



# A quasi-experimental evaluation of the impact of forensic property marking in decreasing burglaries

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## Abstract

Property marking is a popular tool used by police agencies in burglary prevention programmes. 345 property marking kits were distributed to households in a treatment area in an English city. Changes in burglary in the treatment area were compared to three control areas. Crime type displacement to vehicle crime, criminal damage and violent crime, and changes in crime while controlling for geographic displacement were examined. Burglary decreased significantly by 82% in the treatment area in comparison to control areas during the first six months of the intervention. A significant diffusion of benefit effect to vehicle crime and criminal damage was also observed. The decreases, however, were short-lived with burglary levels returning to pre-intervention levels in the treatment area after 12 months.

**Keywords** Property marking · Burglary · Forensic traceable liquid · Displacement · Deterrence

## Introduction

The marking of property, such as electronic goods, jewellery, and valuable items of infrastructure, aims to decrease the theft of property and assist in returning stolen property to its owner. For personal items, property can be marked with the owner's address details using ultra-violet (UV) pens or engraving (Laycock 1985), or for wider applications uses bar codes, electronic security tags (Beck and Palmer 2010; Sidebottom et al. 2017), radiofrequency identification devices (Jones et al. 2005) and forensic traceable liquid. In interventions that use property marking to decrease residential burglary, the application of forensic traceable liquid—using liquid that is unique to each household—has in most cases replaced the use of UV pens and other property marking devices. Many police agencies use property marking in residential

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burglary prevention programmes. The evidence, however, on the impact of property marking for decreasing burglary is limited. Most published studies are dated, refer to the use of UV pens in property marking interventions, with the results being mixed (Heller et al. 1975; Knutsson 1984; Laycock 1985; Sutton 2010). More recent evidence suggests that property marking interventions using forensic traceable liquid do decrease burglary (Kyvsgaard and Sorensen 2020).

In this paper we contribute to the evidence about the use of property marking for decreasing burglary with results from an evaluation of an intervention that used forensic traceable liquid to mark property in households in a city in England. We build on the existing evidence by examining if crime type or geographic displacement occurred, and if changes in crime were consistent across the 12-months post-intervention analysis period. The study uses an approach that compares the change in crime in a single treatment area to multiple control areas to examine for consistency in changes in crime.

## Property marking and its application in the prevention of burglary

The marking of household property to help in the prevention of residential burglary is an approach that began to be increasingly used in the 1970s. Heller conducted the first known study of property marking (Heller et al. 1975) in Seattle and St Louis, USA. Participants were required to mark household items, using a pen, with an identification code that could link the property to the participant. The intervention resulted in decreases in burglary of 33% in Seattle and 25% in St Louis where it was applied. In 1984, Knutsson tested the use of property marking in a residential area of 3500 homes in Stockholm, Sweden. Street signs were also displayed indicating that residents in the area had property that was marked. Initially, only 13% of residents participated in the programme, later rising to 30%. No decreases in burglary were observed and interviews with burglars suggested that the majority took little notice of the signs indicating that property was marked. However, the sample size of offenders was small and interviews were with burglars from the whole of Stockholm rather than with only those who were known to operate in the area where the property marking programme was implemented.

An evaluation of a property marking programme in Wales in 1983 found that the programme almost halved the number of reported burglaries (Laycock 1985). In this evaluation the analysis only considered burglaries that resulted in the loss of products that could be marked (using UV pens to write the owner's postcode on their property), rather than burglaries that only involved the theft of cash (which was not marked). The programme was implemented in three villages—Trethomas, Graig-y-Rhacca and Machen. 2,234 households participated in the programme,<sup>1</sup> with participation rates of between 70 and 75% in the three villages. A significant decrease in burglaries of 40% (reducing from 128 to 74)

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<sup>1</sup> Participation was based on whether a house owner displayed a sticker on any outside door or window that had marked their property.



was observed across the participating households in the 12 months after the implementation of the intervention, with the results being similar in each village. There was no change in burglaries for non-participants in the treatment areas. Of the burglaries that were committed in houses where property was marked, there was no evidence of any stolen goods being recovered or returned to their owners, and no difference in the number of offenders detected. 21 of the 74 burglaries had been detected, but there was no evidence to suggest that property marking played any role in these detections. Of note also was the apparent effect on police–public relations, with many police officers commenting on the welcoming reception they received when handing out kits to residents. Laycock (1985, 1992) concluded that although the property marking programme was successful, this was more likely to be associated with the advertising of the scheme (using stickers on doors and windows of participating households that promoted a ‘burglar beware’ signal), rather than the marking of property.

Between 1990 and 2015 there were no known peer reviewed studies that examined the impact of property marking in decreasing burglary, however its use was popular, particularly in the United Kingdom. My review of applications submitted to the UK’s Tilley Problem-Oriented Policing awards between 1990 and 2010 (available at [www.popcenter.org](http://www.popcenter.org)) identified several examples that reported on the impact of burglary prevention initiatives that used property marking. This included a study in Staffordshire in 2004 that used forensic traceable liquid to mark property (referred to from this point as forensic property marking) as part of a burglary prevention intervention that also used alley-gating and improved street lighting (Staffordshire Police 2005). It was claimed that the intervention resulted in a 68% decrease in burglaries. Another example from Doncaster in 2006 used forensic property marking in 15,000 households, alongside a ‘Trap Car’ scheme to lure offenders and catch them in the act of attempting to steal a car (Safer Doncaster Partnership 2008). The intervention was suggested to have decreased burglary by 26%, and the trap car led to the arrest of 32 offenders. Several of the offenders that were caught while attempting to steal the trap car were also known to have previously committed burglaries, and so it was likely that their arrest had an impact on their subsequent commission of burglaries. The Doncaster example also reported on a survey of known offenders who were asked about the property marking scheme: 91% of offenders stated they were aware of the increased use of property marking in houses in Doncaster because of the advertising of the scheme, and three in four stated that this was enough for them to be deterred from targeting properties that displayed property marking notices.

