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Abstract This study measures the effectiveness of anti-burglary security devices, both individually and in combination. Data for 2008–2012 from the Crime Survey of England and Wales are analysed via the Security Impact Assessment Tool to estimate Security Protection Factors (SPFs). SPFs indicate the level of security conferred relative to the absence of security devices. It finds that, for individual devices, external lights and door double locks or deadlocks, are most effective but, counter-intuitively, burglar alarms and dummy alarms confer less protection than no security. Combinations of devices generate positive interaction effects that increase protection more than additively. In particular, combinations with door and window locks plus external lights or security chains confer at least 20 times greater protection against burglary with entry than no security. Although further research is needed, the findings are consistent with improved security playing an important role in long-term declines in burglary rates.
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Keywords: burglary; security devices; Crime Survey for England and Wales; security impact assessment tool; security protection factor; burglary rates

Introduction

The Crime Survey for England and Wales (CSEW) estimates that 2.1 per cent of households in England and Wales were burgled in 2012/2013 and experienced 694 000 burglaries (Office for National Statistics, 2013). The impact of burglary upon victims is significant, and includes considerable psychological costs in addition to the financial costs of replacements and repairs. In response, many households have adopted security measures of various types. Victim Support and Crime Prevention Officers routinely advise victims of crime to improve aspects of their household security (Spackman, 2000). However, unlike household insulation and other similar ‘green’ interventions there is, by and large, no government support for the installation of security devices within households in the United Kingdom and so security is

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generally left to the discretion of the individual. Poorer households in society are evidently less able to afford the installation of physical security measures. Where target hardening is provided to householders as part of specific crime reduction campaigns, this is often limited in scope because of funding availability, and may be provided to those who are perceived to be more vulnerable (for example, the elderly) regardless of whether or not they are shown to be at greater risk ([redacted] et al, 2012). Households in the rental sector also require the cooperation of landlords to make changes to their residence, which may not always be forthcoming. In the United Kingdom, fire alarms are mandated in rental properties (Gov.uk, 2013). There is no equivalent requirement for household security, although a minimum security standard for new buildings is currently under consideration (DCLG, 2014).

Household anti-burglary security comes in a variety of forms, and there is mixed evidence about their effectiveness: it appears that some devices are more effective in thwarting burglaries than others. Homes with no or low-level security have 7 times and 75 per cent, respectively, more burglaries than homes with high-level security (Pease and Gill, 2011).[1] Van Dijk (2008, p. 55) suggests that routine investment in security devices can result in a higher proportion of 'failed burglaries'. The use of preventive security measures is increasing in most countries, with the highest levels in developed countries (Van Kesteren et al, 2000). This correlates with a higher proportion of attempted, rather than successful, burglaries in these countries (ibid.). In a natural experiment whereby newly built homes were required to have burglary security in the Netherlands, the burglary rate fell in areas with new housing but without displacement to areas with older less-protected houses (Vollaard and van Ours, 2011). It was concluded that by 2010 the national burglary rate in the Netherlands was 5 per cent lower than it would have been otherwise.

Nee and Meenaghan (2006) interviewed 50 offenders, finding burglars preferred properties with relative wealth and physical cues that offered them cover, access and getaway routes. They write that: 'Interestingly, security cues were mentioned least frequently … In any case, all participants felt security features were rarely enough to deter them, due to a lack of vigilance in locking up on the part of homeowners' (Nee and Meenaghan, 2006, p. 942). This fits with earlier offender interviews that suggested that, in isolation, common household security measures may have a limited deterrent effect (Reppetto, 1974). However, Cromwell and Olson (2009) found some practical burglary prevention measures, such as target hardening and visibility improvements, to have a deterrent effect, while a study of four police divisions in Kent concluded that 'the security of victim households is no lower than the average' (Winchester and Jackson, 1982, p. 20).

A possible reason for the apparent mixed findings is that security devices are often grouped together or analysis appears to be conducted simply on the basis of presence or absence of, say, a burglar alarm with little or no regard for whether other devices were in place. This makes it difficult to precisely identify the protective role of individual devices or the different possible combinations. The CSEW asks respondents whether their household has any burglary devices, such as burglar alarm, door double or deadlocks, window locks, CCTV and others. The list of devices has changed, but not dramatically, over time, and recent data sets include information about nine devices (discussed further later). Existing CSEW-based research found that households with more security have lower burglary rates (Mayhew et al, 1993; Budd, 1999; Office for National Statistics,

2013). For most CSEW analysis, security is grouped into four categories (Murphy and Eder, 2010):

- no security;
- less than basic – any device except the concurrence of the those in basic;
- basic – window locks and door double locks or deadbolts; and
- enhanced – basic plus at least one other device.

Households with less-than-basic security were found to experience 6 times more burglaries than those with basic security, and 10 times more than those with enhanced (Flatley et al, 2010, p. 2). Households with no security were also found to be at greater risk than those with basic or enhanced security (■■■■■■, 2009; Flatley et al, 2010). A further study found that households with an income less than £5000 and in possession of enhanced security had 25 times lower odds of burglary with entry than same-income households with no security. In contrast, basic security conferred effectively no protection for £20 000–£29 999 income households in 1997 (■■■■■■ et al, 2011). With the exception of this categorisation, past research on the relative effectiveness of security devices does not, to our knowledge, examine the effectiveness of each separate device or the various permutations of their combination. For this reason it seems that the evidence on the effectiveness of anti-burglary security devices is somewhat mixed.

It is in this context that the present study aims to shed further light on this important issue and to separate the effects of devices used individually and in combination. In particular, it aims to answer the following question: What are the preventive effects, if any, of individual and combined burglary security devices against domestic burglary with entry and attempted burglary in England and Wales?

