

# Risky Facilities: Crime Radiators or Crime Absorbers? A Comparison of Internal and External Levels of Theft

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## Abstract

*Objectives* To undertake the first exploration of the nature of the relationship between internal crime (those that happen within facilities) and external crime (those occurring outside but in the nearby locale of facilities). The following questions are addressed. Do those localities that suffer high volumes of crime internally within their facilities also suffer high levels of crime in their immediate external environment? How is this influenced by the distribution of internal theft across facilities? What are the likely mechanisms for any relationship found?

*Methods* Spatial regression is used to explore these relationships using data for 30,144 incidents of theft from a Metropolitan area of the UK arranged into small 50 × 50 m grid squares. Variables used in the analysis include counts of external and internal theft, counts of victimized and ‘risky’ facilities, indicators of land-use and a proxy for the on-street population.

*Results* There is found to be a strong positive relationship between internal and external theft that appears to be strengthened by the existence of facilities suffering particularly high crime volumes. Results suggest that internal theft problems precede external ones and that the physical concentration of chronically risky facilities is a particularly strong predictor of external theft problems.

*Conclusions* An argument is made that risky facilities act as crime ‘radiators’, causing crime in the immediate environment as well as internally. This has implications for crime prevention policy in terms of facility placement and management.

**Keywords** Risky facilities · Crime attractors and generators · Land-use · Theft

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## Introduction

That land-use and crime are inextricably linked is both intuitively plausible and well-evidenced.<sup>1</sup> With the advent of better technical tools and more accurate and detailed data, empirical testing of this relationship at the micro-level has become feasible. This paper aims to add to understanding of the crime–land-use relationship by combining concepts from two bodies of literature; that which looks at the impact of certain land-uses on crime in the immediate external environment and that which looks at the internal risk (within buildings, facilities or institutions) associated with certain land-uses [known as ‘risky facilities’ (Eck et al. 2007)]. In essence, it examines, for the first time to my knowledge, the relationship between internal and external crime problems associated with certain types of land-use.

Much of the salient conceptual research concerned with the relationship between land-use and crime has been conducted by Pat and Paul Brantingham and their colleagues. Research on the geometry of crime conjectures that offender mobility patterns have distinct temporal and spatial regularities that relate to their everyday lifestyles or routine activities (Cohen and Felson 1979) and that they become familiar with the places that are significant to them (‘nodes’) and the corridors that link them (‘paths’) (Brantingham and Brantingham 1993). These nodes and paths constitute an offender’s awareness space, and it is within or on the fringes of this space that they are most likely to offend, by dint of their recognition of opportunities and familiarity with encapsulated locales. Assuming that nodes are shared in varying extents according to land-use, it follows that the awareness spaces of multiple offenders may converge across, say, a cityscape. And, hence that crime risk will be higher in areas with certain types of land-use—such as busy road junctions, schools, shopping centres or entertainment facilities (Brantingham and Brantingham 1981).

Brantingham and Brantingham (1995) usefully differentiate between crime generators and crime attractors in terms of how they might affect crime risk. Generators are those places that have higher associated volumes of crime as a by-product of the legitimate activities they host. Schools and hospitals are good examples of generators. Attractors are those places that are likely to be known for hosting illegitimate activities or presenting opportunities that an offender might travel to with the intention of exploiting them. Red light districts or areas with a high density of night-clubs or bars are examples of these. Although perhaps implicit in these descriptions, there is no clear distinction made between crime in the internal environment of the generator/attractor and associated crime in the immediate external environment.<sup>2</sup> It is also likely that there will be differentiation in terms of the types of crime most highly associated with generators or attractors. Property crimes could well be more common in locations that are considered generators while violent crime, disputes and disorders may feature more often in attractor areas. Furthermore, it is possible that external environments (drug corners/red light strips) have a greater tendency to function as attractors and that internal environments are more likely to generate crime. I return to these possibilities later.

### Land-Use and Crime in the Nearby Locale

An increasing number of empirical studies have examined the relationship between certain land-uses and the level of crime in the surrounding area. Some of the places found to have

<sup>1</sup> In this research, land-use is used in a broad sense and it is taken to mean the defined function of a piece of land or a place.