The examples described above provide some indication that property marking of household items can have an impact in decreasing burglaries. However, the Tilley POP award examples where property marking was used were usually part of a wider programme that involved other interventions (e.g., alley-gating and the use of trap cars) which meant they did not provide a clear indication of the specific impact of property marking. The studies before 1990 describe the use of UV pens in property marking, which from about the year 2000 became increasingly obsolete and replaced with forensic property marking. One of the benefits in using forensic traceable liquid is that items of jewellery can be marked—a common item that is targeted by offenders (ONS 2020). Also, it is likely that owners of expensive portable items



such as cell phones and tablet computers are more willing to mark this property with a drop of liquid rather than using pens, engraving or tags.

To date the evidence on the impact of forensic property marking in decreasing burglaries is limited. The only peer reviewed study by Kyvsgaard and Sorensen (2020) involved a randomised control trial of a forensic property marking intervention in Aarhus, Denmark. The treatment group was arranged into two groups: Households that requested property marking kits and used stickers on a door or window promoting their use (T1,  $n = 1080$ ), and; households that requested the property marking kits but who did not use the sticker or said they used the sticker but these could not be observed when checked (T2,  $n = 808$ ). The control group consisted of 3225 households. Over the 15-month period after the implementation of the property marking programme the T1 group experienced a burglary victimisation rate of 3.8% compared to a victimisation rate of 4.6% in the T2 group and a rate of 6.2% in the control group. The aggregate treatment group recorded a significant 21% fewer burglaries than the control group.

The evidence from the Danish study adds to Laycock's (1992) suggestion that promoting the presence of property marking is important to its success. However, even in instances when it was not clear that property marking had taken place, the burglary victimisation rate decreased significantly in comparison to the control group (Kyvsgaard and Sorensen 2020). The saturation rate of a property marking programme also appears to be important to its success, with one other study suggesting that a saturation rate of at least 80% is required for property marking to be effective in decreasing burglaries in a treatment area (Brooks 2015).

Forensic property marking involves the application of a small amount of forensic traceable liquid to the item of property. The liquid is distributed in a kit that includes a brush, a sticker to advertise that property has been marked, and instructions about how to apply the liquid and register its use. Often, police officers conduct door-to-door visits to distribute the kits and advise on their use. In most instances, street signs stating the presence of property marking are also mounted on lamp posts in the streets where the property marking kits have been distributed. Recording the use of the kit often involves the home owner registering their details using a cell phone app provided by the company that manufactured the kit, which in turn assists the police in returning items to the owner in the event of property being stolen and recovered. The distribution of property marking kits is also often supported by a promotional campaign. This can include a senior police officer writing to residents in the treatment area and telling them about the scheme (Laycock 1985).

Deterrence is the key theoretical framework for explaining how property marking most likely works. Deterrence aims to reduce the appeal and rewards of offending (Nagin 1998; Sherman 1993). For deterrence to work, offenders and potential offenders need to know of the risks involved in crime commission. This requires the risks and the consequences of crime commission to be advertised because if the risks are unknown, they cannot deter (Kennedy 2009). Competing against deterrence is the experiential effect. If an offender commits an offence without consequence, or sees or learns about others doing so, they adjust their risk estimate downwards (Minor and Harry 1982; Saltzman et al. 1982). This means that as time passes and the offender commits crime without getting caught, the strength of deterrence



decays. Communicating the risks of offending is, therefore, vital to how deterrence works (Kennedy 2009; Paternoster et al. 1983). Advertising a property marking programme using street signs and door and window stickers is, therefore, important to how a property marking intervention works.

Although marking property and its advertising using house stickers and street signs can deter offending, it only partly explains how this offending may reduce, especially over a sustained period. In addition to deterrence theory, one of the techniques of situational crime prevention (Clarke 1983; Cornish and Clarke 2003)—*identifying property*—also helps explain how property marking works. Identifying property seeks to reduce the rewards of offending by denying the offender the benefit of being able to sell marked property. Identifying property can also lead to the offender believing it is now more difficult for them to sell any property they steal because it is marked, which in turn decreases their offending behaviour. In the studies that have examined property marking, even though burglary decreased, several households that marked property and displayed a sticker were burgled. Here, it seems, that not all offenders were deterred in committing burglaries by signs and stickers, or were aware of property being marked. This means that property marking is unlikely to work if property is not marked and only advertising is used. If an offender is caught in possession of property marked items, these items can be proven as being stolen and assist in the offender's prosecution. However, there is little evidence of police agencies charging offenders for possessing marked property from a household that is a participant in a property marking intervention. Also, for property marking to work, offenders need to be denied the benefits of selling marked property. This requires property marked items that an offender steals to be checked for their provenance and not purchased by any buyer.