The present study is broadly consistent with the criminological theory of environmental criminology. A term coined by Jeffrey (1971), environmental criminology encompasses the rational choice and routine activity perspectives. In the present context, security devices tend to make the target – the household – less suitable for victimisation (target suitability being a cornerstone of routine activity theory (Cohen and Felson, 1979). The way in which the target becomes less suitable varies with type of security device, with each either increasing the actual or perceived risk or effort involved. This is consistent with situational crime prevention which is a key operational component of environmental criminology (see Cornish and Clarke, 2003 for the definitive statement of the 25 techniques of situational crime prevention). Each of the preventive mechanisms is intended to tip essentially ‘rational’ offenders away from the decision to commit crime.

The structure of this article is as follows. The next section details the data and methodology used to identify the effectiveness of anti-burglary security devices. The preventive effects of individual devices and selected configurations are then detailed and the study concludes with a summary of the findings and a discussion of their policy implications.

With respect to terminology, we recognise that some security devices require an action on the part of the owner to be activated. For this reason, the term security availability that denotes whether certain burglary devices are present in the home rather than security use is used herein. This recognises the fact that whether devices are in use is a different research question which is not within the scope of the present study but might, at least in part, be addressed in future research that focuses on modus operandi. For brevity,

‘burglary with entry’ is sometimes referred to as burglary, and attempted burglary as attempt(s).

Data and Method

This study analyses the CSEW (formerly the British Crime Survey, BCS) data from 2008/ 2009 to 2011/2012. The CSEW is a national (for England and Wales) victimisation survey, currently run by the Office for National Statistics. CSEW sweeps were undertaken on an occasional basis between 1982 and 1992 and biennially between 1992 and 2000. Since 2001/ 2002 it has used an annual rotating sample of roughly 40 000 respondents. The survey uses a multistage stratified sample, which is representative of the adult (16 years or older) population living in private accommodation in England and Wales. For a brief history and details of the methodology, questionnaire modules and items, and topics covered in the CSEW, see Hough and Maxfield (2007) and the various CSEW Technical Reports (www .ons.gov.uk/ons/taxonomy/index.html?nscl=Crime+in+England+and+Wales, accessed 25 September 2013). Response rates have been consistently high varying between 73 and 81 per cent (Jansson, 2007).

The CSEW provides a wealth of information on respondents’ crime and related experiences and attitudes, and assembles factual information about the respondents, their households and area of residence, including security measures. The Crime Prevention Module C is administered to a randomly selected quarter of the survey sample. The Crime Prevention Module for the 2008/2009–2011/2012 CSEW included questions about the availability of any of nine burglary security devices in the respondent’s home:

- Burglar alarm
- CCTV
- Door double locks or deadlocks
- DummY alarm box
- External lights on a timer or sensor
- Indoor lights on a timer or sensor
- Security chains
- Window bars or Grilles and
- Windows locks

For economy of space the enlarged capital bold letters in the previous list will denote the respective security device in the remainder of the article.[2] Information about the availability of the same list of security devices at the time of the incident is solicited (via the Victim form Module) from respondents whose household was burgled. However, not all burglary victims were asked about their home security. This is because respondents complete a maximum of six Victim Forms – three using a long questionnaire and three using a shortened version. As questions about home security availability are included only in the long Victim Forms, data on home security at the time of the burglary are not available for the minority of respondents who reported at least three unconnected crime incidents of higher seriousness than burglary (according to standard offence classification – see Hales et al, 2000) during the year preceding the interview.[3] This means that information about the anti-burglary security adopted by the survey’s most victimised respondents is not available.

The unit of analysis here is the household. For this reason when a victim reported repeated burglary incidents via more than one long Victim Form, their home security availability at the time of the first burglary during the survey's reference period has been retained for analysis. In the 2008/2009–2011/2012 CSEW data, 2.66 per cent of burglaries with entry and 1.65 per cent of attempted burglaries with available security information were repeats. After an initial burglary the use of external lights and burglar alarms doubles while acquiring window locks increases by 50 per cent among burglary victims in England and Wales (Budd, 1999). Similarly in the United States an additional burglary for every 1000 people increases the demand for burglary alarms by 3 per cent (Philipson and Posner, 1996). Victims' response to a first burglary and whether this alters subsequent burglary risk, while acknowledged as of great interest, is outside the scope of the present study.

For the purposes of this analysis the Crime Prevention Module C sample represents the exposed population of households or the homes fleet in England and Wales. Burglary victims, as identified by the CSEW long Victim Forms, reflect the targeted households of this analysis. A minority of cases where a respondent experienced both an attempt and a burglary with entry are, however, excluded.[4] To increase the potential number of homes with any possible security configuration from the above list of devices the four sweeps, that is, 2008/ 2009, 2009/2010, 2010/2011 and 2011/2012, of the CSEW data have been merged in a single data set. Together these record crimes that occurred to respondents from April 2007 to March 2012.

This work uses the Security Impact Assessment Tool (SIAT) methodology developed and described by ■■■■■■■ et al (2011) in their study of the effectiveness of car security devices. Here the SIAT methodology compares the likelihood of burglary for populations without security, with a particular security device or combination of devices to the overall likelihood of burglary. This comparison results in odds ratios. Contrasting the odds ratios given the availability of a security device or combination of devices with respect to no security identifies the amount of protection conferred relative to no security. The resulting metric is termed the Security Protection Factor (SPF). The coincidence between this abbreviation and that denoting Sunscreen Protection Factor is serendipitous because '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' (■■■■■■■ et al, 2011, p. 23). The underlying principle of the SIAT is simple. If no protection is conferred, the distribution of security devices would be the same between burgled households and all households in the population, the homes fleet. Specific aspects of the methodology will be clarified as the results are described.

