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The effectiveness of vehicle security devices and their role in the crime drop

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Abstract

Car theft in the UK fell two-thirds from the mid-1990s as part of more widespread crime drops, and has been attributed to improved vehicle security. This study develops a Security Impact Assessment Tool (SIAT) to gauge the contribution of individual security devices and their combination. The metric of impact derived is termed the Security Protection Factor (SPF). Cars with central locking plus an electronic immobilizer, and often an alarm, are found to be 'SPF 25', that is, they were up to 25 times less likely to be stolen than those without security. That impact is greater than expected from the individual contributions of those devices, and is attributed to interaction effects. Tracking devices are found to be particularly effective but rarer. Protective effects were greater against theft of cars than against theft from cars or attempts, almost certainly reflecting the difficulty imposed on thieves by electronic immobilizers. It is suggested that this type of analysis could be usefully extended to other crime types and security combinations. The analysis also lends support to a 'security hypothesis' component of an explanation for the major national and international crime drops that is based in the criminologies of everyday life.

Keywords

British Crime Survey, crime drop, security hypothesis, vehicle security, vehicle theft

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Introduction

The most important criminological phenomena of recent times are the major drops in crime experienced in many industrialized countries over the last two decades. Between 1995 and 2007 in England and Wales, violent crime fell 49 per cent, domestic burglary 58 per cent, other household theft 48 per cent, bicycle theft 20 per cent and other theft of personal property 47 per cent according to the British Crime Survey (Hoare, 2009: 21). These are the most substantial declines ever experienced in such crimes.

The UK experience parallels that of many, perhaps most, industrialized countries. The crime drops were first observed in the United States where serious violent crime including homicide fell by 40 per cent (Blumstein and Wallman, 2000, 2006; LaFree, 1999). With variation by country and crime type there were significant declines across the 15 European countries for which reliable comparison could be made using the International Crime Victims Survey (Van Dijk, 2006a, 2006b; Van Dijk et al., 2007). Significant falls in crime have been identified in other countries including Australia, Canada, Japan and elsewhere (see, for example, Rosenfeld, 2009; Rosenfeld and Messner, 2009; Tseloni et al., 2010; Zimring, 2007).

Amid the more general falls in crime, declines in vehicle theft were particularly pronounced. In the United States, both the national police recorded crime data of the Uniform Crime Reports and the National Crime Victims Survey data show that from 1991 to 2008 vehicle theft fell around 70 per cent. Between 1995 and 2008, vehicle-related theft in England and Wales fell steadily and by two-thirds (65 per cent: Walker et al., 2009: 3).

The most prominent explanations for the crime drops offered to date are changes in: demographics; sentencing and imprisonment practices; the extent and practice of policing; gun control and concealed weapons laws; teenage pregnancy and abortion; lead pollution; crack cocaine markets; and economic strength. Yet despite a range of imaginative research and innovative analyses, most of these 'early' hypotheses appear to have little explanatory value. Some appear particular to the US experience, which differed from other countries, including those relating to sentencing and imprisonment, policing, gun control, abortion and the crack cocaine market (for recent reviews see Blumstein and Rosenfeld, 2008; Farrell et al., 2010, in press).

The theoretical orientation for the present study is drawn from the 'criminologies of everyday life' (Garland, 2000). The three prominent theories that we categorize as the criminologies of everyday life are routine activity theory (see Felson and Boba, 2010), crime pattern theory (see Brantingham and Brantingham, 2008) and rational choice theory (see Cornish and Clarke, 2008). These interpret crime trends in terms of the changing patterns of provocation and opportunity. Those patterns are a function of the supply, distribution and movement of suitable targets, of guardians who might protect those targets, and of those most likely to commit crime, all in the context of changes in technologies and the built environment. Cohen and Felson (1979) use this basic, and apparently rather simple, idea to explain the rise in crime in the United States following the Second World War. The increased supply of suitable targets for crime (for example easily removed cars and electronic goods), the decreased supply of some forms of guardianship (for example with increased participation in the labour market and hence reduced levels of day-time home occupancy) and the increased availability and movement of likely offenders (for example young men freed from domestic chores) created a rapid rise in crime. None of the developments producing the rise in crime was undesirable in itself. Increased criminal opportunities were a by-product of socio-economic progress. The actual increase in crime spawned efforts to reduce it. Methods focusing on opportunity reduction included efforts first, to reduce the suitability of targets that would otherwise be attractive to likely offenders and second, to improve guardianship where the supply of suitable targets was likely to be matched by a supply of likely offenders. One possible explanation for the widespread crime drop is, thus, that improvements in security have reduced opportunity. Just as routine activity theory explained the rise in levels of volume crime (notably vehicle crime and burglary) after the Second World War in terms of widening crime opportunities, so too perhaps the recent falls in those crimes can be explained in terms of shrinking crime opportunities effected by increases in security.