In the current study we examine the impact of a forensic property marking programme in a residential neighbourhood in a city in England. The study involves a quasi-experimental evaluation design that compares changes in burglary in the neighbourhood where property marking kits were distributed, to changes in crime in control areas. We also examine for geographic displacement. To date, no known evaluations have examined if property marking results in displacement to other types of crime. Also, few evaluations have examined if any decreases in crime were most observed when the intervention was initially implemented or if decreases in crime were sustained for longer periods. We add to the evidence on the impact of property marking by examining crime type displacement and changes in crime for two 6-months periods after the intervention's implementation. Although it was beyond the scope of the current study to test specific mechanisms associated with how property marking may work to decrease burglary, we revisit these mechanisms in the discussion section.

## Data and methods

In May and June 2018, 345 forensic property marking kits were distributed by police officers to properties in a residential neighbourhood in West Bromwich, England (referred to from this point as the treatment area). The treatment area was chosen by



the police as it was an area that had a higher than average burglary rate. Distributing the kits involved police officers visiting houses in the treatment area, explaining the purpose of the kits, demonstrating how to mark an item of property and providing instructions on how the resident could mark the remainder of their property (i.e., it was up to the resident to complete any property marking). Before leaving, the police officer would place the sticker advertising the marking of property on the resident's front door or front window, and would use a mobile app to register property marking had been applied. All households in the neighbourhood were invited to participate in the programme. When occupants were not present, follow-up attempts were made to distribute property marking kits. There were 1120 dwellings within the treatment area. The 345 property marking kits that were distributed represented a saturation rate of property marking in the treatment area of 31%. Prior to the distribution of the kits, in April 2018 visits were made to the treatment area by police officers to notify residents of the planned intervention. This included the posting of notices about the programme on community bulletin boards in the treatment area. Street signs advertising property marking were mounted on lamp posts in May and June 2018 in the treatment area.

The analysis was organised into four parts: a comparison of the changes in burglary between the treatment area and control areas; an examination of crime type displacement; an examination of changes in crime while controlling for geographic displacement, and; an examination of when changes in crime were greatest after the implementation of the intervention. Recorded crime data were sourced for the period April 2017 to March 2019 and were checked for geocoding accuracy and completeness. Data was also available on the outcome of each incident, such as if an offender had been charged for a burglary. The initial intention was to use these data to examine if the property marking intervention led to an increase in the number of offenders that were charged for burglary in the treatment area. A review of these data found that very few offenders were charged for burglary in the study area between 2017 and 2019, which meant it was not possible to generate any reliable statistical comparisons between the treatment area and control areas.

Propensity score matching was used to identify potential control areas (Gelman and Hill 2007), using the number of burglaries in the one-year period prior to the implementation of the intervention, the number of households, and deprivation as match control variables. Three potential control areas were identified. Each were sufficiently far from the treatment area for them not to be affected by the intervention. It was decided that all three control areas would be used in the evaluation. Often, evaluations only compare changes in crime in a single treatment area to a single control area, however, this can make the comparison sensitive to unique events that may take place in the single control area (as observed by Bennett 1981). This can mean the results from the evaluation are unreliable, even when controls are carefully selected. Using three control areas meant that the differences in the changes in crime between the treatment area and each control area could be examined for consistency. Pooled measures of the controls were also calculated.

The first analysis involved grouping the burglary data into three 6-months periods and one 12-months period: three pre-treatment periods of April to September 2017, October 2017 to March 2018 and April 2017 to March 2018, and a post-treatment



period of April to September 2018. April 2018 was chosen as the beginning of the intervention because this was when the police began to promote the property marking programme.<sup>2</sup> The second part of the analysis used three types of crime to examine crime displacement: vehicle crime; criminal damage, and; violent crime.<sup>3</sup> It was hypothesised that a diffusion of benefit effect may be observed in vehicle crime in the treatment area because of the property marking focus of the intervention. That is, offenders may believe that property left inside vehicles, and even the vehicles themselves, may have been marked, even though no property marking of vehicles or property marking of items inside vehicles may not have taken place. For criminal damage, it was hypothesised that a diffusion of benefit effect may be observed. Often, when criminal damage occurs against residential property this is associated with damage that results from attempted break-ins to homes, garages, sheds or vehicles. Crimes of this type may have decreased in the treatment area because offenders perceived that property inside a home, garage, shed or vehicle may have been marked and hence did not attempt a break-in. It was hypothesised that the intervention would have no effect on violent crime because of the property crime focus of the intervention. Displacement to robberies and thefts from the person was considered but the number of these incidents were too few in the treatment area for any analysis to be meaningful.

The first two parts of the analysis used Relative Incident Rate Ratios (RIRRs), recommended instead of odds ratios, to compare changes in crime between the treatment and control areas (Wilson 2021). The RIRR is calculated as follows:

$$\text{RIRR} = (b/a)/(d/c),$$

where  $a$  is the count of crimes in the treatment area for a period before the intervention,  $b$  is the count of crimes in the treatment area during the intervention (or from the date the intervention was implemented),  $c$  is the count of crimes in the control area for a period before the intervention, and  $d$  is the count of crimes in the control area during the intervention. An RIRR that is less than one indicates the intervention was associated with a decrease in crime in the treatment area in comparison to the control area. An RIRR of 0.77, for example, would be equivalent to a decrease of 23% in the treatment area relative to the control area. The RIRR can be used when comparing changes in crime in a treatment area to the pooled changes in crime for multiple control areas because it is not sensitive to differences in the size of areas if these do not change between the testing periods. The RIRR can also be used to compare changes in crime when the pre and post intervention periods are of different length (Wilson 2021). RIRRs were calculated for burglary, vehicle crime, criminal damage and violent crime for each treatment–control comparison and for each pre and post time period comparison, and for pooled changes in crime in the three control areas.