The nine security devices listed above would produce such a large set of possible combinations that it would be effectively useless for practical purposes. Hence two strategies were used to keep the study practical, in a similar fashion to ■■■■■■■ et al (2011). First, we removed window bars and dummy alarms from much of the analysis except to identify their individual effects, because they are rare and for present purposes judged to be largely undesirable. This is shown in Table 1, which demonstrates that window bars and dummy alarms are rare relative to most other devices. Further, when they are each the only device present in a household, they occur in only 0.06 and 0.09 per cent of households, respectively. Their unpopularity is perhaps not surprising though. Window bars and grills in England and Wales are generally aesthetically displeasing, with little resemblance to the art deco ironwork one sometimes encounters elsewhere. They also present a potential fire hazard and insinuate a fortress-like society. We also found, in analysis not presented here, that the

Table 1: Availability of security devices per sweep, 2008/2009–2011/2012 CSEW

Security device	CSEW sweep			
	2008/2009	2009/2010	2010/2011	2011/2012
Burglar alarm	29.4	29.4	28.3	27.6
CCTV	4.6	4.6	4.9	5.3
Dummy alarm	4.6	4.1	5.2	4.6
Door double or deadlocks	78.9	80.3	77.7	76.9
External lights on Sensor/Timer	46.6	45.1	42.6	42.5
Indoor lights on Sensor/Timer	26.0	24.2	21.5	21.5
Security Chains	33.9	31.6	31.0	29.6
Window Bars or Grilles	1.8	2.5	2.4	2.2
Window Locks	85.2	87.0	82.0	83.0

availability of window bars has dropped since the mid-1990s, likely reflecting a continuing change in preferences for the reasons suggested. Dummy alarms on the other hand are no more displeasing than functioning ones, but the protection they confer relies on the false perception of the potential burglar who might mistake it as an operating burglar alarm. Therefore dummy alarms by construction do not offer any improvement in 'real' security that may explain why they are not preferred by households, except perhaps where households cannot afford a working alarm. For these reasons window bars and dummy alarms are examined individually but are not included in the security combinations (configurations) for which more extensive results are offered, on the grounds that this exclusion is of negligible consequence. The 7 remaining security devices generate 128 possible configurations.[5] Second, and consistent with [redacted] et al (2011), we utilised a cut-off point for sample availability of each security configuration. Of the 128 combinations of security devices, less than half (n = 52) were available in at least 50 households in the sample. This is an arbitrary cut-off point and, as mentioned, dummy alarms and window bars do not even reach this threshold. The use of indoor lights alone was also infrequent, occurring only 47 times over the 4 years surveyed, and is excluded.

Results

The extent of the protection conferred by individual anti-burglary devices and selected combinations is discussed in this section. 2 presents the information that enables calculating the SPFs. The SPFs for individual devices are shown in Figure 1 and those for combinations in Figures 2 and 3 and 3 later in this section. An indication of the statistical significance of the odds ratios is given in both s 2 and 3.[6] Burglary security devices in 2 and their configurations in both tables are listed in descending order of sample size in the 2008/2009–2011/2012 CSEW to allow the extent of their use in and better to be appreciated.

The first three columns of Table 2 present the samples sizes for all households in the sample (hereafter 'all households') and for victims of burglary with entry and of attempted burglary. Recall that only security configurations with more than 50 households in the sample are shown. The odds ratios that are given in the last two columns of Table 2 are

Table 2: Sample sizes and odds ratio of burglary with entry and attempted burglary across individual security devices and their configurations (2008/2009–2011/2012 CSEW)

Security devices[a]	Number of respondents			Odds ratio	
	All households	Victims of		Burglary	Attempt
		Burglary	Attempt		
No security	1835	821	286	7.46**	4.30**
WD	5381	192	111	0.59**	0.57**
EWD	3307	43	37	0.22**	0.31**
WSD	2743	38	56	0.23**	0.56**
EWBD	1953	53	40	0.45**	0.57**
W	1765	120	69	1.13	1.08
EWSD	1687	24	15	0.24**	0.25**
EIWBD	1589	24	23	0.25**	0.40**
EIWD	1537	14	11	0.15**	0.20**
WBD	1455	73	39	0.84	0.74
IWD	961	26	6	0.45**	0.17**
EIWSBD	931	3	13	0.05**	0.39**
D	905	145	105	2.67**	3.20**
EWSBD	870	12	15	0.23**	0.48**
EIWSD	824	13	4	0.26**	0.13**
WSBD	709	17	13	0.40**	0.51*
WS	678	24	26	0.59**	1.06
EW	675	17	17	0.42**	0.69
IWBD	530	13	8	0.41**	0.42*
IWSD	515	10	7	0.32**	0.38**
SD	463	27	23	0.97	1.37
S	321	70	38	3.63**	3.27**
IWSBD	314	6	9	0.32**	0.79
ED	313	13	18	0.69	1.59
WB	272	26	13	1.59*	1.32
EWS	253	8	9	0.53	0.98
E	242	36	19	2.48**	2.17**
EWB	229	10	14	0.73	1.69
B	212	106	52	8.33**	6.77**
EIW	177	6	2	0.56	0.31
ESD	171	5	3	0.49	0.48
CWD	161	3	2	0.31*	0.34
CEIWBD	152	2	4	0.22*	0.73
IW	149	8	3	0.89	0.56
CEWD	145	0	7	—	1.33
CEWBD	145	2	6	0.23*	1.14
BD	136	31	21	3.80**	4.26**
CWSD	116	1	1	0.14*	0.24
Don't know	114	44	61	6.43**	14.76**
EIWB	103	4	7	0.65	1.88
WSB	93	3	6	0.54	1.78
EBD	90	6	6	1.11	1.84
ID	86	4	6	0.78	1.93
EWSB	85	3	4	0.59	1.30

Table 2 continued

Security devices[a]	Number of respondents			Odds ratio	
	All households	Victims of		Burglary	Attempt
		Burglary	Attempt		
CEWSBD	82	0	2	—	0.67
EID	82	4	2	0.81	0.67
ES	71	7	6	1.64	2.33*
EIWS	69	0	3	—	1.20
CW	65	2	1	0.51	0.42
CWBD	64	0	2	—	0.86
IWS	57	5	1	1.46	0.48
C	57	16	9	4.68**	4.36**
IWB	56	4	2	1.19	0.99
Other configurations[b]	1171	101	93		
Including: I	47	6	5	2.13	2.94*
Y	34	11	9	5.39**	7.30**
G	21	7	2	5.56**	2.63
Total	37 416	2245	1356		

[a]The configurations 'CEWSD', 'CEIWD', and of all 7 security devices, 'B, D, S, W, I, E and C', were reported by 81, 72 and 97 respondents, respectively but no burglary victims in the 2008/2009–2011/2012 CSEW merged data set. Therefore they are omitted from Table 2.

