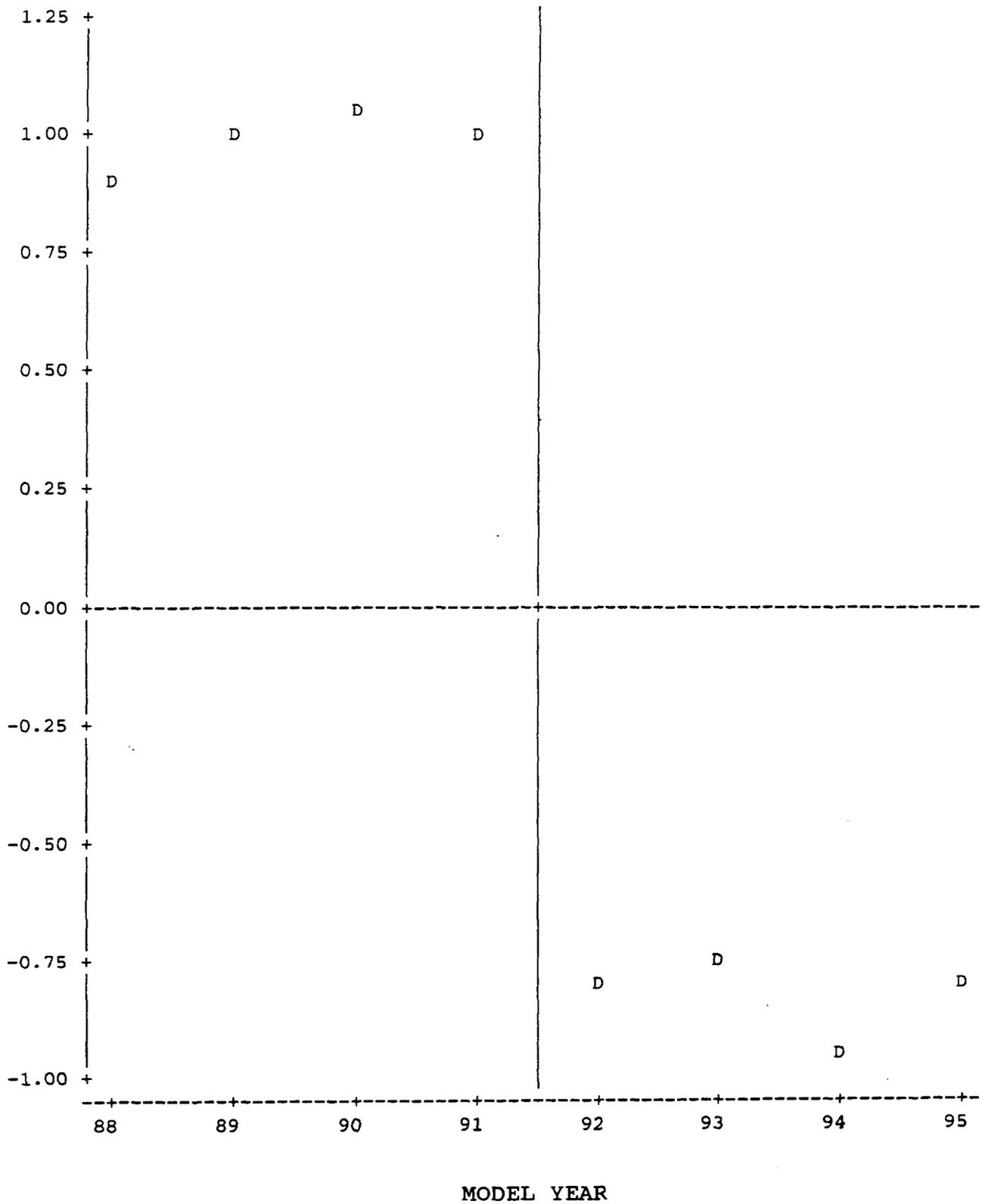


FIGURE A-18: RECOVERY RATE DIFFERENTIAL, MY 1988-95
 LeSABRE + 88 + BONNEVILLE (ANTITHEFT DEVICES IN 1992-95) VERSUS
 TAURUS + SABLE (NO PARTS MARKING OR ANTITHEFT DEVICES IN 1988-95)

0-3 year old cars

log of the recovery rate for models that got antitheft devices
 minus log of the recovery rate for models that didn't

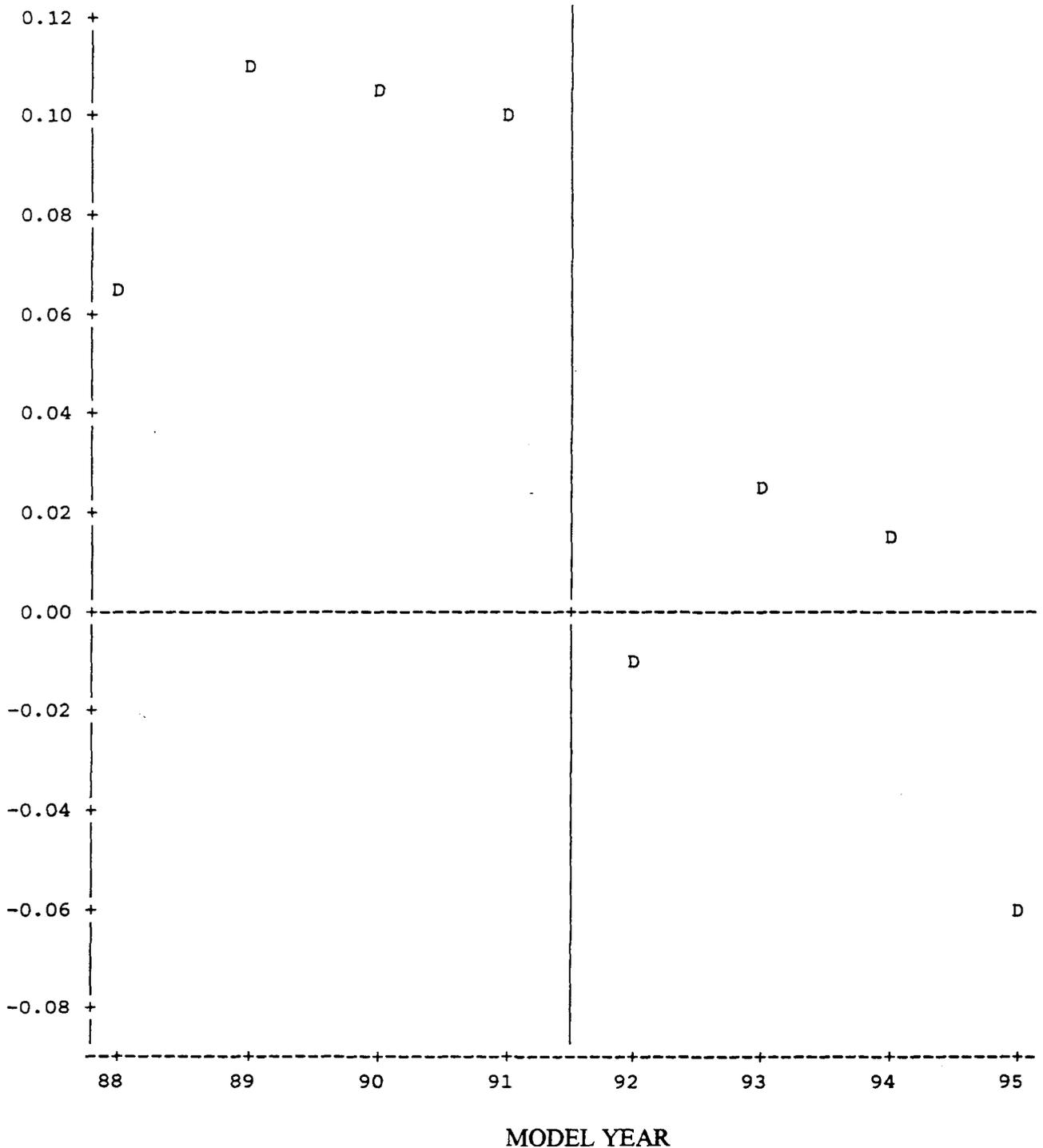


FIGURE A-19: UNRECOVERED-THEFT RATE DIFFERENTIAL, MY 1988-95
 LeSABRE + 88 + BONNEVILLE (ANTITHEFT DEVICES IN 1992-95) VERSUS
 TAURUS + SABLE (NO PARTS MARKING OR ANTITHEFT DEVICES IN 1988-95)

0-3 year old cars

log of the unrecovered-theft rate for models that got antitheft devices
 minus log of the unrecovered-theft rate for models that didn't

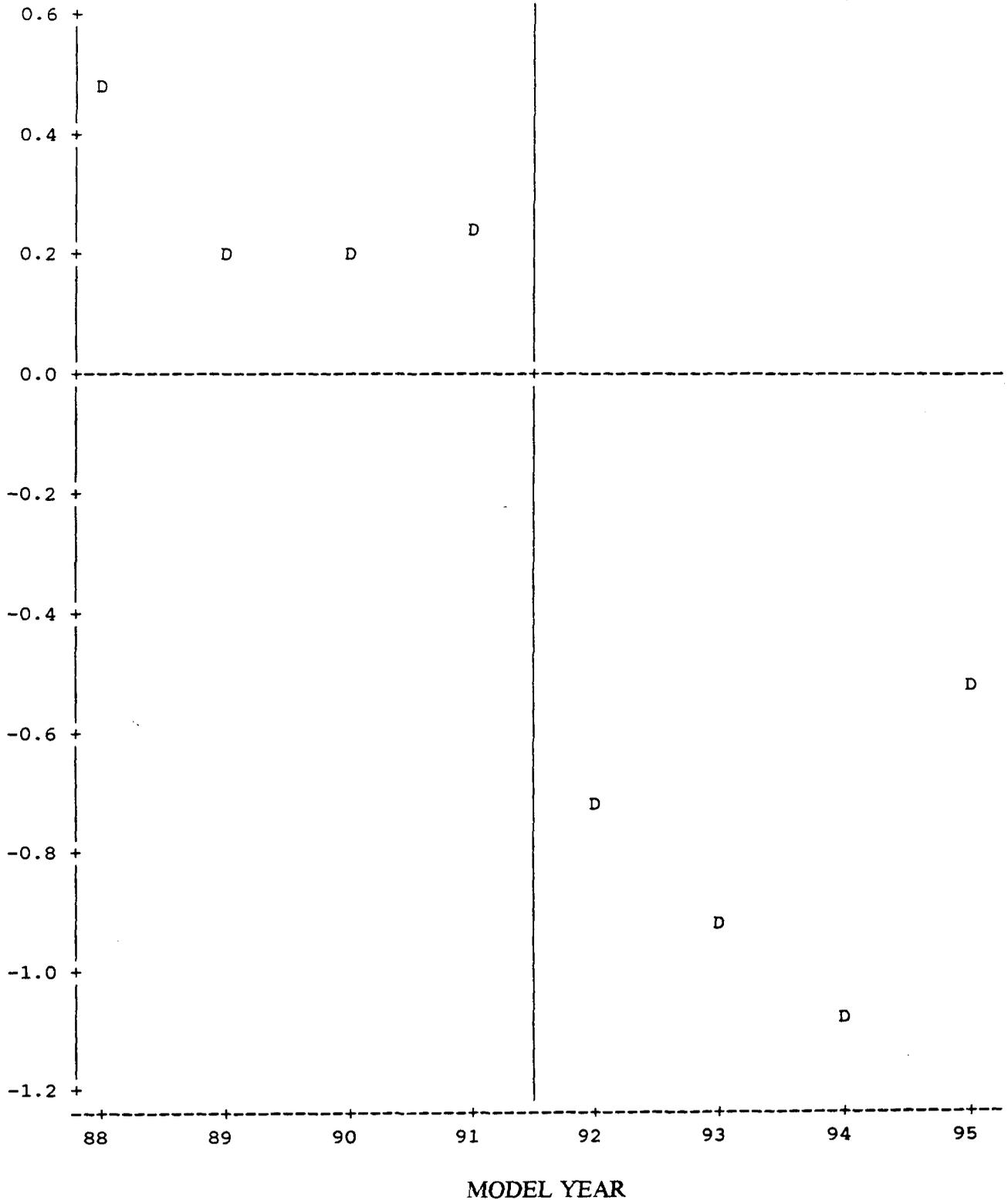


FIGURE A-20: THEFT RATE DIFFERENTIAL
 GENERAL MOTORS CARS THAT GOT ANTITHEFT DEVICES, STARTING IN 1989-92
 VERSUS CONTROL GROUP CARS THAT DID NOT GET ANTITHEFT DEVICES IN 1985-95
 0-3 year old cars

log of the theft rate for models that got antitheft devices
 minus log of the theft rate for models that didn't