<sup>2</sup> There are also crime ‘enablers’ that occur when there is a lack of regulation or enforcement of rules (Clarke and Eck 2005).

an association with higher crime risk nearby are bars (e.g. Roncek and Bell 1981; Roncek and Maier 1991), liquor stores/off licences (e.g. McCord and Ratcliffe 2007; Rengert et al. 2005), transport nodes (e.g. Block and Block 1999), parks (e.g. Newton and Bowers 2007) and schools (e.g. LaGrange 1999; Roman 2005). The most appropriate method of approximating the range of influence that such types of land-use have on levels of crime nearby remains a matter of debate (see, e.g. McCord and Ratcliffe 2009).

A recent paper by Bernasco and Block (2011) comprehensively examined the impact of a large number of land-uses on robberies in Chicago. Using data for 75,065 robberies and potential attractors and generators of crime across 25,000 census blocks in Chicago, they found that blocks that had a crime generator or attractor within their boundaries had the highest robbery counts. This was true for a long list of facilities types including but not limited to: bars and clubs, fast-food restaurants, liquor stores, groceries, gas stations, laundromats, pawn shops and general stores. Importantly, they also found that there were often slightly higher counts of robbery in blocks that had these facilities in the block directly adjacent to them. In blocks further away from these facilities there were fewer robberies.

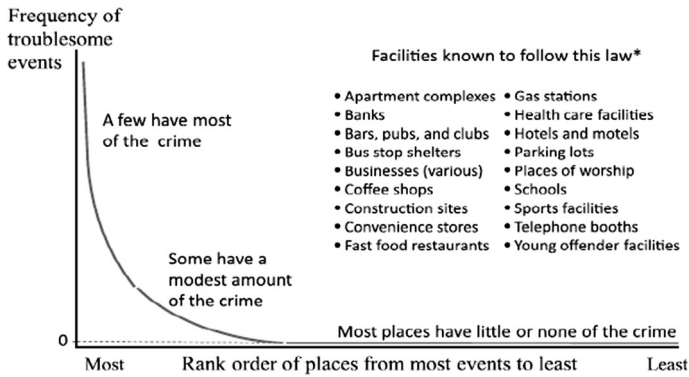
Other studies concentrate on much larger parcels of land-use. It would be remiss not to mention the contribution of Shaw and McKay (1942) in this context, whose seminal work in Chicago separated the city into a number of zones (e.g. the ‘loop’ containing the central business district, the ‘zone in transition’ being taken over by industry, the zone of working men’s homes and the commuters zone) demonstrating differential crime risk between them. More recently, there has been a body of work in the US examining offending rates at different distances from entire public housing estates. Results have been mixed, but generally demonstrate that there are higher volumes of crimes in areas that are in close proximity to such projects. For example, Holloway and McNulty (2003) demonstrate that the distance to a public housing project was a significant predictor of violence rates for some, but not all, of Atlanta’s public housing communities. Similarly, using data on violent crime in New York, Fagan and Garth (2000) demonstrate higher rates of crime in buffer zones just outside public housing projects compared to those further away.

### Risky Facilities

A second key area of research has focused on the level of risk concentrated *within* particular types of facility. Eck et al. (2007: 226) define risky facilities as ‘any group of similar facilities... (for which) a small proportion of the group accounts for the majority of crime.’ Figure 1, replicated from Wilcox and Eck (2011) summarises research in this field and demonstrates that many types of facility follow this rule. Hence, for example, there are some banks that have a large volume of crime, but there are many more that have little or no crime in them.

This recurrent pattern is often referred to as the ‘80–20 rule’: 80 % of the crime problem tends to concentrate within 20 % of the places or facilities (Clarke and Eck 2005). This is useful in a policy context because it demonstrates that it is only some, but not all facilities of a certain type that are ‘problematic’, and hence identifying and concentrating prevention effort on these few facilities could lead to cost effective crime reduction.