[b]'Other configurations' refers to all the remaining ones with each reported by less than 50 respondents. For this reason they are not examined further here except for the individual devices that are included within this category.

*0.05>P 0.01; **P 0.01.

Notes: Abbreviations: B = Burglar alarm; C = CCTV; Y = Dummy Alarm; D = Door double or deadlocks; E = External lights on a timer or sensor switch; I = Indoor lights on a timer or sensor switch; S = Security chains; G = Window bars or grilles; W = Window locks.

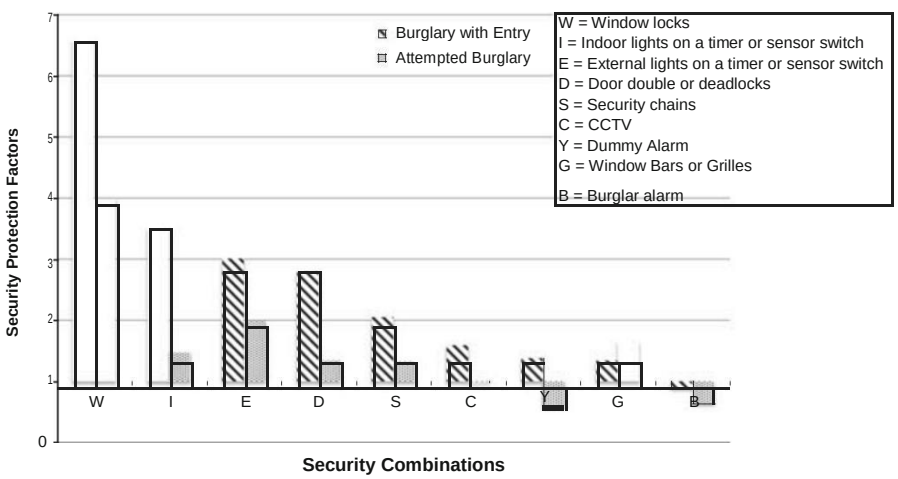

Figure 1: SPFs for individual devices by crime type (significant at 5 per cent level unless shaded in white) based on the 2008/2009–2011/2012 CSEW.

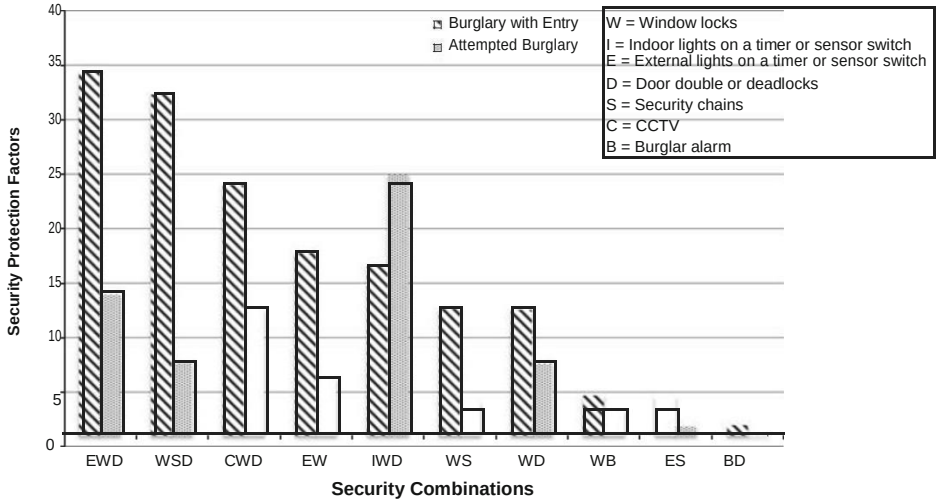

Figure 2: SPFs for pairs or triplets home security configurations by crime type (significant at 5 per cent level unless shaded in white) based on the 2008/2009–2011/2012 CSEW.

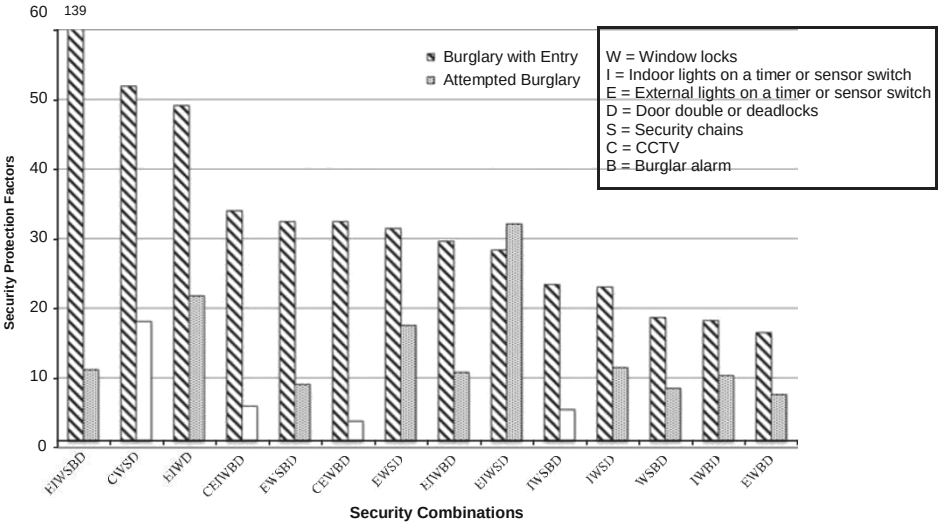

Figure 3: SPFs for four or more home security configurations by crime type (significant at 5 per cent level unless shaded in white) based on the 2008/2009–2011/2012 CSEW.