What we refer to as the 'security hypothesis' has been mooted by Clarke and Newman (2006) and Van Dijk (2006b). Building on this, Farrell et al. (2008, in press) proposed that change in the quality and quantity of security was a key driver of the crime drop by reducing opportunities. Their work sought to explain trends in England and Wales, and in Australia, and focused on vehicle theft and the role of security. In keeping with the work of Brown (2004), Brown and Thomas (2003), Laycock (2004) and Webb (2005) relating to England and Wales, and that of Kriven and Ziersch (2007) and Potter and Thomas (2001) relating to Australia, the study concluded that better and more widespread vehicle security underpinned the crime drops.

The present study complements those of Farrell et al. (2008, in press). It attempts more precisely to identify the effectiveness of different car security devices and their combination. Furthering the understanding of the contributions from different devices, from their combinations, and from them as a whole, is a means of drilling down into the details of the causes of the most significant drops in car theft ever experienced. By looking in detail at whether the form of opportunity reduction promised by a particular security device is matched by detailed patterns of crime, greater confidence can be had that the device itself is responsible for the reduced risk of crime. This is feasible because different security devices work in different ways to reduce opportunities for different forms of crime, as will become clearer as the article unfolds. Moreover, from a rather practical viewpoint identifying the most effective single and/or in-combination car security measures may direct the industry towards additional 'crime-proofing' of products and provide consumers with information that empowers them to make more informed decisions.

In addition to the substantive contribution of this work we propose that the approach should be replicable in other contexts, and so we term it a Security Impact Assessment Tool (SIAT). The product of this tool is a metric of the effectiveness of security devices relative to the absence of security, which we term the Security Protection Factor (SPF). There is serendipitous correspondence with both the popular acronym and impact measure for sunscreen protection where the Sun Protection Factor is a metric of the protection conferred by sunscreen relative to its absence. In both cases the SPF states the multiples of additional exposure time, relative to the absence of protection, beyond which the average owner is burned.

The next section gives a brief overview of key aspects of vehicle security to provide context. Most of the remainder of the article is concerned with explaining the data and the SIAT method, plus some interpretation of the SPFs.

Vehicle Security

Vehicle security is almost as old as the automobile itself. Newman (2004) provides a fascinating account of the parallel evolution of car security and car safety. Many seemingly everyday features such as keys and licence plates arose as early responses to theft. Keys were an early immobilizer as they isolated the ignition system. Licence plates reduced anonymity and allowed one stolen black Ford to be distinguished from the next. Following the rapid rise in car ownership and theft in the 1950s and 1960s, mechanical immobilizers (steering wheel and gear locks) showed some potential to reduce crime (Mayhew, 1992; Mayhew et al., 1976; Webb, 1994). However, many mechanical immobilizers could be overcome: one test found many could be overcome in seconds, and half of them in three minutes and 20 seconds (BBC, 2000). Electronic immobilizers have evolved as the preferred response. Good quality electronic immobilizers tend to be built-in rather than retro-fitted and work by disconnecting one or more of the fuel, starter and ignition systems (see Tilley et al., 2009). Likewise, door locks have evolved in form and placement. Individual windowsill-top push-button door knobs have been displaced by more discreetly located central-deadlocking with remote or proximity-activation by increasingly encrypted radio-frequency identification (RFID) devices. Systems relating to cars are now better regulated: the Vehicles (Crime) Act 2001 introduced the registration of motor salvage dealers and number plate suppliers and the Vehicle Identity Check scheme, all aimed at targeting the re-selling of stolen vehicles.[2] Licence-plate systems are becoming more sophisticated to reduce false registration of stolen vehicles (Webb et al., 2004). Southall and Ekblom (1985) dreamed of the crime-free car a quarter of a century ago, and it seems that many of the measures they recommended have become routinely incorporated during manufacture. In addition, although the present focus is on devices fitted in vehicles, environmental influences upon car crime have also proved amenable to prevention efforts. Work and leisure routines make car parks key nodes, but risks can be reduced by quality surveillance, access control and other measures (Clarke and Mayhew, 1998; Mayhew and Braun, 2004; Poyner, 1992; Webb et al., 1992; see also http://www.saferparking.com). Car crime at residential nodes can be reduced by better layout that facilitates surveillance by owners, particularly parking on driveways and in garages (see, for example, Clarke and Harris, 1992). In recent years, automated number plate recognition systems (ANPR) have sought to deny criminals the use of the road (see Henderson et al., 2004).

Market imperfections mean little information on risk and protection was previously available to consumers, so there was little incentive for manufacturers to develop security. Hence car theft indices were developed to 'name and shame' manufacturers and alert customers to the most stolen makes and models, those in the UK (Houghton, 1992; Laycock, 2004) following those in the USA (Hazelbaker, 1997). Likewise, detailed information derived from security tests by Thatcham (the Motor Insurance Repair Research Centre) are now publicly available.[3] Shaw and Pease (2010) have explored the potential to develop alternate measures akin to the theft index. They analyse information from *Motoring Which* to determine whether vehicle security level informs the decision of consumers to recommend purchase, and they include some examination of change in security and its relationship to vehicle price. The importance of the Shaw and Pease study lies in its recognition of the potential for publicly available market research data to inform the development of novel market-based incentives for crime reduction. That is an avenue worthy of further investigation but outside the remit of the present study.