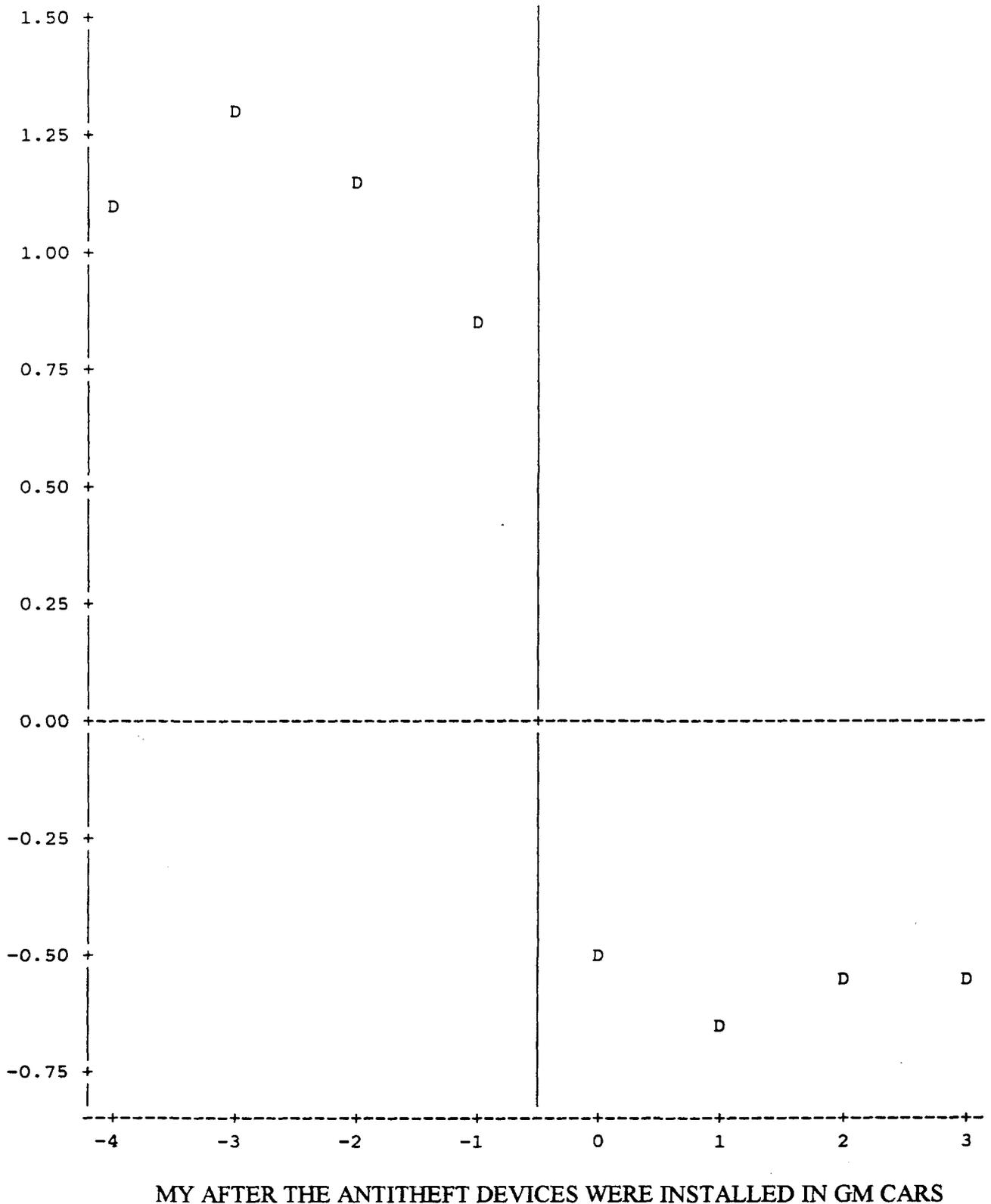
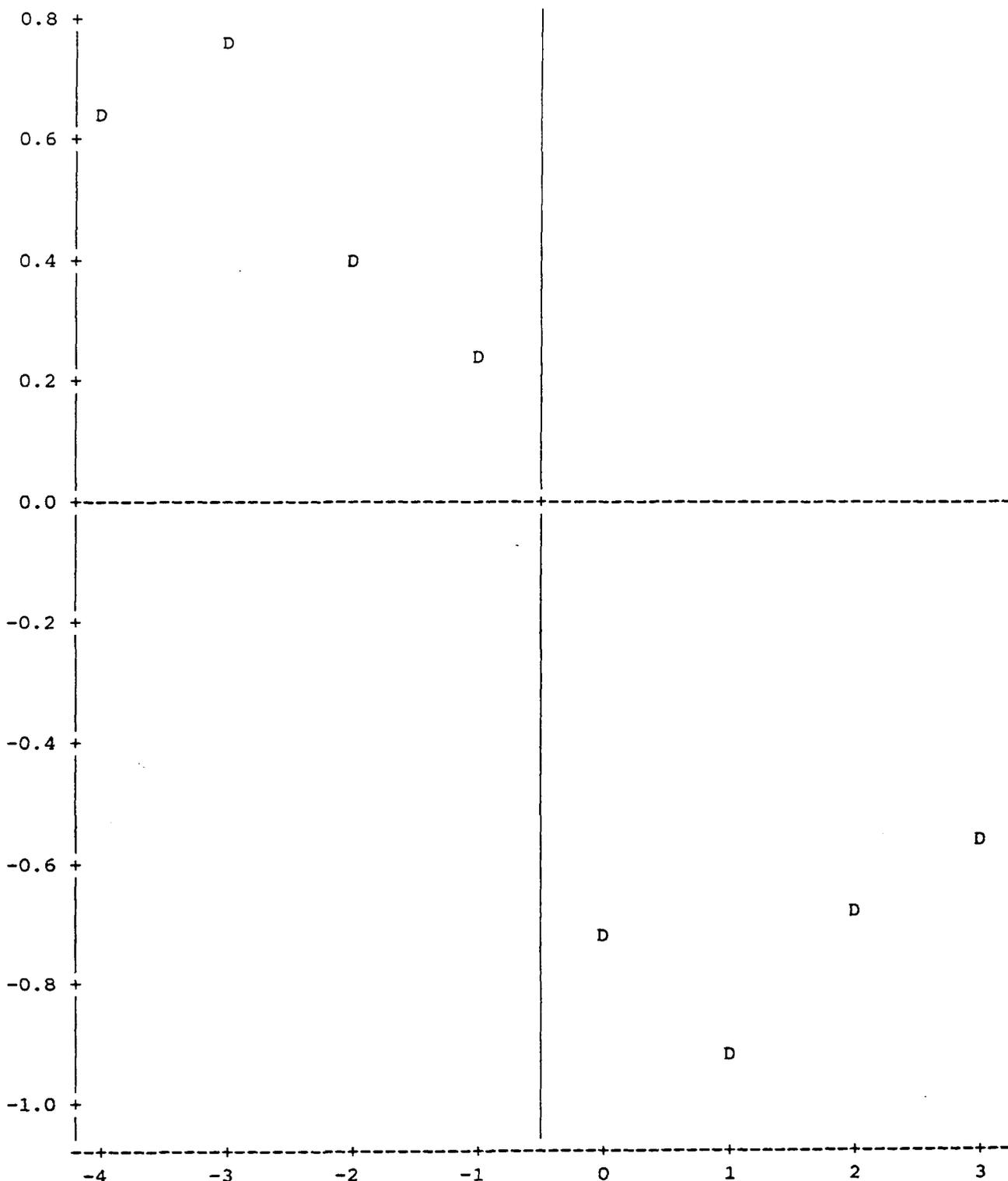


FIGURE A-21: UNRECOVERED-THEFT RATE DIFFERENTIAL
 GENERAL MOTORS CARS THAT GOT ANTITHEFT DEVICES, STARTING IN 1989-92
 VERSUS CONTROL GROUP CARS THAT DID NOT GET ANTITHEFT DEVICES IN 1985-95
 0-3 year old cars

log of the unrecovered-theft rate for models that got antitheft devices
 minus log of the unrecovered-theft rate for models that didn't



MY AFTER THE ANTITHEFT DEVICES WERE INSTALLED IN GM CARS

"In-part" Recovery Rates Just Before and After Model Year 1987

The file assembled by the Highway Loss Data Institute (HLDI) from data supplied by the National Insurance Crime Bureau (NICB) not only specifies what percentage of stolen cars was recovered, but also what percentage of the recoveries were "in part," "in whole," or "intact." A vehicle is recovered "in part" if "major" parts are missing (viz., marked parts, or parts that would have been marked if the car had parts marking). It is recovered "in whole" if only "minor" parts, such as the radio, are missing, or if the car was damaged but nothing was missing. The recovery is "intact" if the car was essentially undamaged and no parts were missing. The type of recovery perhaps, but not necessarily says something about the motive for the theft. In general, cars that have been stolen by nonprofessional thieves for joyriding or other temporary transportation would more often be recovered intact or in whole, whereas cars worked over by a chop shop, if they are recovered at all, would more likely be recovered in part. If parts marking or antitheft devices have a deterrent effect on chop shop operations, and professional thieves generally - while having little deterrent effect on joyriders and other nonprofessional thieves - a reduction in the frequency of "in part" recoveries might be expected, relative to "in whole" and "intact" recoveries. Throughout the analyses that follow, a **reduction** of "in part" recoveries is a change in the "right" direction.

At first glance, the HLDI-NICB data are strongly consistent with that hypothesis. These data are complete from CY 1986 to 1991, and in each of those years include at cars that are 0-2 years old (and in a few years, some older cars as well). In the analyses that follow, the data have been limited to 0-2 year old cars of model years 1984-89. They are further limited to the specific make-models of passenger cars that were included in most of the NCIC/Polk data analyses: make-models produced throughout 1984-89 that (1) got parts marking in 1987 and did not get antitheft devices in 1984-89, (2) got exemptions from parts marking in 1987 because antitheft devices were installed in 1987 or earlier, (3) got parts marking in 1987 and antitheft devices in 1989, or (4) did not get parts marking or antitheft devices throughout 1984-89. For these cars, the overall recovery rate [recoveries/thefts] in the HLDI-NICB data shows a gradual downward trend throughout 1984-89, no different from the preceding NCIC/Polk data analyses. However the percentage of in-part recoveries [i.e., in-part recoveries/total recoveries] shows a much stronger downward trend, especially for the make-models that got parts marking or antitheft exemptions in 1987:

Percent Recovered "In Part"

<u>MY</u>	Parts Marking <u>in 1987</u>	Antitheft Exemption <u>in 1987</u>	P. M. in 87 A-T. D. <u>in 89</u>	<u>Neither</u>
84	19.1	10.0	23.9	13.2
85	19.5	11.1	22.8	12.8
86	15.7	11.2	21.4	11.7
87	11.6	7.1	18.2	9.1
88	10.2	8.2	17.3	9.3
89	10.3	8.1	14.3	10.7

At first glance, these results appear to have all the desired characteristics: the reduction is stronger from MY 1986 to 1987, when parts marking was first installed, than in other years. The downward trend is substantially stronger for cars that got parts marking (from 19 to 10 percent) than for cars that did not get parts marking or antitheft devices (13 to 10 percent). It looks like a focused deterrent effect for cars that got parts marking in 1987, with spillover to other cars and subsequent years.