calculated as follows: The bottom row shows that there were 37 416 households in the sample, of which 2245 experienced burglary and 1356 experienced attempted burglary. The first row of the table shows that 1835 of all 37 416 households (4.9 per cent) reported no security devices. However, 821 of 2245 burgled households (36.6 per cent) reported no security, as did 286 of 1356 (21.1 per cent) of household that experienced attempted burglary. The odds ratios compare the percentage with respect to the two crime types to that

Table 3: SPFs and NIEs of burglary with entry and attempted burglary across security devices configurations (2008/2009–2011/2012 CSEW)

Security devices	Burglary with entry		Attempted burglary	
	SPF	NIE	SPF	NIE
WD	12.54**	3.17	7.56**	2.23
EWD	34.41**	22.03	13.93**	6.62
WSD	32.30**	20.87	7.63**	0.99
EWBD	16.49**	3.21	7.61**	−0.34
EWSD	31.45**	17.02	17.53**	8.90
EIWBD	29.62**	12.84	10.77**	1.35
EIWD	49.12**	33.23	21.78**	13.00
WBD	8.92	−1.35	5.81	−0.15
IWD	16.54**	3.66	24.96**	18.17
EIWSBD	138.85**	120.01	11.16**	0.43
EWSBD	32.44**	17.11	9.04**	−0.23
EIWSD	28.36**	10.42	32.11**	22.01
WSBD	18.66**	6.34	8.50*	1.22
WS	12.64**	4.01	4.06	−1.24
EW	17.76**	8.18	6.19	0.22
IWBD	18.24**	4.47	10.33*	2.89
IWSD	23.04**	8.11	11.47**	3.35
SD	7.67	2.83	3.14	0.48
IWSBD	23.41**	7.59	5.44	−3.31
ED	10.77	4.97	0.69	−0.62
WB	4.68*	−2.79	3.26	−1.36
EWS	14.15	2.51	4.38	−2.91
EWB	10.25	−0.24	2.55	−4.06
EIW	13.20	0.11	13.79	6.36
ESD	15.30	7.45	8.88	4.24
CWD	24.01*	13.04	12.55	6.23
CEIWBD	34.00*	15.63	5.92	−4.48
IW	8.33	7.74	7.74	2.29
CEWD	—	—	3.23	−5.07
CEWBD	32.44*	17.57	3.77	−5.17
BD	1.96**	−1.72	1.01**	−0.97
CWSD	51.90*	38.88	18.08	10.45
EIWB	11.52	−2.47	2.29	−5.78
WSB	13.87	4.34	2.42	−3.52
EBD	6.71	0.02	2.34	−1.63
ID	9.62	3.32	2.23	−0.57
EWSB	12.68	0.14	3.31	−4.61
CEWSBD	—	—	6.39	−3.86
EID	9.17	−0.13	6.39	1.60
ES	4.54	−0.52	1.84*	−1.46
EIWS	—	—	3.58	−5.17
CW	14.54	6.37	10.13	5.16
CWBD	—	—	4.99	−1.97
IWS	5.10	−7.04	8.88	2.12
IWB	6.26	−4.72	4.36	−1.72

*0.05>P 0.01; **P 0.01.

Abbreviations: B = Burglar alarm; C = CCTV; D = Door double or deadlocks; E = External lights on a timer or sensor switch; I = Indoor lights on a timer or sensor switch; S = Security chains; W = Window locks.

Notes: Results are given in descending order of sample size that reported each configuration; configurations not reported by victims at the time of first burglary cannot produce SPFs.

for all households. Therefore for households with no security, the odds ratio is 7.46 (calculated as 36.6/4.9) and for attempts it is 4.30 (calculated as 21.1/4.9). The superscript notation shows that these odds ratios are highly statistically significant. In a similar way, the odds ratios of different security configurations can be calculated. However, not all configurations have significant odds ratios. In total, 31 individual devices and configurations show odds ratios that are statistically significant for either type of burglary.

The (multiplicative) difference of odds ratios between any individual device or config-uration and no security gives its SPF value. These are shown in the graphs of this section and the second and fourth columns of Table 3 with an indication of their statistical significance. They are calculated as follows: In the second row of figures of Table 2, households with window and door locks have an odds ratio with respect to burglary with entry of 0.59, which is 12.54 (7.46/0.59) times lower than no security. This SPF implies that window and door locks confer 12 times higher protection against burglary with entry than no security. Another way of expressing this is that window and door locks reduce the odds ratio of burglary with entry down to one-twelfth compared with no security. This is considerable compared with previous evidence on car security SPFs that did not exceed 25 (■■■■■■■ et al, 2011). It appears, however, modest in relation to other burglary security configurations as will be seen in the following paragraphs. The discussion here uses both interpretations interchangeably.

The SPFs of the individual devices and configurations with at least one statistically significant odds ratios from Table 2, as mentioned, are shown across three graphs, Figures 1–3. They are listed in descending order of the SPFs against burglary with entry values that is in general more responsive to security than attempted burglary as found in previous research (Van Kesteren et al, 2000). An SPF of 1 implies that the odds ratios of no security and the examined device or configuration are equal and therefore the latter confers no protection. SPFs lower than 1 imply that the respective device or configuration is counter-productive: the odds of burglary are actually lower without any security than the device examined. Therefore the following discussion and related graphs of SPFs use 1 (rather than 0) as baseline (the value of the y-axis at which the x-axis intersects) which best reflects the protection conferred by each burglary device configuration.