<sup>2</sup> Advertising an intervention before the actual implementation of the programme can impact on crime levels (Bowers and Johnson 2003).

<sup>3</sup> It was not possible to examine shorter time periods or subsets of the crime types analysed because of the low counts of crime in treatment and control areas.



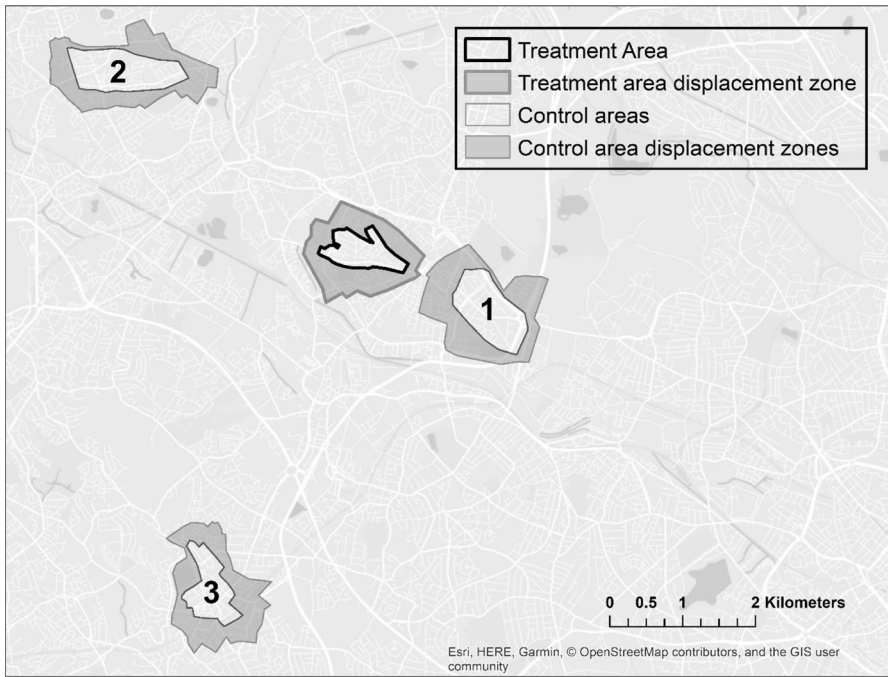


Fig. 1 Treatment and control areas, and displacement zones

Table 1 Numbers of burglary in the treatment area, control areas and displacement zones

	Burglaries (April 2017–March 2018)
Treatment area	49
Displacement zone	48
Control area 1	52
Displacement zone 1	48
Control area 2	45
Displacement zone 2	47
Control area 3	52
Displacement zone 3	51

For the third part of the analysis a *displacement zone* was created around the treatment area, and displacement zones were created for each control area (Fig. 1). The use of displacement zones around control areas is useful for comparing changes in crime in a treatment area whilst controlling for changes in crime in similar areas and controlling for geographic crime displacement. The size of each displacement zone was controlled so that the number of burglaries in each zone was similar to that which had been experienced in its respective control area. Also, displacement zones were drawn so that they did not cover large non-residential areas. Table 1 lists the





number of burglaries in the treatment area, control areas and displacement zones for the year prior to the implementation of the intervention.

The Weighted Displacement Difference (WDD)  $Z$  test statistic was used in the third part of the analysis (Wheeler and Ratcliffe 2018) and is defined as follows (Eq. 1):

$$Z = \frac{D}{\sqrt{\text{Var}(D)}}, \quad (1)$$

$$Z \sim N(0,1),$$

where  $D$  is the total net effects observed before and after the intervention in the treatment area, control area and displacement zones, given by (Eq. 2):

$$D = (\Delta T - \Delta Ct) + (\Delta Td - \Delta Cd) \quad (2)$$

where  $\Delta T$  is the change in crime in the treatment area,  $\Delta Ct$  is the change in crime in a control area,  $\Delta Td$  is the change in crime in the treatment area's displacement zone, and  $\Delta Cd$  is the change in crime in a control area's displacement zone. WDD software (which runs as a series of functions in an Excel spreadsheet template) is available at <https://andrewpwheeler.com/2018/09/25/new-paper-a-simple-weighted-displacement-difference-test-to-evaluate-place-based-crime-interventions/>.

A WDD  $Z$  score value of less than one indicates that crime decreased in the treatment area while controlling for changes in crime in the treatment area's displacement zone, the control area, and the control area's displacement zone. Two-tailed critical values were used to assess if crime decreased or increased during the intervention period, and from  $p < 0.1$  because of the low counts observed in some cases which could make decreases in incidence harder to detect. WDD values were calculated for burglary, vehicle crime, criminal damage and violent crime using the 6-months pre and post intervention periods previously described. The WDD test was also applied to the pooled values of all control areas, but required the number of crimes in the treatment area and the treatment area's displacement zone to be multiplied by three (to be comparable to equivalent levels of crime observed in all three control areas) because of the test's sensitivity to different levels of crime between areas (Wheeler and Ratcliffe 2018).