Unfortunately, the HLDI-NICB data are subject to the same bias as all data on parts marking (regression-to-the-mean effect due to the nonrandom selection of the make-models that got parts marking) plus possible additional biases of their own. The first indication of possible bias emerges when the rates are presented by **calendar year** rather than by model year. Since the data base is limited to cars 0-2 years old, there is a strong relationship between MY and CY (e.g., data on the MY 1989 cars are derived only from CY 1989-91, while data on the MY 1984 cars are from CY 1986). The apparent MY effects in the preceding table might, to some extent, be CY effects:

<u>Calendar Year</u>	<u>Percent Recovered In Part - All Cars</u>
86	18.6
87	17.2
88	11.3
89	10.0
90	10.1
91	12.9

It is immediately apparent that the strong drop of "in part" recoveries takes place in CY 1988, and not in CY 1987 as might be expected if the effect were really due to parts marking and antitheft devices. It might be argued that the effect was delayed for a year because it took time for an awareness of parts marking to "sink in" with professional thieves. Frankly, a more plausible explanation (although this analyst does not have detailed knowledge of the HLDI-NICB data base to prove the point) is that the 1988-91 data are not directly comparable with the 1986-87 data; that the definition of an "in part" recovery may have explicitly or implicitly changed. After all, the analysis of NCIC/Polk theft data (Figure A-9) showed an immediate effect for parts marking in 1987, not a delayed effect.

The strength of the calendar year effect, relative to the model year effect, is evident if the rates are computed by CY and MY:

<u>CY</u>	<u>MY</u>	<u>Percent Recovered</u> <u>in Part - All Cars</u>
86	84	18.1
	85	18.5
	86	19.7
87	85	17.2
	86	18.4
	87	15.4
88	86	10.9
	87	11.4
	88	12.1
89	87	9.9
	88	10.5
	89	9.3
90	88	10.6
	89	9.4
91	89	12.9

In any CY, the in-part recovery rate is essentially the same for every MY. Specifically, in CY 1988, the in-part recovery rate is low even for MY 1986. The only hint of a model year effect is that in CY 1987, the in-part recovery rate is somewhat lower for MY 1987 than for MY 1985 or 1986 (although not nearly as low as the rates for any MY in CY 1988). This modest MY effect for MY 1987 in CY 1987 raises a hope that parts marking has played a role. However, a further classification of the rates by CY, MY and make-model group (parts marking in 87 vs. no parts marking; models that got antitheft devices at any time in 1984-89 are excluded from the table) dashes this hope while creating others:

Percent Recovered In Part			
<u>CY</u>	<u>MY</u>	<u>Parts Marking in 1987</u>	<u>No Parts Marking</u>
86	84	19.1	13.2
	85	19.6	13.2
	86	19.7	14.7
87	85	19.5	12.5
	86	19.9	13.9
	87	17.3	10.8
88	86	9.7	8.6
	87	11.1	8.6
	88	11.2	10.1
89	87	9.2	8.7
	88	10.1	8.7
	89	9.9	8.7
90	88	10.0	9.4
	89	9.8	9.2
91	89	11.3	13.6

In both cases where a direct comparison of MY 1986 and 1987 are possible - i.e., in CY 1987 and 1988, the year-to-year reduction is actually greater for the cars that did not get marked parts. In CY 1987, the rate for models without marked parts dropped from 13.9 to 10.8, but for the cars that got marked parts, it only dropped from 19.9 to 17.3. In CY 1988, the rate for cars that did not get

marked parts remained unchanged at 8.6, but it increased from 9.7 to 11.1 for the cars that got marked parts. Thus, there does not appear to be a focused effect for marked parts in the expected direction in 1987.

On the other hand, the preceding table clearly shows a longer-term reduction in the differential between the models that got marked parts and those that didn't.

In CY 1986, the rate for the models that would subsequently get marked parts was consistently 50% higher than for those that would not. That differential got smaller every year, especially in 1988, and by 1991 the cars with unmarked parts had a higher "in part" recovery rate. This long-term trend is perhaps not related to any possible changes in the HLDI-NICB definitions, since such changes ought to affect both make-model groups in the same direction. On the other hand, the long-term trend could well be a reflection of the same regression-to-the-mean pattern that was seen in all the analyses of theft rates - or, optimistically, it could be a true indication that cars with marked parts were becoming less and less attractive to chop shops and professional thieves.

Additional insight on the relative strength of the various factors can be obtained by performing regression analyses on the "in part" recovery rates. One regression that fit the observed rates exceptionally well had the dependent variable DELRIP, the differential in the logs of the recovery rates, which was defined for each of the 15 allowed combinations of CY and MY.

$$\text{DELRIP}(\text{CY}, \text{MY}) = \log(r_{1p}/(r_1 - r_{1p})) - \log(r_{0p}/(r_0 - r_{0p}))$$

where

r_{1p} = in-part recoveries, make-models that got parts marking

r_1 = all recoveries, make-models that got parts marking

r_{0p} = in-part recoveries, make-models that did not get parts marking

r_0 = all recoveries, make-models that did not get parts marking

The independent variables included certain interactions of

MARKED = 1 if MY is 87-89, 0 if MY is 84-86

CYGE88 = 1 if CY is 88-91, 0 if CY is 86-87

MY_87 = MY-87

CY_88 = CY-88

and the regression weight factor was r_1+r_0 . With 15 data points, the regression had an R^2 of .921 and an F value of 29.02 ($p < .0001$). The regression coefficients were

Parameter	Estimate	T for H0: Parameter=0	Pr > T	Std Error of Estimate
INTERCEPT	0.4544791569	13.42	0.0001	0.03386093
MARKED	0.1050890833	1.71	0.1185	0.06154310
CYGE88	-.3144454287	-5.25	0.0004	0.05994914
MARKED*MY_87	0.0145630024	0.34	0.7421	0.04304260
CYGE88*CY_88	-.1286890860	-3.57	0.0051	0.03599973

In other words, the excess of the "in part" recovery rate for the models that got parts marking in 1987, relative to the models that did not, was originally quite large (INTERCEPT). It shrank significantly in CY 1988 (CYGE88) and continued to shrink significantly in each subsequent calendar year (CYGE88*CY_88). The direct effect of parts marking was nonsignificant when it was originally introduced in MY 1987 (MARKED), and it changed little in subsequent model years (MARKED*MY_87). By CY 1991, cars with marked parts had slightly lower "in part" recovery rates than cars without marked parts.

Whereas this particular regression fit the actual recovery rates exceedingly well and suggests that the CY effect was strong while the direct parts-marking effect was nonsignificant, it should be noted that other sets of independent variables also fit the data well and some of them showed a stronger parts-marking effect. Thus, it would not be appropriate to draw firm conclusions about the effects of parts marking, especially under the current circumstances, where possible biases inherent in the data limit the utility of any regression model.

Conclusions

The analyses of theft and recovery data were unable to generate reliable quantitative estimates of theft reductions or recovery enhancements attributable to parts marking. They do not even allow an unequivocal conclusion that parts marking has been effective. That was almost inevitable given the highly nonrandom method whereby make-models were selected for parts marking or antitheft devices, resulting in biases in the theft rate trends that would tend to obscure any effects that could reasonably be expected for parts marking.

Nevertheless, the analysis results are not totally inconclusive or neutral. They produced five concrete indications of benefits for parts marking, each one hedged with caveats that made it fall short of a firm conclusion:

- (1) Above all, there was a conspicuous shift in theft rates in 1987, the first year of parts marking. Thefts shifted from the 1987 make-models with marked parts to their 1986 predecessors without marked parts, or to other 1987 make-models without marked parts. However, this effect had vanished by the time the cars were two years old; also, the effect was more a shift in what cars were stolen than a reduction of overall theft rates.
- (2) Recovery rates for 1987 cars with parts marking were consistently higher than for the same make-models in 1986, the last year before parts marking. Unlike the effect on theft rates, this benefit persisted as the model year 1987 cars got older. On the other hand, the 1986-87 favorable effect was followed by an unexplained but consistent deterioration, starting in model year 1988, in the recovery rates of cars with parts marking relative to other make-models without the markings.
- (3) The rate of unrecovered thefts per million registration years is a surrogate for the incidence of "professional" thefts. In calendar year 1987, the unrecovered-theft rate of model year 1987 cars with parts marking was 26 percent lower than expected. As the model year 1987 cars got older, this benefit diminished, but not to zero; it persisted at about 6 percent. That is the closest thing to a specific "effectiveness estimate" for parts marking. However, that observed benefit is within the "noise range" of possible biases in the data and it cannot be attributed to parts marking without considerable doubt.

- (4) In the very long term (cars of the early 90's vs. cars of the late 70's), parts marking and antitheft devices appear to be associated with a reduction in theft rates. In other words, the make-models that were selected in 1983-84 to get parts marking or antitheft devices in 1987 historically had higher theft rates than other make-models, even as far back as model year 1976. But from model year 1991 onwards, their theft rates were slightly lower than other make models. Unfortunately, little can be said about the crucial intervening years, the 1980's. The nonrandom selection of high-theft lines for parts marking caused a "regression to the mean" situation that obscured all other trends. It is only possible to compare cars of the late 70's and early 90's, before and after the "regression to the mean" phenomenon. So many other factors could be affecting theft trends over a 20-year period that it would be foolhardy to attribute the observed long-term reduction to parts marking. Additionally, the unrecovered-theft rates did not experience a similar long-term improvement.
- (5) There was a strong reduction of "in part" vehicle recoveries, and a corresponding increase of "in whole" and "intact" recoveries in all make-models after parts marking was introduced in 1987, and especially in the make-models that got the markings. The reduction of "in part" vehicle recoveries could be an indication that chop shop operations and some other types of professional car theft are declining. However, a closer examination of the data showed that the reduction did not coincide with the introduction of parts marking, but mostly came 1-3 years later, possibly as a result of factors unrelated to parts marking, such as biases in the data.

By contrast, for at least one type of factory-installed antitheft device, the available data provide unequivocal evidence of effectiveness. One domestic manufacturer installed a system as standard equipment in various car lines during 1989-94. This system was associated with an immediate - and persistent - 70 percent reduction in the theft rate and a 58 percent reduction in the unrecovered-theft rate. In other words, the devices appear to be quite effective in reducing all kinds of thefts, both the "professional" and the "casual" type.

Substantially fewer data were available on the antitheft devices installed by other manufacturers. Specific estimates were not obtained, but the available data suggest considerable variation in effectiveness. With some of the devices, little change was seen in theft rates; with others, there were reductions comparable to those for the domestic manufacturer.

On the whole, the analysis results seem to suggest that the approach of the Anti Car Theft Acts, which view both parts-marking and factory-installed antitheft devices as effective deterrents to automobile theft, has had benefits. Only a small effect, such as a 2 percent reduction of unrecovered thefts is necessary for parts marking to be cost-effective. An effect of that magnitude would have been obscured in the data available for the analyses. However, the positive results described above hint that the effect of parts marking might have been greater than 2 percent, at least at certain times. Antitheft devices, at least those installed in certain vehicles, are many times more effective, but also many times higher in cost. Parts marking and antitheft devices are components of a larger program that has, on the whole, succeeded. As shown in the main report, overall theft rates have leveled off and even began to decline after 1989-90. When the team wins, each of the individual players gets some credit.

Two other issues tie in with the analysis results. It has been mentioned repeatedly that the nonrandom selection of high-theft make-models for parts marking impeded the evaluation, leaving the effectiveness of parts marking in doubt. Hopefully, future introductions of similar countermeasures will be done on a random basis or according to an experimental design that makes it easier to measure effectiveness.

Some of the analyses hinted that parts marking had a short-term effect that may have waned in subsequent years. That's at best a tentative finding, given the uncertainties in all the analyses. However, it corresponds to the view that many professional thieves, before too long, learned how to obliterate the markings. If so, that might encourage consideration of more permanent systems of parts marking, given the high potential for benefits relative to cost.