Single devices

It remains relatively common to use a single type of security device, as shown by the sample sizes in Table 2. As expected, the SPFs for individual devices tend to be lower than those for combinations in Table 3. For visual clarity the SPFs of individual burglary security devices across crime type are also given in Figure 1. When devices are used individually, window locks have the highest SPF followed by indoor sensor lights, but neither has statistically significant odds ratios and for this reason their respective SPFs are shown in solid white bars. This suggests we cannot conclude with confidence that they confer greater than no security. Given that the Home Office classifies window locks together with door locks as basic security, the fact that on their own they do not confer statistically significant protection comes as a surprise. The reasons for this remain uncertain and further research might clarify that issue. Perhaps window locks fall quickly into disuse if they are add-on rather than built-in, as may be more likely in older households with less security generally. Perhaps integrated

(built-in) window locks work automatically when a window is closed whereas add-on locks typically require the fitting of a nut onto a bolt, producing significant variation in usage between window locks (perhaps particular in summer months when windows are opened more frequently). Future analysis on modus operandi in burglary incidents recorded by the CSEW will shed some light on this. In addition, window locks are an essential built-in feature of double-glazed windows and therefore their widespread availability (see Table 1) has possibly more to do with heat insulation and less with burglary security. Indeed Table 2 shows that they are available to burgled households at the same rate as in the general population. Similarly, indoor lights on sensor and window bars have statistically non-significant odds ratios for burglary with entry and attempted burglary (solid white bars in Figure 1), respectively. This might be partially because of the low number of households using indoor lights (47 or 0.13 per cent) or window bars (21 or 0.06 per cent) as the only security feature of their homes (see Table 2).

It is evident from Figure 1 that individual devices are much more effective against burglary with entry than attempts which is an anticipated and welcome result. Of the statistically significant results, external lights or door locks confer the highest protection (SPFs of 3 and 2.8, respectively, for burglary with entry) among all individual devices, that is, assuming the presence of no other. Previous research, some based on offender interviews, has indeed identified high visibility by overlooking occupied properties or passers-by as a main burglary deterrent (Coupe and Blake, 2006; Coupe and Hahn, 2010). Door locks increase the effort and time needed for breaking into a property and thus the risk of the potential burglar being interrupted by passers-by or neighbours (Chenery and Pease, 2013). Security chains are roughly twice better than no security while CCTV, dummy alarm and window bars confer some protection against burglary with entry but none for attempts.

Burglar alarms and dummy alarms appear to increase risk of attempted burglary. The SPFs of dummy alarm for attempts and burglar alarm for any type of burglary are less than 1 implying a counter-productive effect: having just a burglar alarm and no other form of security confers less protection than no security at all. This is counter-intuitive but not without some plausible explanations. It is conceivable that a burglar alarm in a house with no other security features may flag the existence of valuables relative to other ‘unsecured’ properties. In addition, as with the window locks discussed earlier it requires some action on the part of the householder to become functional against burglary. Its simple availability unless set does not by definition confer any active protection, but even worse it may give a false sense of protection that makes such households ‘careless’. Another plausible explanation is that burglar alarms were fitted to homes that had been burgled before the CSEW reference period and therefore the respective households are repeat burglary victims, although the data cannot confirm this. There is ample research evidence that victims have a higher risk of a subsequent (repeat) burglary and that policies that prevent repeat burglary reduce the overall burglary rates (Pease, 1998; [redacted] et al, 2012). Therefore the repeat victimisation risk may counterbalance the potential protection conferred by the burglar alarm. It is also possible that respondents to the CSEW may misinterpret false alarms as attempted burglary. However, dummy alarms also do not offer any active protection and so their protective effect against burglary with entry is hard to explain. One possibility is that burglars believe a silent alarm, and perhaps a personnel response, has been triggered if there is no audible alarm. These results suggest that a range of issues exists for future research including the role of modus operandi of burglars and the attributes of households and residential areas.

Device pairs and triples

Generally speaking, protection increases with the number of devices, as evidenced by the different maximum ordinal scale values of Figures 1–3. The SPFs of pairs and triplets of security devices are given in Figure 2. As mentioned, the exact SPF values can be found in Table 3 (second and fourth column). These results suggest that triples are more effective than pairs. The exception is the pairing of external lights and window locks (EW) which, for burglary, is more effective than the IWD triplet (indoor lights, window locks and door locks). Examining, first, pairs of security devices burglar alarm and door locks (BD) confer no protection for attempted burglary but nearly half the risk of burglary with entry compared with no security. By contrast, window and door locks (WD), the Home Office basic security configuration, reduce the odds ratios of burglary with entry or attempts to roughly 1/13 and 1/8, respectively. This is a considerable effect which, compared with the SPFs of pairs of car crime prevention devices calculated by ■■■■■■■ et al (2011) , suggests that burglary is much more responsive to target hardening than car crime. The remaining three pairs that incorporate window locks, that is, together with external lights (EW), security chains (WS) or burglar alarm (WB) confer statistically significant protection only against burglary with entry with respective SPFs at roughly 18, 13 and 5. Owing perhaps to the great effectiveness of external lights, their combination with window locks confers the highest protection against completed burglaries, among all pairs of devices with significant odds ratios, including WD, the Home Office's basic security. Finally external lights and security chains (ES) have a small protective effect against attempts.

Considering now the configurations of three security devices, that is, triplets, in Figure 2, it is clear that they generally confer double the protection provided by pairs. As perhaps anticipated, the highest (roughly 34 and 14 SPFs for completed and attempted burglary, respectively) is offered by external lights, window and door locks (EWD). Among the remaining triplet combinations the addition to window and door locks of security chains (WSD), CCTV (CWD) or indoor lights (IWD) confers roughly 32, 24 and 17 times higher protection against competed burglary than no security. Their protection factor against attempts is 8, non-significant and 25, respectively. The magnitude of the protection against burglary conferred by triples is considerably greater than that against attempts. For the three triplets conferring greatest protection against burglary, they confer more than double the protection against attempts. However, the combination of indoor lights, window and door locks (IWD) is one out of two (the second such configuration discussed in the next paragraph) that confers more protection against attempts than burglary with entry. As will be seen next, EWD and WSD confer more protection than most combinations of four or more devices.