It is clear that built-in and automated security has gradually changed the default in recent years, from insecure to secure among many new vehicles. Time-delayed auto-locking means the forgetfulness or apathy of car owners is now less likely to generate easy criminal opportunities. This means, to adapt the insightful old pun, that the careless are no longer the carless. At the same time, remaining thieves are faced with an increasingly difficult task requiring extra time, skills and know-how, tools and other resources, and risk.

Data

This study employs the British Crime Survey (BCS) data which were retrieved from the UK Data Archive at the University of Essex. The BCS is a nationally representative survey of adults 16 years or older living in private accommodation in England and Wales (Bolling et al., 2008). It has been conducted since 1982, and annually with continuous sampling since 2001. Data from the six contiguous annual surveys to 2007 are grouped together here to increase the number of responses relating to the many combinations of security devices. Data from both the Crime Prevention and Witness Intimidation Module C, and from the Victim Module of the survey are used. In Module C, a randomly selected sub-sample (one-fourth) is asked about the security measures relating to the main household car. Based on these answers we estimate the prevalence of car security devices in the population of cars which is referred to herein as the fleet. In the Victim Module, victims of car crime are asked about the security measures relating to their victimized car, the prevalence of which we then compared to that of the fleet to generate our initial outcome measure. We note at the outset that, in the BCS, the classification of ‘attempt’ does not distinguish between attempted theft of car and attempted theft from car because of the ambiguity of determining the aim of the offender when an attempt is thwarted.

The methodological limitations warrant acknowledgement. First, only those security features recorded in the BCS can be examined. Second, the sample of main household cars on which security information is collected is unlikely to be perfectly representative of the population from which victimized cars are drawn because 41.2 per cent of households (in our merged 2001 to 2007 BCS file) had more than one car. We anticipate this may over-estimate security effectiveness only slightly and would have little or no effect on the between-device differences which are our main focus.[4] Third, the car security devices of the most vulnerable 1 per cent of the population are unknown. This is because detailed information is only collected on the first three crime series per victim, and so it is missing for about 1 per cent of the sample who experienced more than three. The BCS survey strategy for victim module completion prioritizes personal over property victimizations. This means that when a respondent reports more than six series of crime (six being the maximum allowed, with a crime series being those of the same type that the victim reports as being of a similar nature and committed by the same perpetrators), car crimes are more likely to be excluded (Bolling et al., 2008). Hence in our merged file, 9.8 per cent of thefts of car, 7.3 per cent of theft from cars and 5.2 per cent of attempts lacked information on security devices.

The following analysis employs the data without weights. The incident weight adjusts the sample-based crime rates to represent the population in England and Wales. In this analysis however we do not have an estimate of the security features in the population of cars, as discussed above, and therefore it would have been pointless to adjust the number of victimized cars.

The BCS requested information on six main types of car security. These were central locking, electronic immobilizers, car alarms, tracking devices, mechanical immobilizers and window security etching. Information on whether devices were built-in or retro-fitted was not requested in the BCS except for cars bought in the last five years. Likewise, information on the technical specifics of individual devices was not available. It also seems reasonable to expect that the quality of new devices has improved over time (particularly electronic immobilizers) and that they have become more likely to be built-in rather than retro-fitted – issues not addressed in the present study but which could form part of future research. Such information might be available or inferred from data on manufacturing or parts-sales, but identifying and collating such information was outside the scope of the present study.

Each of the six types of security device examined could be used alone or in combination with others, giving 64 possible configurations (including ‘no security’).[5] However, preliminary analysis suggested window etching conferred little additional security and so it was not examined further, a finding that squares with that of Tilley et al. (2009). The omission of window etching reduced the possible configurations to 32. In reality, some combinations were more popular than others. Cars with electronic immobilizers always had at least one other form of security. There were few cars with tracking devices. These patterns probably reflect the more recent implementation of such devices into the manufacturing stages of cars that already had other devices (alarms and/or central locking). There were 31 configurations in the survey responses. However, there were 13 categories which we categorized as minor because they each had only a small number of cases (always less than 50) and accounted for only 150 cases in total. Findings relating to the remaining 18 categories accounted for 22,616 cases, or 99.3 per cent of the total, and are reported here.

Analysis: Developing the Security Impact Assessment Tool

The prevalence of security in the vehicle fleet relative to that for victimized cars constituted the initial outcome measure. In essence, the fleet measures the expected level of security which, *ceteris paribus*, would be found among stolen cars. This can be compared to the observed level of security among victimized cars. The proportions of each were used to derive odds ratios. The odds ratio for each security combination could then be compared to that for ‘no security’ to develop a score for the degree of protection conferred.