Part four of the analysis involved calculating the RIRR and WDD values for burglary, vehicle crime, criminal damage and violent crime for the six-month period of October 2018 to March 2019 to examine the longer term effects of the intervention.

## Results

Four sets of results are presented. The first set of results show the change in burglary in the treatment area and control areas for the pre and post-treatment periods. The second set of results show if crime type displacement (or a diffusion of benefit effect) occurred. The third set of results show how crime changed over time while controlling for geographic displacement, and the fourth set show if the changes



**Table 2** RIRRs for three pre-intervention periods in comparison to April–September 2018

Pre-intervention period	Control area 1	Control area 2	Control area 3	Pooled controls
<b>Burglary</b>				
April–September 2017	0.11	0.31	0.11	0.15
October 2017–March 2018	0.16	0.21	0.36	0.21
April 2017–March 2018	0.14	0.26	0.24	0.18
<b>Vehicle crime</b>				
April–September 2017	0.67	1.66	0.62	0.92
October 2017–March 2018	0.30	0.55	0.25	0.35
April 2017–March 2018	0.41	0.87	0.35	0.52
<b>Criminal damage</b>				
April–September 2017	0.51	1.38	0.44	0.75
October 2017–March 2018	0.21	0.81	0.27	0.41
April 2017–March 2018	0.32	1.03	0.34	0.54
<b>Violent crime</b>				
April–September 2017	1.30	1.56	1.12	1.35
October 2017–March 2018	0.81	0.82	0.90	0.84
April 2017–March 2018	1.01	1.12	0.99	1.05

in crime were sustained beyond the initial 6-months post-intervention evaluation period.

Table 2 shows the RIRR results for burglary comparing the treatment area to each control area by comparing the level of crime during the first six months of the intervention to two 6-months pre-treatment periods and the 12-months pre-treatment period. When comparing April–September 2017 to April–September 2018 the RIRR for each of the three treatment–control comparisons was less than one (0.11, 0.31, and 0.11 respectively), with each result indicating substantial decreases in burglary. The pooled controls RIRR was 0.15. This is equivalent to a percentage change in the treatment area relative to the control areas of a decrease in burglaries of 85%. When comparing October 2017–March 2018 to April–September 2018 the RIRRs in each case were also less than one (0.16, 0.21, 0.36 respectively). The pooled control RIRR was 0.21, suggesting there had been a decrease in burglaries of 79% in the treatment area relative to the control areas when comparing the six months immediately prior to the intervention to the first six months of the intervention. The pooled controls RIRR for the comparison between the 12-months period before the intervention to April and September 2018 was 0.18, suggesting there had been a decrease in burglaries of 82% in the treatment area relative to the control areas in the first six months after the intervention was implemented.

Table 2 also shows the RIRR results for vehicle crime, criminal damage and violent crime. For vehicle crime and for each time period comparison between the treatment area and the three control areas, the RIRRs were less than one, with the exception of one occasion in Control Area 2 when the RIRR was 1.66. Inspection of the data in Control Area 2 revealed there was a spate of vehicle crimes involving 24 incidents that appeared to be unique to this control area between



April and June 2017 when on average only six of these crimes would be experienced each month in the year before the intervention. The pooled control RIRRs were less than one for each time period comparison. The RIRR of 0.52 for the comparison between the intervention period and the 12 months before the intervention was equivalent to a percentage change in the treatment area relative to the control areas of a decrease in vehicle crimes of 48%. This result suggests there was a diffusion of benefit effect of the property marking intervention on vehicle crime.

The RIRRs for criminal damage for each treatment area and control area comparison and each time period comparison were less than one, with the exception of one occasion in Control Area 2 when the RIRR was 1.38. The pooled control RIRRs were less than one for each time period comparison. The RIRR of 0.54 for the comparison between the intervention period and the 12 months before the intervention was equivalent to a percentage change in the treatment area relative to the control areas of a decrease in criminal damage of 46%. This result suggests there was a diffusion of benefit effect of the property marking intervention on criminal damage. The pooled controls RIRR of 1.05 for violent crime when comparing the intervention period to the 12 months before the intervention suggested there had been no change in violent crime in the treatment area in comparison to the control areas.

Table 3 shows the WDD results for burglary, showing that for each of the comparisons between pre and post intervention the decrease in burglary was statistically significant ( $p < 0.05$ ). That is, after controlling for changes in crime between the treatment area and control areas, and controlling for geographic displacement, significant decreases in burglary were experienced in the treatment area. With regards to vehicle crime, criminal damage and violent crime, although the results for the three control areas differed, the pooled control WDD results suggested there had not been any significant changes in these types of crime when comparing April–September 2017 to April–September 2018. Significant decreases were observed, however, in vehicle crime, criminal damage and violent crime when comparing October 2017–March 2018 to April–September 2018.