Device quadruples and greater

Figure 3 presents the SPFs of combinations of four or more security devices with significant odds ratios. The SPFs with regard to burglary with entry are discussed in this and the next two paragraphs. The most striking feature is the extraordinary SPF of 139 against burglary for the combination of all seven security devices examined here except CCTV (EIWSBD). These devices in combination were reported by 931 households (see Table 2) in the 2008/ 2009–2011/2012 CSEW and the effect is statistically reliable albeit a clear outlier that has

not been replicated in preliminary (not shown here) analyses of previous CSEW sweeps. The respective bar has been truncated in Figure 3 to allow the effects of the remaining configurations better to be appreciated. The second most surprising finding shown in Figure 3 (and in comparison with Figure 2) is that burglary protection does not consistently increase with the number of devices that make up each configuration.

The second and third highest SPFs against burglary (after the above-mentioned outlier effect) are, perhaps surprisingly, delivered by the combination of only four security devices out of the seven examined. One of these high-impact four-way combinations includes CCTV, window and door locks and security chains (CWSD). It confers 52 times more protection against burglary compared with no security. The other refers to lights (external and indoor) and locks (for windows and doors) (EIWD) that confers similar protection by a factor of 49. Window and door locks, security chains and external lights (EWSD) confer protection by a factor of 31.5, whereas the remaining four devices configurations, that is, IWSD, WSBD, IWBD and EWBD, reduce burglary odds ratios by a factor of between 23 and 16.5 in the above order.

Looking at combinations of five devices the most effective protection against burglary is conferred by external lights, window and door locks, burglar alarm and either CCTV (CEWBD) or security chains (EWSBD) – by a factor of about 32. Similar protection is found for the two quintuplets of locks and lights with either burglar alarm or security chains, that is, EIWBD and EIWSD, with SPFs of about 30 and 28, while locks, security chains, burglar alarm and indoor lights (IWSBD) reduce burglary with entry odds ratios to 1/23 of that of no security. Finally, households reporting the combination of all devices except security chains (CEIWBD) are protected against burglaries 34 times than those having no security.

Turning now our attention to attempts in Figure 3, the highest protection is conferred by EIWSD which is the second burglary devices configuration to affect attempts more than burglary with entry. EIWD and EWSD are the third and fourth most protective configuration against attempts while the second and fifth place are held by triplets: IWD, mentioned earlier for its higher effectiveness against attempted than completed burglary, and EWD.

The more the merrier?

One question one may ask is whether the SPFs of burglary security combinations are a straightforward extrapolation of the SPFs of the individual devices that make up each configuration. The answer is that they are not. For example, the impact of car security configurations against theft of car is greater than the expected from the individual contributions of the devices that make up each combination (■■■■■■■ et al, 2011). The difference between expected and observed SPFs gives the net interaction effect (NIE) which is calculated as follows: As seen earlier in Figure 1 the SPF for window locks, W, is 6.58 (albeit non-statistically significant) and that for door locks, D, is 2.79. The sum of the two individual impact factors is the expected protection from their combination, WD, and equals 9.37. In Figure 2 and the first row in Table 3, however, the WD configuration has an SPF of 12.54. This exceeds the expected impact by 3.17 which is the NIE of this particular combination. The third and fifth columns of Table 3 give the NIEs of security configurations against burglary with entry and attempts, respectively. Non-surprisingly the greatest NIE (120) refers to the combination of all security devices except CCTV (EIWSBD), which had

Table 4: Mean security protection factor across security devices combinations

Number of devices	Burglary with entry		Attempted burglary		Crime type ratio of mean SPFs
	Mean SPF	Number of combinations	Mean SPF	Number of combinations	
6	86.43	2	11.16	1	7.74
4	29.84	7	12.87	6	2.32
5	29.25	5	17.31	3	1.69
3	26.82	4	15.51	3	1.73
2	11.91	4	4.18	4	2.85
1	2.05	6	1.22	6	1.68
Grand mean	31.05		10.38		3.00

extremely high impact against burglary with entry. The next four greatest NIEs for the same crime type refer to the following configurations in descending order: CWSD (38.9), EIWD (33.2), EWD (22) and WSD (20.9). The five configurations with greatest NIE with respect to attempts are EIWSD (22), IWD (18.2), EIWD (13), CWSD (10.5) and EWSD (8.9).

Two points are worth mentioning here. First, the number of devices is not the main driver in burglary prevention. It is rather the effectiveness of a particular combination. For instance, the second best SPF and NIE against attempts is provided by the combination of only three devices: IWD. Second, the magnitude of the NIE roughly reflects the SPF value for each security configuration but not always. For example, WSD has a higher NIE but lower SPF against burglary with entry than, say, CEIWBD (15.6), EWSBD (17.1) or CEWBD (17.6).

Protection against burglary and attempts does not consistently increase with the number of devices that make up each configuration. This is evidenced in Table 4 that shows the mean SPF protection across the different number of burglary devices per combination (in descending order with respect to burglary with entry). Protection increases greatly from two to three devices against both burglary and attempts. The mean level of protection conferred against burglary by three devices is, however, almost as high as that of four or five devices. Against burglary, the SPF means of four and five devices are almost identical. The protection conferred against burglary is always greater than that against attempts, irrespective of the number of devices, as shown in the final column as the ratio of the SPF of burglary to that of attempts. On average, protection conferred against burglary is three times that of attempts, although this is skewed by the SPF of six devices against burglary (Table 4, last row). If six-device combinations are excluded, the mean SPF conferred against burglary is double that against attempts. Consequently, as might be expected, it is not simply a case of 'the more the merrier', as the types of devices that are combined has an effect. More precisely gauging the marginal effect of devices added to particular combinations may be an area for further research.