Table 1 shows counts of the number of survey responses for the 18 most popular security configurations. A particular type of security is denoted by its capital first letter, so that A is Alarms, C is Central Locking, E is Electronic immobilizer, M is Mechanical immobilizer and T is a Tracking device. Multiple capital letters denote a configuration of multiple devices, so that CE denotes cars with both central-locking and an electronic immobilizer. The first numeric column of Table 1 relates to the fleet. Hence in the top left numeric cell, there were 249 households where the main car had the four security types constituting ACET. The second numeric column shows the number of stolen cars with that security configuration. So, in the top row there were only three stolen cars which had the ACET security configuration. The third and fourth columns show the corresponding numbers for theft from cars and attempted theft.

For each security configuration, comparing the proportion of cars victimized relative to the proportion of cars in the fleet, produces an odds ratio. Hence three of 1364 stolen cars had ACET compared to 249 of 22,616 for the total population of cars with that security combination. The odds ratio is calculated as (3/1364) / (249/22,616) = 0.2. The set of odds ratios are shown in the last three columns of Table 1 for each crime type and

Table 1. Sample sizes and odds ratios by crime type and security configuration

Security configuration	Number of respondents				Odds ratio		
	Population	Theft of	Theft from	Attempts	Theft of	Theft from	Attempts
ACET	249	3	28	16	0.20***	0.45*	0.56**
CEM	1151	14	335	109	0.20	1.16**	0.83***
ACEM	3363	54	438	241	0.27*	0.52*	0.63*
ACE	5923	119	797	405	0.33*	0.54*	0.60*
ACM	1087	26	126	81	0.40*	0.46*	0.65*
CE	2074	54	541	219	0.43	1.04	0.92
ACEMT	168	5	23	11	0.49	0.55*	0.57***
AEM	164	6	41	44	0.61*	1.00	2.35*
EM	302	12	133	56	0.66*	1.75*	1.62*
AE	182	10	57	54	0.91*	1.25	2.59*
CM	874	50	250	100	0.95	1.14***	1.00
AC	1955	120	369	179	1.02**	0.75*	0.80*
E	400	31	173	79	1.29*	1.72*	1.73*
AM	145	12	47	28	1.37**	1.29	1.69*
M	723	80	287	180	1.83*	1.58*	2.18*
C	2086	239	782	266	1.90	1.49*	1.12***
A	240	60	117	68	4.15*	1.94*	2.48*
No security	1530	469	1133	450	5.08*	2.95*	2.57*
Total	*22616*	*1364*	*5677*	*2586*			
Other	150	5	38	16			
Don't know	19	5	8	0			

Key: A = Alarm; C = Central locking; E = Electronic immobilizer; M = Mechanical immobilizer; T = Tracking device.

Notes:

(1) 'Other' = 13 minor security configurations (see text for explanation).

(2) Symbols refer to statistically significant difference in proportions (p-test):
* p-value ≤ .01; ** .01 < p-value ≤ .05; *** .05 < p-value ≤ .10.

security configuration. The odds ratios were complemented by a *p*-test for difference in proportions. While the odds ratio shows the difference in the proportions, the *p*-test says whether or not the difference was statistically significant (the three levels of significance indicating the confidence held in that determination). The bulk of the findings did show a statistically significant difference between security levels in victimized cars and the fleet.

The security protection factor (SPF) shown in the first three columns of Table 2 is derived from the odds ratios. The odds ratio for each individual security combination was compared to that for 'no security'. Hence the odds ratio of 0.2 for ACET was a multiple of 25.4 that of 5.08 for 'no security', that is, 5.08/0.2 = 25.4, our highest SPF. Tables 1 and 2 are ranked by the SPF for theft of car. Independent SPFs could not be calculated for tracking devices, reflecting their rarity plus the fact that when they were used it was always in combination with another type of security device.

In the final three columns of Table 2, a net interaction effect (NIE) is shown. This is the difference between the expected and observed SPFs for security combinations. The expected SPF is the sum of the independent SPFs of security devices when used alone. For example, the independent SPFs for theft of car, at the bottom left of Table 2 are: A = 1.2, C = 2.7, M = 2.8 and E = 4.0. Hence the expected car theft SPF for the AE configuration is the sum of 1.2 for A plus 4.0 for E, a total of 5.2. This is compared to the observed

Table 2. Security Protection Factor and net interaction effect

Security configuration	Security Protection Factor			Net interaction effect		
	Theft of	Theft from	Attempts	Theft of	Theft from	Attempts
ACET	25.4	6.6	4.6	17.6	1.4	–0.3
CEM	25.2	2.5	3.1	15.8	–3.0	–1.9
ACEM	19.1	5.7	4.1	8.5	–1.4	–1.9
ACE	15.3	5.5	4.3	7.4	0.3	–0.5
ACM	12.8	6.4	3.9	6.1	1.0	–0.6
CE	11.8	2.8	2.8	5.1	–0.8	–1.0
ACEMT	10.3	5.4	4.5	–0.3	–1.7	–1.5
AEM	8.4	3.0	1.1	0.4	–2.1	–2.6
EM	7.7	1.7	1.6	1.0	–1.9	–1.1
AE	5.6	2.4	1.0	0.4	–0.9	–1.5
CM	5.4	2.6	2.6	–0.1	–1.3	–0.9
AC	5.0	3.9	3.2	1.1	0.4	–0.1
E	4.0	1.7	1.5	–	–	–
AM	3.7	2.3	1.5	–0.3	–1.1	–0.7
M	2.8	1.9	1.2	–	–	–
C	2.7	2.0	2.3	–	–	–
A	1.2	1.5	1.0	–	–	–
No security	1.0	1.0	1.0	N/A	N/A	N/A

Key: A = Alarm; C = Central locking; E = Electronic immobilizer; M = Mechanical immobilizer; T = Tracking device.