Table 4 shows the RIRRs, WDD Z score and  $D$  values for burglary, vehicle crime, criminal damage and violent crime when comparing changes in these crimes between October 2018 to March 2019 and October 2017 to March 2018. Burglary levels significantly increased in the treatment area in comparison to the control areas (when comparing this second 6-months post-intervention period to its equivalent pre-treatment period), indicated by the pooled control RIRR value of 1.84 and the significant WDD Z score. The pooled controls RIRR was equivalent to an 84% increase in burglary in the treatment area in comparison to the control area. The pooled RIRR values for vehicle crime and criminal damage were 0.54 and 0.56 respectively, suggesting that decreases in these types of crime were sustained into the second 6-months period (in comparison to its equivalent pre-treatment period). The pooled control RIRR for violent crime was 0.78 for this time period comparison suggesting that a modest decrease in violent crime had also taken place in the treatment area in comparison to the three control areas.



**Table 3** WDD Z score and *D* values (in brackets)

Pre and post intervention comparison periods	Control area 1	Control area 2	Control area 3	Pooled controls
<b>Burglary</b>				
April–September 2017 to April–September 2018	- 2.12** (- 33)	- 0.08 (- 1)	- 1.11 (- 14)	- 2.01** (- 48)
October 2017–March 2018 to April–September 2018	- 2.01** (- 33)	- 1.74** (- 23)	0.35 (5)	- 2.01** (- 51)
<b>Vehicle crime</b>				
April–September 2017 to April–September 2018	- 1.43* (- 23)	1.70* (26)	0.40 (6)	0.34 (9)
October 2017–March 2018 to April–September 2018	- 2.50*** (- 44)	- 0.12 (- 2)	- 2.03** (- 33)	- 2.70*** (- 79)
<b>Criminal damage</b>				
April–September 2017 to April–September 2018	- 2.41*** (- 33)	1.43* (21)	- 0.54 (- 7)	- 0.80 (- 19)
October 2017–March 2018 to April–September 2018	- 3.35*** (- 47)	0.20 (3)	- 3.02*** (- 38)	- 3.42*** (- 82)
<b>Violent crime</b>				
April–September 2017 to April–September 2018	- 0.08 (- 2)	0.82 (19)	- 0.47 (- 10)	0.18 (7)
October 2017–March 2018 to April–September 2018	- 0.97 (- 24)	- 1.54* (- 36)	- 1.79** (- 40)	- 2.46*** (- 100)

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ , \*\*\*\* $p < 0.001$



**Table 4** RIRRs, WDD Z score and *D* values for changes in crime between October 2017 to March 2018 and October 2018 to March 2019

	Control area 1	Control area 2	Control area 3	Pooled controls
<b>Burglary</b>				
RIRR	1.74	1.30	2.54	1.84
WDD Z score (and D)	3.16*** (51)	1.83* (26)	2.98*** (46)	4.65**** (123)
<b>Vehicle crime</b>				
RIRR	0.70	0.52	0.38	0.54
WDD Z score (and D)	-0.24 (-4)	-1.78** (-32)	-2.37*** (-40)	-2.55*** (-76)
<b>Criminal damage</b>				
RIRR	0.51	0.60	0.49	0.56
WDD Z score (and D)	-0.35 (-5)	-0.78 (-13)	-1.19 (-16)	-1.32* (-34)
<b>Violent crime</b>				
RIRR	0.70	0.60	1.45	0.78
WDD Z score (and D)	-1.68** (-43)	-3.28**** (-82)	-0.89 (-20)	-3.43**** (-145)

\* $p < 0.10$ ; \*\* $p < 0.05$ ; \*\*\* $p < 0.01$ ; \*\*\*\* $p < 0.001$

## Discussion

The forensic property marking intervention implemented in a treatment area in West Bromwich, England suggested that the intervention contributed to a significant decrease in burglaries during the first 6 months of the intervention. A significant diffusion of benefit effect was also observed in vehicle crime and criminal damage in the treatment area. The WDD results for violent crime indicated some decreases in this crime type, however the RIRR results for the first 6 months of the intervention suggested there had been no change in the levels of violent crime. The treatment area received a property marking saturation rate of 31%, with the results suggesting that a relatively low level of property marking saturation can result in significant decreases in burglary and a diffusion of benefit effect to other types of property crime.

Further inspection of the changes in burglary between pre and post intervention periods revealed that some displacement to the treatment area's displacement zone had occurred: burglary in the treatment area decreased from 25 burglaries between October 2017 and March 2018 to five burglaries between April and September 2018; in the treatment area's displacement zone, burglaries increased from 25 incidents to 31 between the same time periods. Even though some local displacement had occurred the overall effect of the intervention, as indicated by the WDD results, was a significant decrease in burglaries. The decreases in burglary in the treatment area were, however, relatively short-lived. During the second 6-months post-intervention period there was a significant increase in burglaries in the treatment area. This meant that a year after property marking had taken place, burglary levels in the treatment area returned to pre-intervention levels. Combined, these results suggest that property marking using forensic traceable liquid can result in significant decreases in crime, but these decreases can be difficult to sustain.



A visit to the treatment area in 2019 showed that street signs and door and window stickers were still visible, raising questions about how property marking and its advertising can sustain decreases in burglary. Difficulty in sustaining the initial impact of an intervention is not uncommon in crime reduction practice. For example, hot spot policing has been extensively evaluated, with results of its impact consistently suggesting it can lead to significant decreases in crime (Braga et al. 2019). However, evaluations that have examined the longer term impact of hot spot policing have shown that when the intervention stopped, crime soon returned to levels that were observed before the intervention (Sorg et al. 2013). The implementation of a property marking intervention usually involves significant investment—investment in the property marking kits<sup>4</sup> and investment in time to distribute the kits. Maximising the sustainable effect of a property marking intervention is, therefore, in the interests of the police to ensure the investments are beneficial.