APPENDIX B

ANALYSIS OF REGRESSION TO THE MEAN IN THEFT RATES OF CARS WITH MARKED AND UNMARKED PARTS

Prepared by Robert F. Cook and Maria T. Woolverton, KRA Corporation under contract with the NHTSA. Some of the specific models with anti-theft devices were incorrectly classified which is corrected in Appendix A and the main report. This appendix is retained to illustrate the effect of regression to the mean

The intent behind the introduction of vehicle parts marking (and installation of anti-theft devices) was to reduce vehicle theft rates. While theft rates of marked and anti-theft equipped vehicles have fallen, rates for unmarked vehicles have risen. This analysis examines whether this convergence in theft rates is due to a statistical phenomenon known as regression to the mean.

The phenomenon of regression to the mean can occur as the result of selection of a subgroup from a larger population using a selection criteria that is somehow related to the variable of interest. Comparison is then made of the average value on some measure for the subgroup to the average result from the same subgroup in a later period. The average of the subgroup can change *systematically* for purely statistical reasons that have nothing to do with the phenomenon that is presumably under study. The extent to which this occurs depends upon the correlation of the values of the measure from one period of time to the next in the overall population.

A good example of this phenomenon is pre- and post-test scores in a class. Suppose students are given a test of statistical ability at the outset of a class in statistics. Let us assume that the average grade on the pre-test is 75 percent. Let us further assume, as is often the case, that the class has no effect on the statistical ability of the average student. Therefore, we would expect that the average post-test score would also be 75 percent. This result is not terribly satisfying, so we want to see if the class helped those who were "statistically challenged." We select those students who scored poorly on the pre-test and find that their average score was 60 percent. In the post-test, the same sample of students obtains an average score of 70 percent. Should we conclude that the class "helped" them? The answer is probably not. Since the average score on the two tests remained the same for all students, if this group of students scored better on the post-test, then some other group must have scored worse than they did on the pre-test. In fact, this has to be the case. Had we selected a similarly sized group of those who did well on the pre-test (let us assume an average score of 90 percent), we would have found that, on average, they did worse on the post-test (likely average score 80 percent). Is it possible that the class made them worse off? The answer is that unless the

scores on the two tests are perfectly correlated, we would expect some regression towards the mean of the second test in the average scores of both subgroups. We should not conclude that the class “helped” the low scoring group or “hurt” the high scoring group.

The same phenomenon seems to occur in the case of vehicle parts marking (or the alternate, anti-theft device installation). Cars that were originally required to have marked parts were selected from among those with above-median theft rates in 1983 and 1984. They were first marked in 1987. Conversely, one could say that the cars that remain unmarked were “selected” from among those with lower-than-median theft rates in 1983 and 1984. This latter group is similar to the group in the example above that had below average pre-test scores, and the marked cars could be considered similar to the high scoring subgroup.

Exhibit 1 shows the time trend of theft rates for new unmarked, marked and anti-theft cars over the period from 1984 to 1991. The theft rate of vehicles in 1984 would be equivalent to the pre-test in our example. The theft rate in any other year could be considered a post-test measurement. Given the method by which cars were selected to be marked, we would expect some regression to the mean in the apparent theft rates.

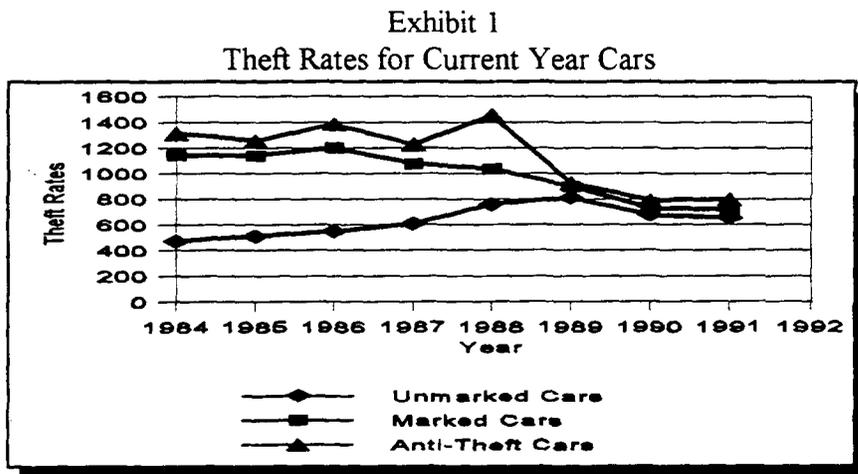


Exhibit 1 appears to show regression to the mean for the marked, anti-theft, and unmarked vehicles. The theft rates of current year marked and anti-theft cars decline and the theft rate of unmarked cars increases until

the groups are roughly equivalent in 1991. This is to be expected if they are selected subgroups of the general population of cars and the theft rates in any two different time periods are not perfectly correlated. The issue then is whether regression to the mean can account for all of the apparent change in vehicle theft rates or whether the requirement of parts marking or installation of anti-theft devices has had an overall effect on vehicle theft.

Estimation of Regression to the Mean Effects

As alluded to in the above example, the extent of regression to the mean of observed results for a given selected subgroup (e.g., marked cars) from the population depends upon the correlation between the two measures (e.g., theft rates) in time in the overall population. If the scores on the pre and post measures are uncorrelated, then any difference in the average score of a particular subgroup is purely random. If this is the case, then the most likely value on a second measure is the average for the population, that is, complete regression to the mean of the population. If, on the other hand, scores on the two tests are perfectly correlated ($r = 1.00$), the most likely value for the average theft rate of a subgroup of cars is the same as in the pre-test (e.g., the average theft rate of the subgroup in 1984). In this case there would be no regression to the mean (average) of the population.

It follows from the above that, if the correlation of the two scores (theft rates) for the entire population is known, as well as the average scores for the population on each measure and the average score of the subgroup for the first measure, we can calculate the expected regression to the mean. In the current example, if the average theft rates for all passenger vehicles at both points in time and the correlation between the two theft rates are known, as well as the theft rate of the subgroups, it is possible to estimate what the theft rate of the subgroup of vehicles would be at a second point in time if it were due only to the regression to the mean phenomenon.

The formula for the percentage regression to the mean is as follows:

$$P_{rm} = 100(1 - r)$$

Where:

P_{rm} = Percentage regression to the mean

r = Correlation between two measures in time

If we then know the average score for the entire population as well as the average score for the particular subgroup in each time period, we can estimate the expected effect of regression. The expected value of the average theft rate of the subgroup at the time of the second measurement is estimated as follows:

$$E\bar{X}_2 = \bar{X}_1 - (U_2 - \bar{X}_1)(1 - r)$$

Where:

$E\bar{X}_2$ = Expected value of the mean of subgroup on the second measure

U_2 = Mean of the measure at a second point in time

\bar{X}_1 = Mean of the subgroup on the first measure

If we know the expected effect of the likely regression to the mean for marked vehicles, then any residual reduction in the observed theft rate in the later period may be the result of vehicle marking. We can also perform the same calculation for unmarked vehicles to observe the likely change in the theft rate of these vehicles. The difference between the actual and expected value of the mean of the subgroup in the second time period is as follows:

$$E(DIF) = \bar{X}_2 - E\bar{X}_2$$

Or, from above:

$$E(DIF) = \bar{X}_2 - (\bar{X}_1 - (U_2 - \bar{X}_1)(1-r))$$

Where:

E(DIF) = Expected value of the difference in theft rate in time period two

\bar{X}_2 = Mean value for the subgroup in time period two

The point should also be made that, in the current analysis, we are concerned with the entire population of passenger vehicles of which a subset are marked, unmarked, etc. The theft rate for each subset is calculated by dividing the number of thefts by the total number of each type of vehicle registered (in this case for the current year model). Thus, the results are not subject to the usual measures of sample significance.

From the above example, the population (the class) has to remain the same from the time of the first measurement to the second. This has not been the case for passenger vehicles. The first passenger vehicle models to have required parts marking were identified in 1984 and first marked in 1987. Subsequently, more models have been designated for parts marking and some manufacturers have elected to install anti-theft devices in lieu of parts marking. For the current analysis, we selected 66 models that were in production continuously from 1984 through 1991. Of these, 43 were marked or had anti-theft devices installed as of 1987 or 1988. The marked and anti-theft equipped vehicles were combined into one group, referred to as the "marked" group for the remainder of this paper.³ We started the series in 1984 since that was the year the first models were selected. Continuing the series through 1991 provided the longest series with the largest cohort of models. Also, successor

³ Of the 43 models included in the marked group, 30 were marked continuously during the period 1987/1988 to 1991. An additional 7 marked models added anti-theft devices in 1990 or 1991. Six models were equipped with anti-theft devices continuously during the period 1987/1988 to 1991.

legislation passed in 1992 designated additional models for marking based on 1990 and 1991 theft rates.

Effects of Regression to the Mean on Average Theft Rates

Table 1 shows the average theft rates for each type of passenger car (and predecessors) in each year from 1984 to 1991 and is the data upon which the graph in Exhibit 1 is based. The theft rate for marked cars declines over the period from 1984 to 1991 from 1.15 percent to .713 percent. For anti-theft equipped vehicles, the theft rate declines from 1.31 percent to .797 percent. At the same time, the average theft rate for unmarked passenger vehicles increases from .470 percent in 1984 to a high of .809 in 1989, and then decreases somewhat in 1990 and 1991 to a rate of .650 in 1991.

Table 2 shows the number of registered vehicles, thefts, and theft rates for marked, unmarked, and total passenger cars in each year from 1984 through 1991 for the 66 models included in this analysis. For the marked group (including anti-theft vehicles), the theft rate in 1984 is 1.292 percent and declines to .760 in 1991. The theft rate for unmarked vehicles rises from .444 in 1984 to a high of .742 percent in 1989 and then declines to .630 in 1991. The weighted average rate for all vehicles included in the analysis declines over the period from .866 to .689.

Table 3 shows the correlation matrix for the overall theft rate by year. The year-to-year correlations of the theft rate are quite high. However, as might be expected, correlations decline as the time interval between measurements lengthens. Of importance to the current analysis, the coefficient of variation (R_{sq}) for 1984 and 1991 vehicle theft rates is .3242. The correlation coefficient (R) is then .5694. We would therefore expect the rate for marked vehicles to regress $(1-.5694)$, or approximately 43 percent of the way from the 1984 rate toward the all-vehicle average rate in 1991, if regression to the mean were the only factor affecting the change in theft rates. Similarly, we would expect the theft rate for unmarked vehicles to rise 43 percent of the distance from the rate in 1984 toward the rate for all vehicles in 1991.

These calculations are shown in Table 4a. The actual rates in 1984 and 1991 are taken from Table 2. The expected rate in 1991 is the 1984 rate plus or minus 43 percent of the difference between the

1984 rate for each class of vehicle and the all-vehicle rate in 1991 of .689. In Table 4a, we calculated the average theft rates of marked and unmarked passenger cars as well as the weighted total of the two. We then calculated the expected theft rates for each type of vehicle and a weighted total in 1991. The difference column in the table shows the difference between the actual and expected theft rates for each category in 1991.

Over the period 1984 through 1991, the actual theft rate for marked vehicles declines from 1.292 percent to .760 percent. The rate calculated on the basis of the expected degree of regression to the mean declines to 1.032 percent. Thus, over the entire period, regression effects account for 55 percent of the observed decline in the theft rate for marked vehicles. Over the same period, the theft rate for unmarked vehicles rises from .444 percent to .630 percent. However, the theft rate expected in 1991 based on regression to the mean rises only to .550 percent. Thus, regression effects account for only 57 percent of the observed rise in the theft rate of unmarked vehicles. The combined theft rate declines from .866 to .689 over the period. However, the expected average rate, which is the weighted average expected rate for marked and unmarked vehicles, is .768. Thus, overall, regression to the mean accounts for 55 percent of the decline in the theft rate for all vehicles in the population.