Notes: Results are based on the odds ratios of Table 1 and so that table's statistical significance levels still apply. N/A = not applicable.

SPF of 5.6 for AE for theft of car, which is greater by 0.4. Hence 0.4 is its net interaction effect. The net interaction effect gauges whether the effect of combining security devices is the same, less or more, than the sum of the independent effects of those devices. For the two security configurations involving tracking devices where an independent SPF was not available (ACET and ACEMT), the NIE is based on the other devices in the configuration as this seems preferable to excluding those configurations.

The NIE thus represents the additional SPF, or bonus, from the interaction effects when security devices are combined. Negative NIEs should not be interpreted as suggesting that those combinations did not confer additional security. A negative NIE generally means only that the total SPF was less than the sum of the individual SPFs, though the total SPF is still greater than that of the individual devices.

Results

Different security devices would be expected to impact differentially by crime type. Immobilizers would be expected to reduce risk of theft of cars because they make them more difficult to drive away, with electronic devices being more effective than mechanical ones. However, immobilizers would not be expected to generate much additional prevention against theft from cars because they do not make it more difficult to break-in. In contrast, alarms would be expected mainly to reduce theft from cars, although they might also deter some more opportunistic thieves. Central dead-locks (central locking) would be expected to reduce the risk of both theft of and theft from cars because they make the car more difficult to enter. The results tend to support these broad expectations.

For theft of car, central locking and electronic immobilizers featured in each of the top four security configurations and in, respectively, seven and six of the top seven configurations. There were no configurations involving both central locking and electronic immobilizers that ranked lower than seventh. Alarms, central locking and either or both immobilizers feature in the three security combinations with the highest significant SPFs. For theft from cars, alarms and central locking featured in each of the six top security configurations and in no other configuration. Alarms and central locking also featured in the top five security configurations for attempted car theft. Tracking devices were present in the most effective ACET combination, and while they remained rare in this sample, they appear likely to play a significant role in the future of car crime prevention, a finding that squares with those of Ayres and Levitt (1998) and Farrell et al. (in press).

Figure 1 presents the SPFs from Table 2 and facilitates easy visual identification of the findings that: (1) crime prevention generally increases with the number of security devices; (2) impact upon theft of car is greatest; (3) impact upon attempts are generally least; and (4) the increase in protection is exponential in relation to theft of car. It also shows that in the one instance where the SPF for theft from cars is greater, it relates to alarms.

Single security devices offered some protection but have relatively low SPFs. Alarms on their own confer 20 per cent greater protection (SPF = 0.2) against theft of car and 50 per cent greater protection against theft from car relative to no security. The use of only central locking (C) or only a mechanical immobilizer (M) approximately doubles protection against theft of cars. The individual measure which on its own confers

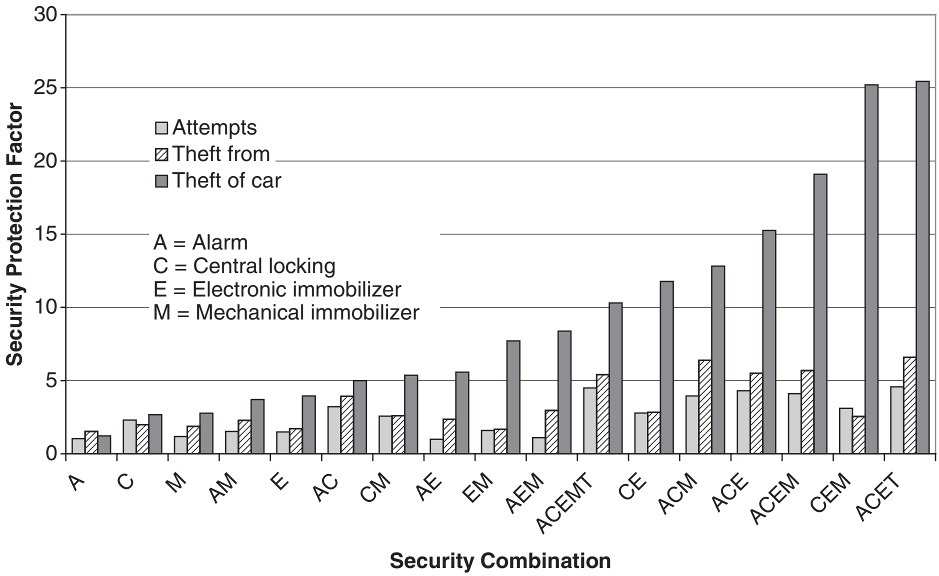

Figure 1. Security Protection Factor conferred by security devices and their combinations.

quadruple the level of protection against car theft is an electronic immobilizer (E), but an electronic immobilizer's effects against theft from cars and attempts are, as expected, less marked than those of central locking.