Deterrence, as previously suggested, is the main mechanism through which property marking is believed to work. The findings from previous research on property marking suggests that the advertising of the programme using ‘burglar beware’ street signs, door stickers and window stickers is an important component to the intervention’s impact (Kyvsgaard and Sorensen 2020; Laycock 1985). However, this is only one of several possible mechanisms that can operate to decrease crime using property marking. I suggest that other possible mechanisms include increased resident vigilance, the arrest and removal of offenders, difficulty in disposing of marked stolen property, and prosecution of traders for selling property marked stolen goods. An examination of each follows.

Property marking tends to be implemented in areas that have experienced high levels of burglary. When a resident is offered property marking by the police, this is usually supported with some justification as to why, such as ‘we want to reduce your risk of being a victim of burglary’. This can inform the resident they are at a heightened risk of burglary, and by giving them a property marking kit they may feel more empowered to do something that reduces their risk. Marking property may then make them more vigilant in monitoring their property, and the visit by the police may make them more vigilant about what is happening in their neighbourhood and more likely to report suspicious behaviour. This may then contribute to burglaries decreasing in the area.

If property marking leads to the arrest and prosecution of an offender, this removes that offender from being able to commit subsequent offences, and hence can contribute to decreasing burglaries in the area. Most burglars steal items for financial gain rather than their own personal enjoyment (Bernasco 2010; Cromwell 1996; Townsley et al. 2015; Wright and Decker 1994), requiring the offender to dispose of the stolen property in exchange for cash. This can often involve selling the stolen property to second-hand traders. To prevent this, the trader needs to check and refuse items if property marking is found and they suspect the product is stolen. Refusing to purchase items that are suspected to be stolen can deny the offender of the rewards they anticipated from the commission of the burglary, and may in turn

<sup>4</sup> The price of kits is not publicly advertised by the companies that produce them.



lead to them decreasing this offending if they find it difficult to sell items they have stolen.

Property marking can also decrease crime if traders are prosecuted for selling stolen goods. In the UK and many other countries, second-hand traders are required to ensure that the goods they purchase are not stolen. This requires the trader to be confident about the provenance of the items they acquire because traders can be prosecuted for selling stolen goods. It is also a legal requirement for the trader to maintain a register for each item they acquire. This register must contain the name and address of the seller (and checked using official proof of identity), the date of the transaction, and a description of the item that has been acquired. It is an offence if a trader fails to keep a register or fails to record the required information.<sup>5</sup> Prosecuting the trader who sells stolen goods and does not maintain a register may then make it more difficult for the offender to dispose of stolen goods.

For each of the suggested mechanisms that can operate to decrease crime using property marking, a consideration of their application in practice can help to understand why decreases in burglary that may initially be experienced can be difficult to sustain. By doing so, several opportunities for improving the use of property marking are suggested. The vigilance of residents may decay within a short period of time after receiving the property marking kits. Also, for this vigilance mechanism to work, it requires the resident to see someone behaving suspiciously, requires them to call the police (if the resident did not question the person themselves), the police respond, and for the person who has been observed to either see the police (and moves from the area), be questioned by the police, or be arrested. There are many connected components that require an increase in vigilance to work to reduce crime. In particular, it involves residents to be on the lookout for suspicious behaviour and a quick response by the police. When resident vigilance decays and police response resources are limited to enable a quick response, this makes it unlikely that this vigilance mechanism operates in a manner that supports sustainable decreases in burglary. Sustaining resident vigilance may benefit from follow up campaigns by the police at least every six months, handing out property marking kits to new residents, and use of dedicated neighbourhood policing personnel that respond to calls for service.

For the mechanism associated with the arrest and removal of offenders to work, offenders have to be arrested. In 2018, detection levels in the England and Wales for burglary were 5% (ONS 2020). If offenders are not arrested and imprisoned, or if their criminal behaviour is not monitored in some way (e.g., via an offender supervision programme), this mechanism does not operate. Also, as this mechanism does not remove the opportunities for burglary that may exist in the area, other offenders can take advantage of these opportunities if a burglar in the area has been removed. Also, once an offender commits a burglary in a property marking area (or learns of others who have done so), and is not arrested the experiential effect means they

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<sup>5</sup> In the UK, this legislation is usually bound within county council acts, such as The County of Lancashire Act 1984 <https://www.blackpool.gov.uk/Business/Licensing-and-permits/Business-and-trading-licences/Second-hand-goods-guidance-notes.aspx>.



reduce their perceived risk of being caught (Kennedy 2009; Minor and Harry 1982; Saltzman et al. 1982).