Conclusions

This study was motivated by mounting evidence that security improvements have played a significant role in the unprecedented long-term decline in volume crime generally, and

household burglary in particular, in many industrialised countries (Van Dijk et al, 2012).This is, to our knowledge, the first work to examine the protective effects of all individual burglary security devices for which data are available in the CSEW and their possible configurations. Previous research on burglary security examined wide groups or the presence of a device while ignoring any complementary or combinatory effects produced by the co-presence of one or more other device. This work complements the previous literature, by distinguishing the individual protection effects across a large number of devices and their combinations. In addition, the SIAT methodology offers a novel approach to examining the specific effects of different combinations of security devices, both individually and in combination. Longitudinal analysis using the SIAT methodology may be a possibility for future research.

The key findings are the following:

- Individual and combined security devices prevent burglaries with entry more than attempts except for the triplet combination of indoor lights, window and door locks (IWD) and the addition to this of external lights and security chains (EIWSD), which has the converse effect.
- Individual security devices confer up to three times greater protection against burglary with entry than no security. However, a burglar alarm (B) or a dummy alarm for attempts without the presence of any other device is counter-productive increasing the odds ratios of burglary.
- Combinations of security devices in general afford up to roughly 50 times more protection than no security. The protection conferred against burglary, however, does not consistently increase with the number of devices that make up the configurations.

What advice should be given to householders themselves or to those, such as landlords or crime reduction partnerships, attempting to reduce the burglary risks to vulnerable third parties? From a strictly practical perspective, the research reported here suggests if only one security device is installed then fitting external lights on a sensor (E) seems to provide greatest protection against any burglary. If a further device is included, adding window locks to external lights (EW) is suggested in relation to burglary with entry. The Home Office defined basic security, that is, window and door locks (WD), produces second best results against burglary with entry but confers additional protection against attempted burglary. Window and door locks together with external lights or security chains (EWD or WSD) seem the ultimate choice for balancing out number of devices and protection effectiveness: they confer more security than most combinations of four or more devices. Indeed these combinations of just three out of the seven examined devices confer, respectively, the fourth and eighth highest protection effect against burglary with entry among all 31 significant combinations (see Figures 2 and 3 and Table 3). If more devices can be afforded, however, the highest total protection (ignoring the outlier effect of six devices mentioned in the previous section) can be gained by CCTV, window and door locks and security chains (CWSD) or lights and locks (EIWD) that is the cheapest and safer option given the high cost of CCTV and potential fire hazard posed by security chains. From a narrow viewpoint of burglary security, households, landlords and crime and safety partnerships should not even contemplate installing five devices since such configurations are less effective against burglary with entry than the above triplets and quadruplets.[7] Therefore there are economies of scale in the number of security devices installed to prevent burglary with diminishing returns

after two. The protective value added by a second or third device is up to six – or two-fold than a single device or a pair, respectively. In some instances adding a fourth or fifth device reduces the overall effectiveness of the combination resulting thus in dis-economies of scale. Forthcoming changes to security standards for housing should take this into account.

In terms of cost-effectiveness, further research into the cost of security relative to the cost of burglary is required. A best guess, based simply on the number of devices and impact, would be that there is preliminary prima facie evidence that window and door locks together with external lights or security chains may be the most cost effective. However, additional variables such as level of disposable income and the likely loss from a burglary is likely to weigh in householder's security decision making, and in that context the present analysis should be viewed as preliminary. 'One size fits all' security is less effective than bespoke security that accounts for group composition and context (Pease and Gill, 2011). The present analysis forms the first part of a wider research project on 'Which Burglary Security Devices Work for Whom and in What Context?' Future work will seek to qualify the findings reported here for different types of houses, households and areas. Complementing such secondary data analyses findings with burglars' accounts on how the security combinations examined here may discourage them from breaking in would fully answer any questions the current findings created.

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Notes

1 High-level security is incorporated in Secured By Design (SBD) planning and building recommendations that are effective in reducing burglary (for example, Armitage and Monchuk, 2011). Burglary security devices are only one element of SBD, however. Athe current results may inform SBD it is not further discussed here.

2 With sincere apologies to readers if the abbreviated security combinations make the 'Results' discussion somewhat cumbersome. If so please refer back to this list.

3 In the 2008/2008–2011/2012 BCS sweeps 4.8 per cent of burglaries with entry and 5.2 per cent of attempted burglaries occurred to victims of at least three more serious crimes.

4 A small number of cases (which make up: 0.17 per cent of the total sample, 1.6 per cent of all burglary victims, 2.6 per cent of victims of burglary with entry or 4.4 per cent of victims of attempts in 2008/2009–2011/2012), where a respondent experienced both an attempted burglary and burglary with entry (separate incidents not considered to be part of a series) were found. For the purposes of this analysis, security device availability was measured at the time of interview for non-victims and at the time of the first incident for victims. It was therefore necessary to establish when each incident happened in order to ascertain which victimisation happened first – the 'successful' burglary or the attempt. Data regarding the month in which each incident happened was originally established for nine cases from the 2011/2012 sweep. Of the nine, four respondents first experienced an attempted victimisation and two burglaries with entry. With regard to the remaining three cases, both incidents happened in the same

month. Therefore, we were unable to ascertain which incident happened first. As a result, and because they constitute a small proportion of the total sample, cases where a respondent experienced both an attempt and a burglary with entry are excluded from this analysis.

5 Note also that a 'don't know' security category refers to respondents who answered so to all seven devices. To preserve the number of valid observations if respondents answered 'don't know' to having some devices and 'yes/no' to others, the 'yes/no' responses have taken preference. Where a respondent answered 'don't know' to some of the devices and 'no' to all others this is coded as 'no security' together with 'no' responses to all seven devices.

6 The significance is based on the P-values of the z-score for testing the hypothesis that the proportions of security availability differs between burgled households and the entire fleet under the assumption of identical, that is, no security effect, but unknown population proportion.

7 Unless the aim is to reduce attempted burglaries at the expense of completed ones since the highest protection against the former crime type is conferred by EIWSD.

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