Pairs of security devices generally produce significantly greater protection and in the anticipated direction. Against car theft, pairs of devices are typically between four and 12 times better than nothing. Pairs generally confer greater protection against theft of cars relative to theft from cars or attempted thefts. This is shown by the net interaction effect values where four of the five pairs are positive for theft of car but only one for theft from car and none of those for attempts. This measure suggests security pairs generally have an effect that is greater than additive against theft of car but not for the other crime types. Central locking and electronic immobilizers are the most effective pairing against theft of car (CE has SPF = 11.8 and NIE = 5.1). It is notable that the added security from most pairs is less than additive for theft from cars and attempts (shown by their negative NIEs). However, it is worth recalling that even when the NIE is negative, the SPF of a combination of devices is generally still much higher than that of any of the individual devices.

Security configuration triplets increase the overall level of security offered. Triplets are most effective against theft of car where they are always at least eight times better than nothing (SPF = 8.4 for AEM), and as much as 25 times greater. Although the SPF 25 for ACET and CEM is arguably the headline finding, it should be treated with caution because the odds ratio for CEM was not statistically significant and there is some uncertainty over the SPF for ACET due to the inclusion of the tracking device. However, ACE and ACEM have SPFs of 15 and 19, which appear to be reasonable minima for the

ACE combination against car theft. These configurations have NIEs that indicate bonus security effects, perhaps due to the interaction of the devices, which are significantly beyond additive.

A brief note is warranted on the possibility that improved car security caused crime to displace to other forms of car crime or other crime types. We know of no evidence to suggest that it did. As noted in the introduction, most crime types measured by the BCS fell sharply from the mid-1990s. The parallel steep declines in each of theft of, theft from and attempts, suggest there was no significant displacement within these types of car crimes. Elsewhere, we have suggested that any increase in theft of car keys to steal cars has been negligible within the overall picture of declining car theft (see Farrell et al., in press).

Conclusion

We offer conclusions in five areas:

1. Tracking devices appear highly effective but were relatively rare in the present dataset. Among the more popular devices about which conclusions can be drawn with greater confidence, electronic immobilizers were the most effective to prevent car theft, and central locking the most effective against theft from cars and attempts. Car alarms make a modest contribution to car security. Combinations of security devices can confer greater safety. Central locking plus electronic immobilizers confer significant security which is augmented by an alarm. Interaction effects are apparent. Cars with this combination of security were 25 times less likely to be stolen than cars without security, which is far above what would be expected from the devices individually. The conclusion we draw is that all new cars – as many already are – should be built with a minimal security configuration of central-deadlocking, an electronic immobilizer, and an alarm system. Each system should meet minimum standards, as they are already required to do in the EU, Australia and many other countries.
2. This study suggests additional avenues for research on vehicle theft. There is a need to isolate any possible confounding effects, particularly any due to vehicle age and vehicle lifestyle (such as its usual parking location). Vehicle age is likely to be positively correlated with the quality and quantity of security, that is, newer vehicles will tend to have more and better devices. The inclusion of vehicle age in the questionnaire for the BCS car security module would facilitate that analysis.
3. This study has implications for research into how crime prevention tactics work individually and in combination. Combinations of tactics are often used – against household and commercial crime, for example – but their individual and interaction effects are rarely distinguished. The possibility of teasing out such interaction effects is an enticing one that warrants further research. The Security Impact Assessment Tool and the metrics it produces, the Security Protection Factor and the Net Interaction Effect, may assist in such endeavours.
4. The major drops in crime that were experienced in the UK and elsewhere from the 1990s were arguably the most important criminological phenomena of recent times. Many types of crime in England and Wales were halved. Car theft fell by

two-thirds and a range of studies suggests this is attributable to more and better vehicle security. The present study has added to that body of work by teasing out the relative contribution of individual security devices and their combination.

5. It took many years of rapidly increasing car crime, including much blood and tears among the enormous social cost, before vehicle manufacturers adopted improved security. Yet since they have done so, the crime reduction effect has been dramatic. It seems reasonable to infer that, in relation to other crime types, manufacturers and business should develop means to ensure that security is the default position, at the very least to speed the pace at which crime prevention is developed and introduced. Frequently stolen electronic devices such as MP3s, smartphones, PDAs, laptops, SatNavs could almost certainly be built so that they could be deactivated or tracked if stolen. This would mean theft would no longer be an attractive option. Residential and commercial buildings and urban transport and road systems should be designed in ways that overtly seek to minimize criminal opportunities. It is clear that there is market failure when it comes to crime, and that there is a critical role for government in nudging planners, manufacturers and designers to improve security as an integral aspect of corporate social responsibility.