To ensure traders of second hand goods are deterred from accepting and selling property that has been stolen requires the police or officers from trading standards authorities to visit second-hand traders, check products that are for sale, confiscate products that can be proven as stolen, and prosecuting the sellers. Confiscating products that have property marking may not be possible because it might be difficult to prove an item as stolen. This, therefore, can make it difficult for this mechanism to operate. However, checking the register of items that have been acquired and that the trader must maintain can improve the operation of this mechanism on two counts. First, in situations where it is a legal requirement for a register to be maintained, these records may reveal the name of individuals who have repeatedly sold property marked items and lead to their arrest. Second, if accurate records are not kept, the seller can be charged or warned that they will face penalties if they do not maintain accurate record keeping. This can have the consequence of offenders being unable to sell items to certain traders because they do not wish to provide official identification and for this to be kept on record for police checks. The police checks also need to take place for this mechanism to operate. When offenders know the police regularly conduct checks of the records kept by traders, this in turn can make offenders think it is now more difficult for them to dispose of stolen goods, and as a result may reduce their burglary offending. Although offenders can sell stolen goods through other means (e.g., eBay), second-hand traders may provide a more convenient, and often anonymous way for offenders to sell stolen property. In the UK, it is also an offence for the person who sold the item to the trader to give a false name or address. Therefore, if registry entries are viewed as being suspicious, these can be further investigated. If those who gave false names and addresses are identified and are suspected to have sold stolen goods this can also add to the mechanism that is associated with the arrest and removal of offenders.

When police agencies and trading standards authorities operate good procedures for preventing the sale of stolen property, the impact that property marking can have in decreasing burglaries can be strengthened by promoting news of any offender or second-hand trader that is prosecuted when property marking was used to assist in them being charged. This can counter the experiential effect that decays the initial deterrence by making other offenders and second-hand traders perceive that handling stolen property that is marked is risky.

Unique property marking can result in the owner of a stolen item being identified, and the goods returned to them. However, there is no strong mechanism in this process that impacts on offending (unless the offender is arrested in connection with the stolen item). Although an item of property that is precious and sentimental to the owner may bring them satisfaction for its return, the offender is likely to have profited from its sale. Also, even if the return of the property may improve a resident's opinion about the police, this opinion is likely to have previously been harmed by the victimisation they experienced (Ashcroft et al. 2003). Also, this process assumes the police have the resources to identify the owner of the stolen property and return it to them. Items that are not sentimental and are returned may have already been





replaced, hence weakening any argument that the returning of property to the owner leads to decreases in burglary.

The current study showed the value in using multiple control areas for evaluating the impact of crime in a single treatment area. In some cases, the results for one control area were different to the results from the other two control areas. This was because of unique events that took place on some occasions. If only one control area was used, this would have impacted on the results, and could have led to generating misleading conclusions. We recommend the use of multiple control areas, and displacement zones, in other impact evaluations of single treatment areas.

The current study was not without limitations. Initially the study aimed to examine if the property marking intervention resulted in the arrest of more offenders, but data limitations prevented this. We suggest this as a topic for future research on property marking. Vehicle crime, criminal damage and violent crime were not used as match control variables when determining suitable control areas, and as a result the levels of these crimes were different in the treatment area and the control areas in some cases. The WDD test is sensitive to differences in the levels of crime between treatment and control areas (Wheeler and Ratcliffe 2018), so some caution is required when interpreting the results for these types of crime.

When distributing the property marking kits, police officers demonstrated how to mark an item of property and provided instructions on how the resident could mark the remainder of their property. This included recommending the specific types of property to mark, such as valuable and easy to remove items (e.g., jewellery and electronic equipment). It was then up to the resident to complete any property marking. No follow-up checks were performed by the police so there was no guarantee that property was marked as instructed. This may have had an impact on the results, and especially in relation to the sustained effect of the programme. If an offender committed a burglary in the treatment area, stole property that had not been marked and which they were then able to sell, this could make the offender think that the commission of other burglaries would also offer similar rewards. It is advised that some form of follow-up process is conducted after the initial distribution of the kits to help ensure items of property have been marked. Follow up visits are resource intensive so a reminder letter distributed to each household in the treatment area soon after the visit could be a practical way to ensure the property marking kits are used as intended.

Uniformed police officers distributing property marking kits in a high risk burglary area is likely to be an activity that some offenders observe. By doing so these offenders are likely to be deterred from committing burglary while the police are present, and for a period of time afterwards. This is an untested mechanism associated with the implementation of property marking, but is supported in part from the evidence relating to hot spot policing (Braga et al. 2019). Additionally, it is likely that the police who make the visits to houses also visit the houses of offenders. It is, therefore, plausible that the visits by the police explaining what they were doing can make the offender think that committing burglary (and perhaps other crimes) is now riskier in the neighbourhood, so their offending decreases. Further research should examine if the police visits when distributing property marking kits results



in a greater impact effect than other subsequent time periods, and if the household visits the police make has a specific deterrence effect on known offenders.

## Conclusions

Property marking using forensic traceable liquid is a popular tool used by police agencies in burglary prevention programmes. The current study found that burglaries decreased significantly by 83% in the area where property marking kits were distributed (in comparison to control areas), supported by the advertising of the intervention using street signs and door and window stickers. There was also a significant decrease in vehicle crime and criminal damage in the treatment area. These decreases were achieved with a property marking saturation rate of 31%—a rate that is relatively low in comparison to other successful property marking interventions. The decreases in burglary, however, were not sustained, with burglary returning to pre-intervention levels after 12 months from when the intervention began. Very few offenders were arrested for burglary during the study period. The findings from the current study suggest that decreases in burglary are more likely to be sustained when the intervention is periodically refreshed with follow-up activities in the area where property marking kits were distributed, when greater effort is made to restrict the sale of property marked items, and promoting the details of prosecutions of offenders and second-hand traders in cases relating to the handing of stolen marked property.

## Declarations

**Conflict of interest** The author declares no conflict of interest.

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