If regression effects account for only slightly more than half of the decline in the theft rate of the marked group, then some other factors (such as parts marking) must be involved in reducing thefts of those vehicles. Similarly, if only a little more than half the rise in the theft rate of unmarked vehicles over the period can be accounted for by regression effects, then something else is contributing to the rise. One possible explanation for the remainder of the increase is that while parts marking may contribute to a reduction in theft for marked vehicles, it may also raise the theft rates of unmarked vehicles by altering the preferences of car thieves.⁴ However, the overall theft rate declines by more than can be accounted for by regression effects. This suggests an effect of parts marking on the overall theft rate.

We performed similar calculations for the 1984 to 1989 interval (Table 4b). The overall correlation of theft rates for this period (from Table 3) is higher, (.3815). Based on this correlation, we would

⁴ A suggested title for this paper was "Do Car Thieves Read the *Federal Register*." In fact, we found an article on how to remove marking from vehicle parts on the Internet.

expect rates to regress approximately 38% of the way toward the mean of the all-vehicle theft rate for 1989. Similar to results from the 1991 analysis, for marked vehicles the actual theft rate is below the expected rate and for unmarked vehicles the actual rate is above the expected rate. Thus, the decline in the theft rate for marked vehicles is greater than can be explained by regression effects. The same is true for the overall theft rate. Similarly, the theft rate for unmarked vehicles rises by more than can be explained by regression effects. Of the overall change in theft rates, regression effects account for 60 percent of the observed change for marked vehicles and 48 percent of the increase in the theft rate of unmarked vehicles over the period. Again, the rest of the change in theft rates must be attributable to other causes, including parts marking.

As shown in Table 4c, we also performed the same calculations for the 1984 through 1986 period. This period was after vehicles had been identified for marking, but before actual marking of parts began. Over this shorter period, the coefficient of variation of the overall theft rate is considerably higher (.6295) and so the expected regression effect on theft rates is smaller (21 percent). During this period, the theft rate for marked vehicles actually declined less than would be expected as the result of regression to the mean. Therefore, something else was raising the theft rate in this period. Similarly, the actual theft rate for unmarked vehicles rises less than would be expected as the result of regression effects (as does the total rate). Therefore, some other cause must be found for the lower than expected theft rate for unmarked vehicles.

The fact that regression to the mean of the theft rates more than accounts for the actual change in theft rates in the period before parts marking took effect and for only 55 to 60 percent of the decline in the theft rate for marked vehicles after parts marking suggests that the "other cause" for the unexpected decline in theft rates of these vehicles may be at least partially the result of parts marking. At the same time, similar, but opposite effects for unmarked cars from the period prior to marking to after parts marking took effect also suggests that parts marking had a *positive* effect on the theft rates of unmarked vehicles. That is, parts marking had the effect of changing the preferences of car thieves toward unmarked vehicles.

A final possibility, not accounted for by this analysis, is a change in taste among those responsible for vehicle theft. This period also saw the beginning of the rise in the population of minivans and sport

utility vehicles. It is possible that the decline in passenger vehicle theft is the result of a shift to increased theft of these other vehicles. Minivans and sport utility vehicles are included in the larger category of light trucks. However, the theft rate for this category of vehicle parallels that of passenger vehicles over the period from 1984 to 1991.⁵

Table 1
Average Theft Rates
Current Year Passenger Vehicles by Type
1984 - 1991
(In Percent)

Vehicle Type	Year							
	1984	1985	1986	1987	1988	1989	1990	1991
Unmarked	.470	.509	.546	.606	.756	.809	.673	.650
Marked	1.15	1.14	1.20	1.08	1.04	.899	.731	.713
Anti-Theft	1.31	1.25	1.38	1.23	1.46	.926	.787	.797

⁵ The theft rate for light trucks rises from .0387 percent in 1984 to .0557 percent in 1989 and then declines to .0535 percent in 1991.

Table 2

Thefts, Registrations and Theft Rates
 For Current Year Marked and Unmarked Passenger Vehicles
 1984 - 1991

Year	Marked Vehicles			Unmarked Vehicles			Total		
	Thefts	Registered	Theft Rate	Thefts	Registered	Theft Rate	Thefts	Registered	Theft Rate
1984	28467	2204121	1.292	9889	2224822	.444	38356	4428943	.866
1985	26365	2116771	1.246	11304	2272655	.497	37669	4389426	.858
1986	26191	2073878	1.263	12358	2399687	.515	38549	4473565	.862
1987	21306	1909210	1.116	13468	2311153	.583	34774	4220363	.824
1988	20633	1920712	1.074	13915	1966599	.708	34548	3887311	.889
1989	16876	1857274	.909	15049	2027029	.742	31925	3884303	.822
1990	13453	1704209	.789	12026	1776966	.677	25479	3481175	.732
1991	11898	1566172	.760	11941	1894401	.630	23839	3460573	.689

Table 3

**Theft Rate Correlation Matrix
1984 - 1991**

	84 Rate	85 Rate	86 Rate	87 Rate	88 Rate	89 Rate	90 Rate	91 Rate
84 Rate	1.0000							
85 Rate	.8795	1.0000						
86 Rate	.6295	.8016	1.0000					
87 Rate	.5387	.7096	.9179	1.0000				
88 Rate	.4709	.5637	.7679	.7856	1.0000			
89 Rate	.3815	.3441	.3110	.4162	.5308	1.0000		
90 Rate	.2600	.1916	.2403	.3599	.5360	.8069	1.0000	
91 Rate	.3242	.1891	.1570	.1654	.4181	.6990	.7981	1.0000

Table 4
Calculation of Expected Regression
Marked and Unmarked Passenger Vehicles

4a. 1984-1991

Vehicle Type	1984 Rate	1991 Rate (Actual)	1991 Rate (Expected)	Difference
Marked	1.292	.760	1.032	-.272
Unmarked	.444	.630	.550	+.080
Total	.866	.689	.768 (weighted)	-.079

4b. 1984-1991

Vehicle Type	1984 Rate	1991 Rate (Actual)	1991 Rate (Expected)	Difference
Marked	1.292	.909	1.112	-.203
Unmarked	.444	.742	.586	+.156
Total	.866	.822	.826 (weighted)	-.004

4c. 1984-1991

Vehicle Type	1984 Rate	1991 Rate (Actual)	1991 Rate (Expected)	Difference
Marked	1.292	1.263	1.203	+.060
Unmarked	.444	.515	.530	-.015
Total	.866	.862	.835 (weighted)	+.027

APPENDIX C

VEHICLE AGE AND PASSENGER CAR THEFT AND RECOVERY EXPERIENCE

The Effect of Vehicle Age on Thefts And Recoveries

It is not clear whether vehicle age is a factor in a thief's motive for stealing a vehicle. Data are not available to determine the motive for thefts or for the theft of a vehicle as the vehicle ages. However, an overview of the theft and age of vehicle relationship can be explored by looking at the theft rates as the vehicle ages.

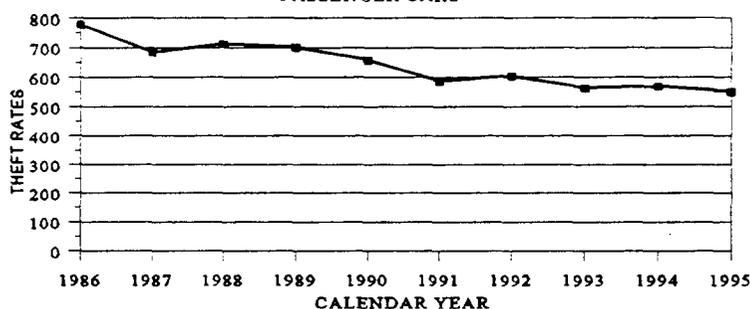
Vehicle Age and Theft Rates of Passenger Cars

Theft rates⁶ by vehicle age for model years 1986 - 1995 were calculated to determine if a relationship exists. When looking at vehicle age over that period of time it appears that theft rates actually increase as vehicles age. Ignoring the effects of both calendar year and model year would lead the analyst to that assumption. The analyses was careful to control for the calendar year and model year effects on the relationship between vehicle age and theft rates.

The calendar year of theft is the year in which any model year passenger car was stolen. For example, if a car produced in 1990 was stolen in 1994 then it would be recorded as stolen in calendar year 1994, just like a car produced in 1986 and stolen in 1994 would be considered stolen in calendar year 1994. Figure C-1 shows the theft rates for the calendar years 1986-1995. Theft rates for vehicles stolen have steadily decreased over that 10 year period of time. Obviously passenger cars have been stolen less often over the past decade.

FIGURE C-1

THEFT RATES - CALENDAR YEAR
PASSENGER CARS



⁶Theft rates are the number of stolen vehicles in a given year (from the FBI files) divided by the number of registered vehicles (from the R.L. Polk files of total vehicles registered by all states in the U.S. in the same given year).

The model year of the theft is the year in which the vehicle was produced. For example, a vehicle produced in the period from September 1995 through August 1996 would be considered a model year 1996 vehicle. Unlike calendar year theft rates, model year theft rates have fluctuated over that same 10 year period. Figure shows that the late 80s' model year thefts rates were declining through the early 90s' models but began to increase again from 1993 to 1995 models. Combining model year and calendar year theft rates produces a confusing pattern.

To explore the relationship of theft and vehicles age, the theft rates for each vehicle age for each of the model years 1986-1994 were calculated. Also, theft rates combining model years 1986 - 1988 were calculated for vehicle ages 0 through 8 years. Theft rates for model years 1987 through 1992 either increased and then remained stable after the first year of age or remained relatively consistent throughout several years of age. The only model year that shows a rise in theft rates as the vehicle ages is model year 1986. The following graphs show the vehicle age theft rates for models 1987-1992.