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Notes

1. The authors are members of the Administrative Criminology Collective.
2. http://www.homeoffice.gov.uk/crime-victims/reducing-crime/vehicle-crime/.
3. http://www.thatcham.org.
4. For example, if main cars had as much as 10 per cent more effective security than non-main cars, then our measure of security effectiveness would be an over-estimate by around 4 per cent (slightly more because 6 per cent of households own three or more cars according to the 2001 census findings. Available at: http://www.statistics.gov.uk/census2001/profiles/commentaries/housing.asp (accessed 25 November 2009). But we anticipate that between-devices differences in security effectiveness would remain only marginally affected if at all.
5. Six types of device with two possibilities (present or not) = $2^6 = 64$.

References

Ayres I and Levitt S (1998) Measuring Positive Externalities from Unobservable Victim Precaution: An Empirical Analysis of Lo-Jack. *Quarterly Journal of Economics* 113(1): 43–77.

BBC (2000) *Car Immobilisers Fail Test*. BBC News online, 1 May. Available at: http://news.bbc.co.uk/1/hi/uk/732669.stm.

Blumstein A and Rosenfeld R (2008) Factors Contributing to U.S. Crime Trends. In: *Understanding Crime Trends: Workshop Report*. National Research Council Committee on Understanding Crime Trends, Committee on Law and Justice, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press, 13–43.

Blumstein A and Wallman J (2000) *The Crime Drop in America*. Cambridge: Cambridge University Press.

Blumstein A and Wallman J (2006) *The Crime Drop in America* (revised edn). Cambridge: Cambridge University Press.

Bolling K, Grant C, and Donovan J-L (2008) *2007–08 British Crime Survey (England and Wales) Technical Report*. BMRB. London: Home Office.

Brantingham P and Brantingham P (2008) Crime Pattern Theory. In: Worley R, Mazerolle L (eds) *Environmental Criminology and Crime Analysis*. Cullompton: Willan, 78–94.

Brown R (2004) The Effectiveness of Electronic Immobilisation: Changing Patterns of Temporary and Permanent Vehicle Theft. In: Maxfield MG, Clarke RV (eds) *Understanding and Preventing Car Theft*, Vol. 17 of *Crime Prevention Studies*. Monsey, NY: Criminal Justice Press, 101–119.

Brown R and Thomas N (2003) Aging Vehicles: Evidence of the Effectiveness of New Car Security from the Home Office Car Theft Index. *Security Journal* 16(3): 45–54.

Clarke R and Harris P (1992) Auto Theft and Its Prevention. In: Tonry M (ed.) *Crime and Justice: A Review of Research*, Vol. 16. Chicago, IL: University of Chicago Press, 1–54.

Clarke RV and Mayhew P (1998) Preventing Crime in Parking Lots: What We Know and What We Need to Know. In: Felson M, Peiser R (eds) *Reducing Crime through Real Estate Development and Management*. Washington, DC: Urban Land Institute, 125–135.

Clarke RV and Newman G (2006) *Outsmarting the Terrorists*. Westport, CT: Praeger.

Cohen LE and Felson M (1979) Social Change and Crime Rate Trends: A Routine Activity Approach. *American Sociological Review* 44: 588–608.

Cornish DB and Clarke RV (2008) The Rational Choice Perspective. In: Worley R, Mazerolle L (eds) *Environmental Criminology and Crime Analysis*. Cullompton: Willan, 21–47.

Farrell G, Tilley N, Tseloni A, and Mailley J (2008) The Crime Drop and the Security Hypothesis. *British Society of Criminology Newsletter* 62: 17–21.

Farrell G, Tilley N, Tseloni A, and Mailley J (2010) Explaining and Sustaining the Crime Drop in Industrialised Countries. *Crime Prevention and Community Safety: An International Journal* 12(1): 24–41.

Farrell G, Tilley N, Tseloni A, and Mailley J (in press) The Crime Drop and the Security Hypothesis. *Journal of Research in Crime and Delinquency*.

Felson M and Boba R (2010) *Crime and Everyday Life*. Los Angeles, CA: SAGE.

Garland D (2000) The New Criminologies of Everyday Life: Routine Activity Theory in Historical and Social Context. In: Von Hirsch A, Garland D, and Wakefield A (eds) *Ethical and Social Perspectives on Situational Crime Prevention*. Oxford: Hart Publishing, 215–224.

Hazelbaker K (1997) Insurance Industry Analyses and the Prevention of Motor Vehicle Theft. In: Felson M, Clarke RV (eds) *Business and Crime Prevention*. Monsey, NY: Willow Tree Press, 283–293.

Henderson C, Papagapiou P, Gains A, and Know J (2004) *Driving Down Crime: Denying Criminals Use of the Road*. Norwich: The Stationery Office.

Hoare J (2009) Extent and Trends. In: Walker A, Flatley J, Kershaw C, Moon D (eds) *Crime in England and Wales 2008/09, Volume 1: Findings from the British Crime Survey and Police Recorded Crime*, *Home Office Statistical Bulletin 11/09*. London: Home Office, 13–42.