FIGURE C-2

THEFT RATES - MODEL YEAR PASSENGER CARS

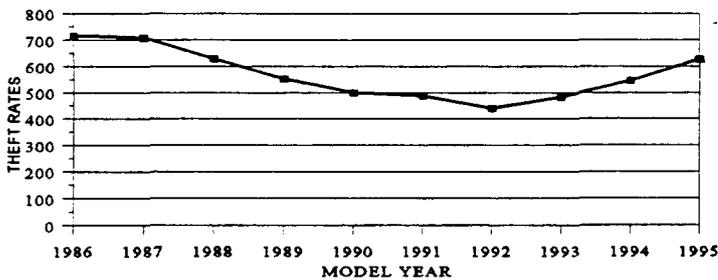


FIGURE C-3

MODEL YEAR 86 THEFT RATES PASSENGER CARS

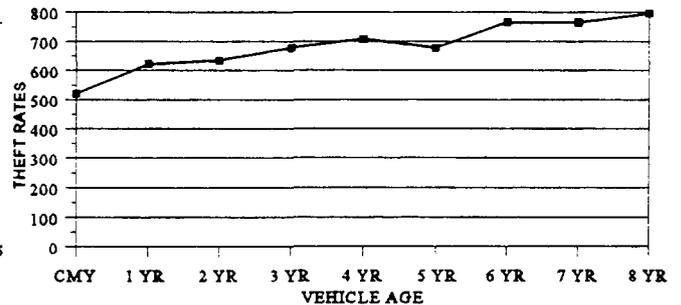


FIGURE C-4

MODEL YEAR 87 THEFT RATES PASSENGER CARS

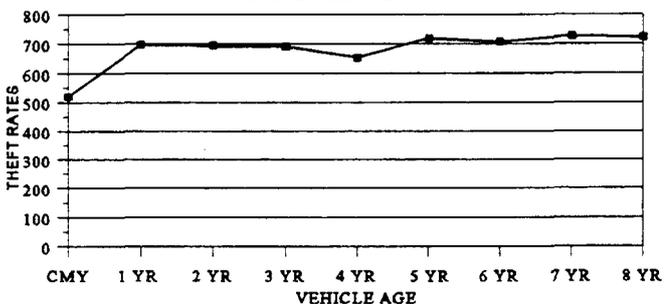


FIGURE C-5

MODEL YEAR 88 THEFT RATES PASSENGER CARS

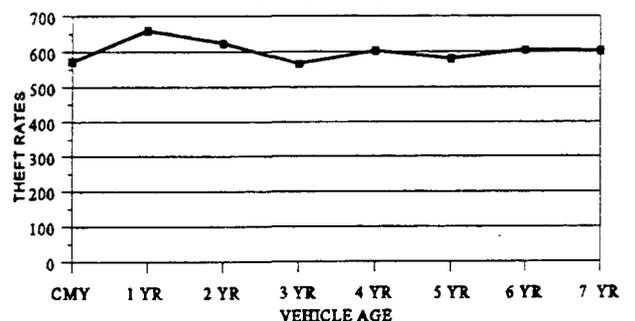


FIGURE C-6

MODEL YEAR 89 THEFT RATES
PASSENGER CARS

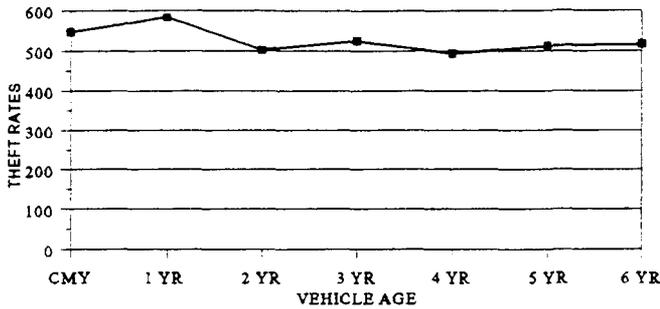


FIGURE C-7

MODEL YEAR 90 THEFT RATES
PASSENGER CARS

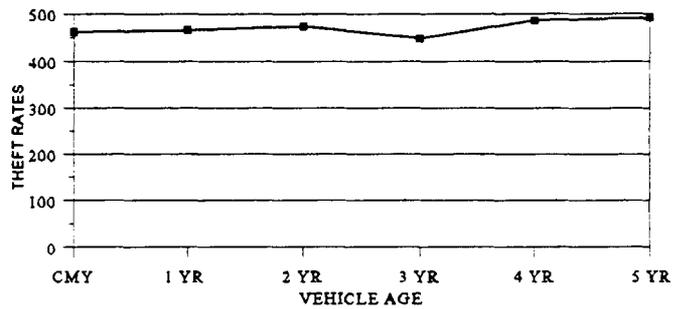


FIGURE C-8

MODEL YEAR 91 THEFT RATES
PASSENGER CARS

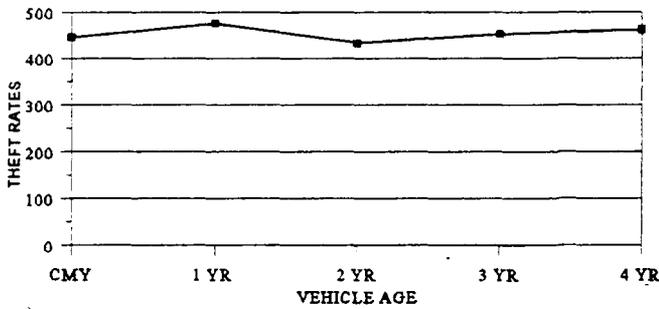


FIGURE C-9

MODEL YEAR 92 THEFT RATES
PASSENGER CARS

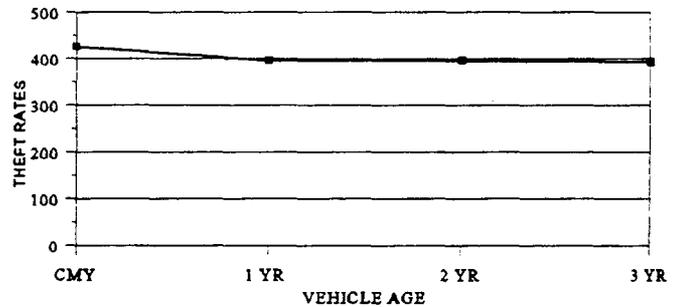


FIGURE C-10

THEFT RATES - MODEL YEAR 86-88
PASSENGER CARS

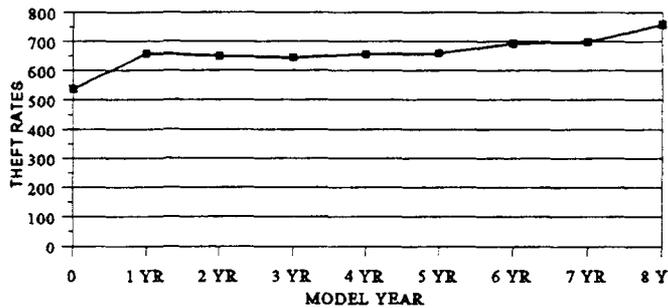
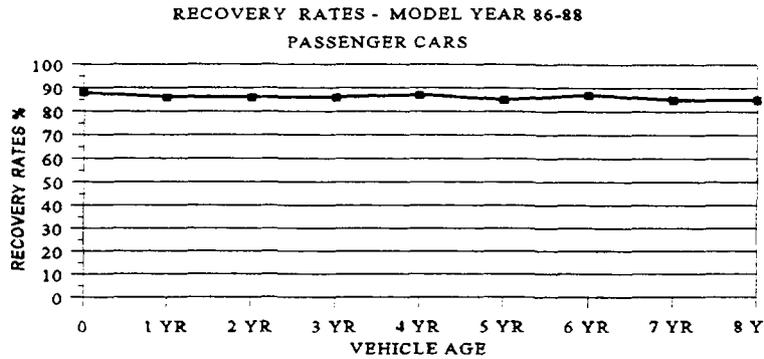


Figure C-10 shows the theft rates for the combined model years of 1986-1988. Theft rates for those models and vehicle ages fluctuated only slightly from ages one through seven. The linear regression for vehicle age and theft rates was not significant. The age of a vehicle does not provide any indication of its likelihood of theft. Vehicles that are seven years old are only slightly more vulnerable to theft than vehicles that are one year old.

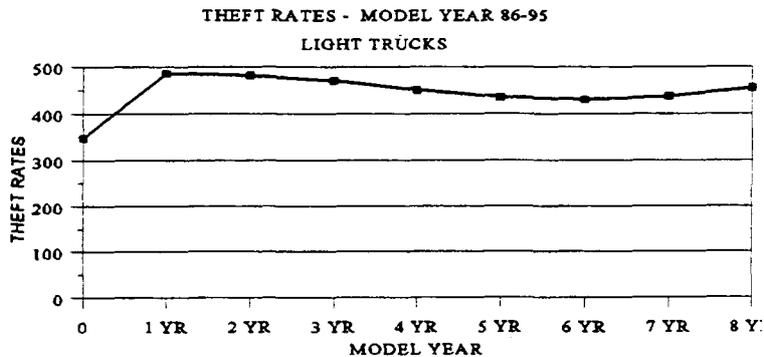
FIGURE C-11



Recovery Rates for Passenger Cars

Recovery rates for passenger cars as they age remain relatively stable. For the same model years 1986-1988 across the vehicle age recovery rates range from 85-88 percent and averaged 86 percent. Figure C-11 shows the recovery rates for model years 1986-1988 for vehicle ages 0 to eight years of age. Older models are not any less or more likely to be recovered than newer model passenger cars.

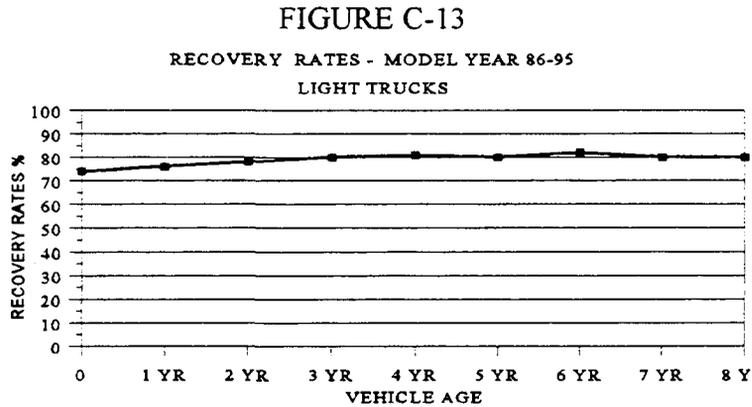
FIGURE C-12



Vehicle Age and Theft and Recovery Rates for Light Trucks

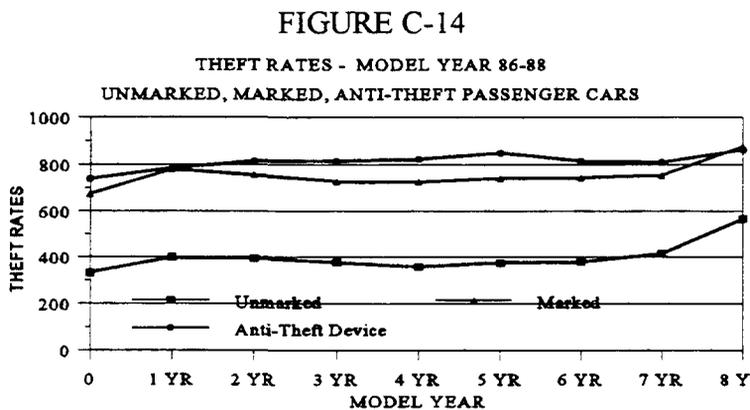
Vehicle age theft rates for light trucks were also calculated. Figure C-12 shows the combined theft rates for model years 1986-1995 as they aged over a nine year period. After an initial increase in theft rates from 0 to 1 year of age, theft rates decreased six percent from vehicle age 2 through age 7. The average theft rate was 444 and ranged from a low of 348 to a high of 481. The linear regression for theft rates and vehicle age was not significant. Vehicle age does not provide any additional information about the likelihood of theft of light trucks as they age.

Recovery rates for light trucks fluctuated only slightly for the same period of time. Figure C-13 shows the recovery rates for light trucks from age 0 to 8 years of age. Recovery rates for light trucks ranged from 74 percent to 82 percent and averaged 79 percent. As with passenger cars, vehicles age tells us little about the likelihood of recovery of light trucks.



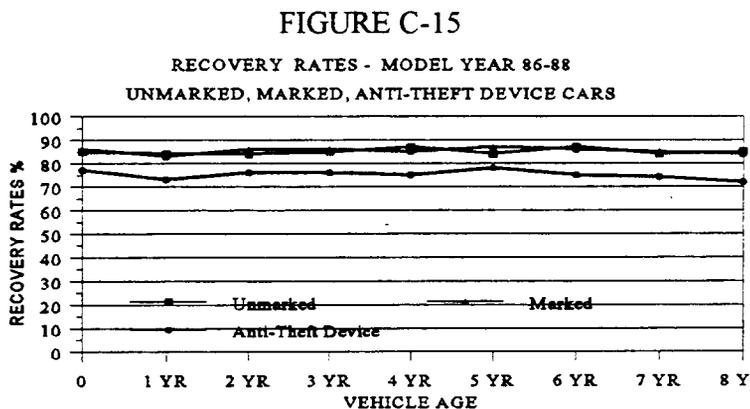
Effect of Parts Marking on Vehicle Age and Theft and Recovery Rates

Theft rates were calculated to determine the effect of parts marking on passenger car theft rates as they age. Figure C-14 shows the theft rates for unmarked, marked, and anti-theft model year 1986-1988 passenger cars as they aged over a nine year period. Theft rates for both the unmarked and marked vehicles increased from 0 to 1 years of age. Theft rates for unmarked vehicles fluctuated slightly for first through seven years of age and then increased from age 7 to 8. Although at a higher rate, theft rates for marked cars mirrored the same trend as the unmarked cars.



Anti-theft device theft rates trends differed slightly from both marked and unmarked models. Anti-theft device theft rates increased slightly from vehicle age 1 to 5 then decreased from age 5 through 7, and increased from 7 to 8 like the other marked and unmarked models did. But for all models, theft rates remain relatively consistent from ages 2 through 7 years of age. None of the linear regressions for the unmarked, marked, or anti-theft passenger cars were significant. Again, age is not a good predictor of the likelihood of the theft of a passenger car.

Recovery rates for the unmarked, marked, and anti-theft 1986-1988 model year vehicles were relatively stable for vehicle ages 0 through 8 years. Unmarked vehicles are recovered slightly less often than either the marked or anti-theft vehicles as they age. Vehicle age is not a predictor of the possibility of recovery for either the unmarked, marked, or anti-theft cars.



APPENDIX D

Summary and Discussion of Docket Comments

Docket No. 97-042, Notice 1

Summary of Docket Comments

Docket No. 97-042, Notice 1

97-042-N01-002 Jaguar Cars Inc.

- A. Jaguar says the Preliminary Report incorrectly shows the Jaguar XJS as an unmarked vehicle for the 1984-1991 model years. According to Jaguar, all models (XJ5, XJ6 Vanden Plas, and Majestic Sovereign) - four-door, coupes, and convertibles have been marked since 1987, when parts marking began.

97-042-N01-003 Florida Motor Vehicle Theft Prevention Authority

- A. The Authority fully supports the continuation of the parts-marking program. Parts marking assists in both investigation and prosecution of thieves. It is an effective deterrent to professional theft when combined with other proactive law enforcement efforts.
- B. The Authority also supports more permanent marking methods since it would further discourage thefts, making selling stolen parts more difficult, costly and add more risk to the stolen parts market. As a minimum, current labeling should be continued.
- C. The Authority thinks that parts marking should be expanded to all newly manufactured vehicles, both imports and domestic.
- D. The Authority feels the insurance industry should be required to be more proactive, such as inspecting and verifying VIN numbers and parts before claims are paid or policies issued.
- E. Theft of air bags is a significant problem with few tools to help auto theft investigators. The Authority supports any laws that would assist in the marking or control of air bags.

A. Antitheft Devices

1. AAMA disagrees with the Preliminary Reports finding that antitheft devices are about as beneficial as parts marking in deterring auto theft.
2. There are errors in the date when certain vehicles had antitheft devices that influences the findings.
3. Antitheft devices have evolved and active systems have been replaced by passive systems requiring no action by the driver. Eventually passive systems were replaced by devices that disabled the engine. The more recent systems are more effective in reducing auto theft.
4. AAMA cites the Highway Loss Data Institute (HLDI) findings of the effectiveness of antitheft devices in reducing theft.
5. Vehicles with antitheft devices are less likely to be stolen for joyriding or transportation, thus their recovery rates are lower.
6. Thirteen states mandate discounts for antitheft devices. No states do so for vehicles with marked parts according to the AAMA. If antitheft devices did not reduce vehicle theft, insurers would provide data to persuade legislators to remove the mandates.
7. In 1997, about 34% of cars and light trucks made by AAMA members had standard antitheft devices. For 1998, this will increase to 54%.

B. Parts Marking

1. AAMA's theoretical discussion of parts marking as an auto theft deterrent indicates that the effect is limited and indirect.
2. AAMA says the Preliminary Report indicates that auto insurers appear to be putting minimal effort into tracking used parts.

C. The Report's Analysis of Parts marking

1. The short term analysis in the Preliminary Report includes models that were redesigned between 1984 and 1989.
2. AAMA disagrees with the hypothesis that a significant reduction in theft rate might be expected starting in 1987. AAMA is not surprised that there was little evidence to support the hypothesis.
3. AAMA says that if parts marking were an effective deterrent, theft and recovery trends should be greater as years pass because more thieves are apprehended and prosecuted. AAMA says the Preliminary Report showed the opposite -- the initial reduction in thefts and increase in recoveries vanished by the time cars were two years old.
4. AAMA says the report is inconsistent: it says that because of other factors, long term reductions cannot be attributed to parts marking; yet, the report identifies long term theft trends as one of four indications of the benefits of parts marking.

D. AAMA says that more permanent markings by stamping and marking glazing would dramatically increase costs.

E. Insurance companies, according to AAMA, should be required to check parts.

- F. Before imposing additional requirements, AAMA contends, the National Motor Vehicle Title Information System and National Stolen Auto Part Information System should be evaluated.

97-042-N01-005 Advocates for Highway and Auto Safety

- A. Because the Preliminary Report finds parts marking useful arresting and prosecuting auto thieves, is cost effective while imposing minimal cost to the auto industry, Advocates for Highway and Auto Safety support the continuation of parts marking which Advocates feels should be mandatory for all passenger vehicles.
- B. The law enforcement agencies surveyed indicated that parts marking was key to detecting stolen parts and as evidence of trafficking in stolen parts which parallels other law enforcement programs to mark valuable personal property for detection and recovery of stolen items and as evidence in prosecuting thieves.
- C. The finding in the report that parts marking plays an important role in detection and prosecution of professional car thieves and chop shop operators is supported by an article on car theft in New York City which shows thefts down from 1980 total because of effective prosecution of professional car theft rings and the closure of chop shops. Parts marking is part of a comprehensive approach to vehicle theft reduction that can be highly effective.
- D. Advocates does not agree that antitheft devices are equivalent to parts marking in effectiveness. Granting exemptions may confound the determination of parts marking effectiveness. Because the report does not desegregate data on antitheft equipped vehicles which are not exempted, the benefits of parts marking alone are difficult to determine. Advocates recommends this be done. Because of the high cost of antitheft devices, their effectiveness must be examined, according to Advocates.
- E. Several exempted car lines with antitheft devices continue to have very high theft rates.

Once granted, the car line exemption seems to continue despite these high theft rates. Advocates says, NHTSA appears not to show interest in reviewing exemptions in light of continued high theft rates and, as a result, revoking the exemption in favor of parts marking.

- F. While Advocates endorses more permanent marking methods, it believes that NHTSA should explore marking all passenger vehicles. Advocates is convinced that this should include vehicles currently exempted: vehicles with antitheft devices should also have marked parts.

97-042-N01-006 Nissan North America, Inc.

- A. Nissan feels the statement in the Preliminary Report that the cost of the labels and their assembly process has not changed may be in error. Nissan found costs of capitalization for plant and equipment, theft labels, and labor and related expenses to mark parts beginning in the 1997 model year for models produced Japan ranged from \$14 to \$20 per vehicle. Nissan vehicles produced in the U.S. have a somewhat lower cost. Approximately 70% of Nissan vehicles are manufactured in the U.S. The overall average cost for all their vehicles, according to Nissan, is substantially higher than the report's estimated \$4.92. Nissan suggests that other manufacturers with low volume production lines subject to parts marking might have costs in excess of the \$22 Congressional ceiling.

97-042-N01-007 Dade County Multi-Agency Auto Theft Task Force

- A. The Task Force includes investigators from the FBI, U.S. Customs Service, IRS, Florida Highway Patrol, Dade County State Attorney's Office, Metro-Dade Police Department, Miami Police Department, Miami Beach Police Department, Hialeah Gardens Police Department, and the NICB. The Task Force found parts marking an invaluable law enforcement toll for combating auto theft.

- B. In 1996, the Task Force recovered 867 stolen vehicles worth an estimated \$17.5 million and made over 400 arrests. Part labels played an important role in a majority of these cases. A label on a major component was consistently being missed which allowed investigators to positively identify stolen vehicles which resulted in vehicles being recovered in chop shops and being exported. This resulted in federal indictments.
- C. The parts marking program should be continued and expanded, according to the Task Force. All new vehicles should be marked. Since the top stolen vehicles vary by geographic region, marking all vehicles will better cover the U.S. If all vehicles were marked, officers in all jurisdictions would become aware of the parts marking program and its benefits. As more officers are educated, recoveries and arrests will increase and thefts will decline says the Task Force.
- D. The Task Force says more parts should be marked and markings should be more permanent. Air bags, a safety item, should also be considered a major part to be marked. With permanent markings, companies could ensure that factory installed airbags were in vehicles -- if there was installation by an unauthorized mechanic, parts marking could prove tampering had taken place.
- E. Factory Etched windows is also recommended by the Task Force. Often windows with original VIN etching are overlooked by thieves.
- F. More permanent markings are better. While the Task Force has been able to prove that labels have been removed, investigators have been unable to identify the original VIN.

97-042-N01-008 Florida Auto Theft Intelligence Unit

- A. The Florida unit is a non-profit organization with 468 active members including Federal State and Municipal law enforcement/auto theft investigators in Florida. Also membership includes representatives of insurance companies, rental vehicle companies, and auto theft deterrent manufacturers.

- B. The Unit has a component part labeling course and has instructed over 3,000 officers nationwide.
- C. The Unit says most law enforcement officers are either not aware or do not know how to identify vehicles using confidential or secondary numbers. Training for parts marking has not been readily available and is lacking in many jurisdictions. Auto theft investigation requires expertise particularly in vehicle identification. However, more agencies are becoming aware of parts marking.
- D. Task forces and prevention authorities are being formed in Florida and nationwide to combat auto theft. Thousands of vehicles have been recovered in Florida as a direct result of parts marking. The Unit hopes that parts marking will cover more car lines and other vehicle classes to provide law enforcement with continued investigative tools.
- E. Law Enforcement is becoming more educated in parts marking and finding altered and counterfeit labels. A more secure/permanent means to mark parts should be considered. Some current labels may be easily peeled while others self destruct and leave footprints. A system called invisographic type labels leave the full VIN as its footprint.
- F. With airbag replacement costing from \$500 to \$1,500 or more, the Unit recommends that airbags be marked. VIN etching of windows has proven to be a valuable tool to law enforcement. In nine years, one investigator only found two cases where etched windows were replaced.
- G. While antitheft devices prevent casual thefts, the professional still can defeat them. The Unit recommends that cars with antitheft devices also have marked parts rather than being granted an exemption from marking.

97-042-N01-009 Volkswagen of America, Inc.

A. Cost of Compliance

1. Volkswagen says for its Cabriolet Convertible and Corrado car lines, the cost of parts marking for labor and materials was \$15.77 [in 1990 dollars], excluding the engine and transmission. From VW's viewpoint, the major disadvantage of parts marking is the investment in the printing equipment for the labels and the factory logistics for applying them. Volkswagen questions the Preliminary Report's average cost per vehicle in 1995 dollars of \$4.92.
2. VW indicates that should additional vehicles be required to have marked parts, the investment cost in equipment for production lines and factories not producing parts marked vehicles would be significant.
3. Import manufacturers such as VW have increasing costs because of parts marking, which is only required in the United States. In contrast, Antitheft devices not only provide theft deterrence, but also customer value and security. The cost of such devices can be spread over larger production volumes because they could be considered as added value features in other countries.
4. VW marked parts on vehicles sold in Quebec and charged the dealer \$35 (Canadian) per car for parts marking.

B. Antitheft Devices

1. The technology of Antitheft devices has improved including adding ignition system immobilizer such as GM's PASS-key, BMW's "coded drive-away protection" system, and, in Germany, VW and other German manufacturers have introduced an electronically coded key and transponder beginning in 1995. Theft rates in Germany for car lines with the new German key dropped by nine percent which was below the national theft rate.
2. Antitheft devices, except for thieves equipped with tow trucks and trailers, deter drive away theft of vehicles for the purpose of selling them to chop shops or for retagging for resale or for personal use. Parts marking relates primarily to chop shop activity with

some possible effect on retagging.

4. NHTSA has been approving parts marking exemptions based on installing factory standard Antitheft devices. In the approval process, NHTSA compares theft rate reduction for comparative car lines. The VW Canadian experience also shows significant theft rate reductions for Antitheft devices.
- C. VW believes that parts marking should be phased-out or its current requirements reduced.
 - D. VW says the current statute or the regulations should not be changed to require parts marking on additional lines of passenger motor vehicles.
 - E. Volkswagen recommends that NHTSA request Congress to allow exempting at least two car lines per year.
 - F. VW believes that the parts marking requirements should be phased-out or limited to car lines with theft rates above the median as called for in the 1984 Act.
 - G. VW says there is no basis for expanding parts marking to more car lines. They question that the cost benefit of parts marking has been established and the regulation is contrary to international harmonization.
 - H. An evaluation study done in Canada for VW's with Antitheft devices and with both Antitheft devices and marked parts showed reduction in auto thefts. The study, VW says, found Antitheft devices showed a major reduction in auto theft but when marked parts were isolated, the reduction was not statistically significant.
 - I. Because the cost benefit of parts marking, according to VW, is inconclusive, VW does not believe that expanding the components to be marked is justified.
 - J. VW believes that insurance premium reductions and theft deterrent vehicle designs provide

positive consumer benefits. Therefore, VW will keep track of these factors in its product planning.