Houghton G (1992) *Car Theft in England and Wales: The Home Office Car Theft Index*. Crime Prevention Unit Paper 33. London: Home Office.

Kriven S and Ziersch E (2007) New Car Security and Shifting Vehicle Theft Patterns in Australia. *Security Journal* 20(2): 111–122.

LaFree G (1999) Declining Violent Crime Rates in the 1990s: Predicting Crime Booms and Busts. *Annual Review of Sociology* 25: 145–168.

Laycock G (2004) The UK Car Theft Index: An Example of Government Leverage. In: Maxfield MG, Clarke RV (eds) *Understanding and Preventing Car Theft*, Vol. 17 of *Crime Prevention Studies*. Monsey, NY: Criminal Justice Press, 25–44.

Mayhew P (1992) Steering Column Locks and Car Theft. In: Clarke RV (ed.) *Situational Crime Prevention: Successful Case Studies*. Albany, NY: Harrow & Heston, 52–65.

Mayhew P and Braun G (2004) Parking Lot Security. In: Maxfield MG, Clarke RV (eds) *Understanding and Preventing Car Theft*, Vol. 17 of *Crime Prevention Studies*. Monsey, NY: Criminal Justice Press, 121–145.

Mayhew P, Clarke RVG, Sturman A, and Hough JM (1976) *Crime as Opportunity*. Home Office Research Study 34. London: HMSO.

Newman G (2004) Car Safety and Car Security: An Historical Comparison. In: Maxfield MG, Clarke RV (eds) *Understanding and Preventing Car Theft*, *Crime Prevention Studies*, Vol. 17. Monsey, NY: Criminal Justice Press, 217–248.

Potter R and Thomas P (2001) *Engine Immobilizers: How Effective are They?* Australia: National Motor Vehicle Theft Reduction Council.

Poyner B (1992) Situational Crime Prevention in Two Parking Facilities. In Clarke RV (ed.) *Situational Crime Prevention: Successful Case Studies*. New York: Harow & Heston, 157–166.

Rosenfeld R (2009) Crime Is the Problem: Homicide, Acquisitive Crime, and Economic Conditions. *Journal of Quantitative Criminology* 25: 287–306.

Rosenfeld R and Messner SF (2009) The Crime Drop in Comparative Perspective: The Impact of the Economy and Imprisonment on American and European Burglary Rates. *British Journal of Sociology* 60(3): 445–471.

Shaw D and Pease K (2010) Car Security and the Decision to Recommend Purchase. *Crime Prevention and Community Safety: An International Journal* 12(2): 91–98.

Southall D and *Ekblom PJ* (1985) *Designing for Car Security: Towards a Crime-Free Car*. *Crime* Prevention Unit Paper 4. London: Home Office.

Tilley N, Farrell G, Tseloni A, and Mailley J (2009) Curbing Vehicle Theft: Experience beyond the United States. Task M of Report to the National Highway Traffic Safety Administration by Maryn Consulting and Rutgers University. New Jersey: Maryn Consulting.

Tseloni A, Mailley J, Farrell G, and Tilley N (2010) The International Crime Drop: Trends and Variations. *European Journal of Criminology* 7(5): 375–394.

Van Dijk JJM (2006a) International Comparisons of Crime: The ICVS and More. Paper presented at the British Crime Survey 25th Anniversary Conference, Cumberland Lodge, England, 16–17 October.

Van Dijk JJM (2006b) What Goes Up, Comes Down: Explaining the Falling Crime Rates. *Criminology in Europe*, *Newsletter of the European Society of Criminology* 5: 3, 17–18.

Van Dijk JJM, Van Kesteren J, and Smit P (2007) *Criminal Victimisation in International Perspective: Key Findings from the 2004–2005 ICVS and EU ICS*. WODC Report 257. The Hague: Boom Jurisische uitgevers.

Walker A, Flatley J, Kershaw C, and Moon D (2009) *Crime in England and Wales 2008/9*. Home Office Statistical Bulletin 11/09 Vol. 1. London: Home Office.

Webb B (1994) Steering Column Locks and Motor Vehicle Theft: Evaluations from Three Countries. In: Clarke R (ed.) *Crime Prevention Studies*, Vol. 2. Monsey, NY: Criminal Justice Press, 71–89.

Webb B (2005) Preventing Vehicle Crime. In: Tilley N (ed.) *Handbook of Crime Prevention and Community Safety*. Cullompton: Willan, 458–485.

Webb B, Brown B, and Bennett K (1992) *Preventing Car Crime in Car Parks*. Crime Prevention Unit paper 32. London: Home Office.

Webb B, Smith M, and Laycock G (2004) Designing-Out Crime through Vehicle Licensing and Registration Systems. In: Maxfield MG, Clarke RV (eds) *Understanding and Preventing Car Theft*, Vol. 17 of *Crime Prevention Studies*. Monsey, NY: Criminal Justice Press, 67–84.
Zimring FE (2007) *The Great American Crime Decline*. New York: Oxford University Press.

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