K. VW is not currently making any vehicles for sale in the U.S. that have marked parts.

97-042-N01-010 State Farm Insurance Companies

- A. The National Salvage Motor Vehicle Consumer Protection Act of 1997 should help reduce auto theft by eliminating opportunities for VIN switching and requiring rebuilt salvage vehicles be inspected for stolen parts.
- B. State Farm develops statistical reports for manufacturers to encourage development of effective factory-installed antitheft devices. This has resulted in several manufacturers upgrading their vehicles' antitheft capability. State Farm also evaluates factory-installed antitheft devices as well as doors, trunks and hoodlatch locking mechanisms.
- C. State Farm feels parts marking would be more effective if it were extended to exempted vehicles which have ineffective antitheft devices and to the remaining [passenger] vehicles not yet addressed by NHTSA rulemaking.
- D. State Farm has experienced a 61% drop in theft claim rates since parts marking began in 1987. While State Farm could not determine what portion of the decrease came from parts marking, they believe it has been a valuable law enforcement tool especially in states that have devoted resources to combat auto theft with programs and organizations. These programs together with antitheft devices, increased insurance investigation, increased consumer awareness have also had an impact on auto theft.
- E. State Farm agrees that parts marking has caused professional thieves to steal unmarked vehicles, hence marking all vehicles would have made a maximum effect on reducing auto theft.
- F. State Farm says law enforcement reporting to the National Crime Information Center on

missing parts is incomplete. The Final Report on the National Stolen Passenger Motor Vehicle Information System supports this finding. This thwarts efforts of insurers and others who purchase used parts in verifying whether the parts are legitimate or stolen.

- G. State Farm says air bags and windows should be marked. A pilot in Indiana on window etching saw claim frequencies drop over 37%. The manufacturing cost for etching, based on the Department of Transportation data [says State Farm] was less than \$10 per vehicle. Thus marking air bags and etching, along with the cost of currently marked parts, would be less than the Congressional limit of \$22 per vehicle.
- H. Antitheft devices which prevent whole vehicle thefts do little to prevent partial thefts and damage. The best devices are passive and electronically lock out both fuel and starting. State Farm only offers discounts when states require it.

97-042-N01-011 International Association of Auto Theft Investigators

- A. IAATI passed a resolution recommending that the parts marking requirement be made to apply to all passenger vehicles, sport utility vehicles, and light duty trucks and that exemptions for antitheft devices be eliminated as well as the 6,000 pound weight limit.

97-042-N01-012 Highway Loss Data Institute

- A. HLDI agrees that the theft frequency, discussed in the Preliminary Report, has declined. However, HLDI says the average theft claim payment has increased fivefold since 1979. Because of this, overall insurance theft losses have not changed over the 18 years. NHTSA does not discuss this.
- B. Antitheft devices show a stronger rather than equal effect as part marking on theft losses.
- C. Recovery data has been erroneously attributed to HLDI.

97-042-N01-013 Document does not exist

97-042-N01-014 Toyota

- A. Toyota says it has no other idea than the current marking methods: plates for engines, stamping for transmissions, and printed decals for body panels.
- B. Marking costs depend on marking methods and, for example, using plates would exceed the \$22 threshold according to Toyota.
- C. Marking glazing was proposed and terminated in 1994 by NHTSA because of public comments that: NHTSA does not have the authority, the cost would exceed the statutory maximum, windows are rarely stolen, there is no evidence that vehicles are stolen for their glazing.
- D. Because of the comments above, and the unreasonable labor costs to coordinate marked glazing to their respective vehicles, and the lack of demonstrable benefits, Toyota opposes marking glazing.

97-042-N01-015 3-M Safety and Security Systems

- A. 3-M believes that antitheft devices and component parts marking should not be seen as mutually exclusive or independent. Both contribute to auto theft deterrence.
- B. 3-M urges that all passenger vehicles, sports utility vehicles, multi-purpose vehicles, and light duty trucks have marked parts, and that the vehicle weight exemption be eliminated.
- C. 3-M is in favor of eliminating the antitheft device exemption provision of the Act.
- D. 3-M urges the expansion of major parts to be marked to include air bags and radios.

97-042-N01-016 Association of International Automobile Manufacturers (AIAM)

- A. AIAM says NHTSA should not make any recommendations concerning expanding the parts marking program because the findings are less than conclusive.
- B. AIAM says NHTSA has no authority to extend the parts marking coverage in the absence of any Attorney General's finding.
- C. AIAM says NHTSA should not expand coverage if benefits are only around two percent.
- D. AIAM says NHTSA underestimated parts marking cost and refers to cost estimates provided under comments 97-042-N01-006 and 97-042-N01-009.
- E. AIAM says NHTSA has underestimated the effectiveness of antitheft devices and should review its analysis.
- F. AIAM recommends eliminating the parts marking requirement.
- G. AIAM recommends expanding antitheft device exemptions.

97-042-N01-017 Iowa State Patrol

- A. In Iowa, few criminal cases are made for possession of a stolen part without its VIN sticker. This appears to stem from officers not being able to determine if the sticker is removed.
- B. The Iowa State Patrol recommends adding air bags and sound systems to the major parts list to be marked.
- C. The Iowa State Patrol recommends stamping all major parts.
- D. The Iowa State Patrol suggests that all vehicles be marked, not just high theft lines.

Discussion of Docket Comments

Docket No. 97-042, Notice 1

Vehicle Designation Changes and Theft Analysis

Comments received indicated that the database of theft and recovery data for the Preliminary Report included some incorrectly designated models and applicable years. Jaguar models from 1984 through 1991 are shown as unmarked when they actually had marked parts beginning in 1987. Several models, that were granted exemptions from parts marking because they had factory-installed antitheft devices, actually were equipped with these devices the year before the exemption was granted. Also some models included in the analysis were redesigned for marketing reasons. All these corrections were made to the database and analyses were redone. Both the charts and discussions in the report have been changed where appropriate. The basic analytical changes include the GM models with antitheft devices showing greater effectiveness than parts marking in deterring vehicle theft. Other vehicles, especially imported models, showed mixed results: some had lower theft rates after being equipped with antitheft devices and others either showed no reduction or an actual increase in vehicle thefts after being equipped with antitheft devices. Obviously the type of antitheft device has a significant effect on theft deterrence.

Participation in Theft Prevention System

Auto manufacturers and law enforcement agencies commented that the insurance industry should take a more active role in having repair parts checked for parts marking and that the VIN marking be checked with law enforcement agencies to determine that the part is not from a stolen vehicle. Conversely, the insurance industry says that law enforcement agencies should take a more active role in checking repair part sources such as salvage yards and body shops.

One comment was that law enforcement officers received little training to determine which cars are marked, what parts are marked, and where the markings are located. Even fewer officers

know how to locate secondary or confidential numbers on vehicles. If all passenger vehicles were marked, the law enforcement community and the insurance industry might be motivated to both learn what and where parts are marked, and to invest the time to actually monitor the salvage and auto body repair industries.

Parts Marking Vehicle Coverage

Law enforcement agencies, consumer groups, and the insurance industry submitted comments that all passenger vehicles should have marked parts. The auto industry comments were against parts marking because they felt that markings were not proven effective since NHTSA had not specified a numeric effectiveness answer with confidence bounds. The auto industry feels parts marking effects are limited and indirect. The auto industry argument is based on parts marking versus antitheft devices. They argue that since antitheft devices are so effective as compared to parts marking that these devices should be the preferred approach to deterring auto theft. Hence the auto industry feels parts marking should be either terminated, phased out, or limited to only the high theft lines.

Based on comments received, much of the current trouble in detecting and prosecuting auto thieves can be eliminated by requiring that all passenger vehicles whether or not they have antitheft devices - passenger cars and light trucks - have marked parts. Then thieves will not have the option of selecting unmarked cars to steal, police officers will know that all used parts are to be marked, the insurance industry can monitor the salvage and repair industry to be sure that used parts are legal, and stolen vehicles and parts can be more easily traced by to the owner. While the preliminary report did not include a definite effectiveness number(s), the report did say that parts marking is effective in reducing auto theft and improving vehicle recovery. Also, parts marking is an aid in apprehending and convicting auto thieves.

Permanence of Parts Markings

Law enforcement agencies favor more permanent methods of parts marking and say that labels have been altered and counterfeited. While evidence of label removal has been used to apprehend

and convict thieves, lack of the VIN has prevented identifying the stolen vehicle/part and owner. Several auto manufacturers indicated that parts marking was already so expensive and any move to make them more permanent would result in costs above the Congressional limit. No one provided any information on more permanent marking methods and their cost. One comment mentioned a type of label (invisographic) which has a footprint that shows the VIN - a step in the right direction. More information is needed to be able to make an informed decision regarding more permanent marking methods.

Additional Parts Recommended for Parts Marking

Several comments were received recommending that airbags be marked as well as glazing and sound systems. Airbags were recommended because they are safety devices and cost between \$500 and \$1,500 to replace. Glazing is recommended as a deterrent to stealing the whole vehicle rather than for the specific parts themselves. Estimates for etching glazing suggest that this could result in the total parts marking cost being at or above the Congressional threshold. While airbags are good candidates for marking, the location and method for marking them will be more difficult than other major parts. Sound systems are also frequently stolen from vehicles and marking them would help in recovering the system to the rightful owner. Since the whole vehicle is usually not stolen, marking the sound system may have a limited deterrent effect.

Antitheft Devices and Parts Marking

Parts marking and antitheft devices have somewhat different effects on vehicle theft and recovery. According to comments received, parts marking tends to discourage professional thieves and chop shop operators, antitheft devices seem to deter the amateur auto thief. The Preliminary Report showed that for parts marking to pay for itself, there only needed to be less than a two percent decrease in thefts. This is the result of the low cost of parts marking. Even if parts marking costs were increased to the Congressional limit, parts marking would only have to deter six to eight percent of vehicle thefts to break even. Antitheft devices are much more expensive than the cost of marking parts. The analyses in this final report shows that a reduction in thefts of over 50% is needed to offset a cost of over \$200 per vehicle for antitheft devices. Some of these

devices have achieved that level of effectiveness. One comment indicated that several of the exempted car lines have continued to have high theft rates. This suggests that a more in-depth analysis of theft and recovery rates for antitheft devices is needed. The analysis would require tracing car line experience by specific type of antitheft device to determine effectiveness. This information could then be supplied to consumers so they could make an informed decision to pay for these devices. The consumer, as is now being done, would make the decision to pay for antitheft devices rather than the Federal government become involved in this decision making process. On the other hand, parts marking, even though estimates are not precise, has been shown to be effective in both deterring theft and increasing vehicle/part recovery. Requiring all passenger vehicles be marked, regardless of them being equipped with antitheft devices, would improve theft deterrence, vehicle recovery, and apprehension and prosecution of thieves.

Cost of Parts Marking

Two comments were received indicating that the government cost estimate to mark parts was too low. One comment included costs for plant and equipment and reported costs that were three to four times as large as the government estimate. The other comment included the cost of printing equipment resulting in their estimate being three times larger than the government cost estimate.

The cost estimate in the Preliminary Report is based on the cost of purchased labels which can be obtained from several large suppliers and time studies performed in auto manufacturing plants during the final assembly process. Government cost estimates include factory burden (overhead) and profit. In another agency study, costs were estimated using a similar approach and with similar results. The government cost estimate does not include marking engines and transmissions. The Congressional ceiling on the cost of parts marking also excludes the marking of engines and transmissions. Traditionally these two parts were marked before the 1984 Theft Act.

Comments received for the 1991 report to Congress included two manufacturers saying their costs were higher and one label supplier reporting that they estimated the cost of parts marking to be lower than the government estimate.