These concentration curves do leave a number of questions unanswered however. First is the issue of how different *types* of facilities compare to each other in terms of internal crime risk (i.e. are coffee shops more or less risky than sports facilities?). The second is methodological, and relates to accurately measuring crime risk based on the number of available opportunities. For example, certain fast food restaurants might be more popular



**Fig. 1** The iron law of troublesome places reproduced from Wilcox and Eck (2011)

than others and have higher footfall counts. Hence, it might be unsurprising that certain places see a higher volume of crime. Third, and most pertinent here, is the question of exactly where these facilities are physically located. A single bar in a small rural village has a very different context to a busy night-spot in the heart of a central business district. Comparing them is unlikely to be a level playing field. Many things will vary; the footfall, the victim and offender pool, and the temporal rhythms of the clientele, to name a few. The rural bar would be unlikely to feature in the collective awareness spaces of the same number of offenders as the city bar. Wilcox and Eck (2011: 476) make this point eloquently: ‘We offer that policy must consider that it is the busy nature of facilities in general and the busy context in which facilities are often situated, rather than the facility type itself, that generates crime.’

### Study Rationale

The first group of studies cited above examined the influence of different types of facility on crime in the nearby locale. To date, none of these have explicitly considered whether the extent of crime experienced within the facility itself mediates this relationship. The second group of studies examine the concentration of crime in particular types of facility and whilst it is acknowledged that the physical location of these will have an influence, this has not been empirically examined. This research aims to address these gaps by empirically exploring the relationship between the level of ‘riskiness’ of the facilities themselves (the ‘internal’ crime problem) and the level of risk in the immediate environment (the ‘external’ crime problem).

### Possible Mechanisms for the Internal/External Crime Relationship

A number of possibilities exist:

1. There is no relationship between internal and external crime

The null hypothesis is that the volume of a crime problem inside facilities is not linked to that outside.

2. That there is a negative relationship between internal and external crime

According to this hypothesis, the exploitation of opportunities on the street prevents opportunities from being exploited inside the facilities and vice versa. This reflects a hydraulic view of crime (e.g. Cornish and Clarke 1987) whereby there is a finite capacity to commit crime and that taking some chances will preclude the taking of others.

### 3. That there is a positive relationship between internal and external crime

Two different mechanisms might explain such a relationship:

#### (a) That risky facilities act like crime ‘radiators’ and transmit risk to the external locale

In this scenario, the volume of offences committed in an external place is very much influenced by the criminogenic properties of nearby facilities. Here, external crime could be seen almost as a by-product of internal crime. In the event of a crime attractor, offenders are attracted to the facility to exploit the presence of a large number of suitable targets. In the event of a generator, the congregation of lots of opportunities lead to unplanned take-up in high volumes. This then spills over onto the street, as the offenders come and go, or as suitable targets, in the form of facility-users, join the on-street population.

A corollary to this is that locations where there is a high density of other (risky) facilities and as a result, a high on-street population, might suffer more (external) crime than expected because of spatial clustering. As Wilcox and Eck put it ‘... strong suggestions in the literature claim that many facilities provide criminal opportunity and it is the contextual clustering of public-use facilities, especially along or near major roads, that is related to area crime.’ (Wilcox and Eck 2011: 475).

#### (b) Risky facilities are crime ‘absorbers’—they absorb risk from the external locale.

Assuming some element of planning, offenders who chose to target a particular street/external locality might also offend opportunistically in the internal facilities nearby. A number of studies propose that offenders often follow a two stage hierarchical procedure when searching for crime targets. They initially select a suitable area in which to search and then for a suitable target within it (e.g. Brantingham and Brantingham 1984; Clarke and Cornish 1985). Under the absorption hypothesis, it seems plausible that choices are influenced by the abundance of opportunities presented by the (external) on-street population. It seems likely that larger on-street populations would lead to more external crime (as a primary pull) and a greater presence of offenders (and offences) would then lead to higher numbers of crimes in the neighbouring facilities. That is, offenders are attracted to a particular street first, and then, as a consequence of observing good opportunities in the local facilities, are deflected and offend within them.

The remainder of this paper explores the viability of these hypotheses and possible mechanisms in explaining the relationship between internal and external crime.

## Data

### Crime Data Preparation

This study used data relating to 30,144 incidents of theft from the person occurring between 1 January 2005 to 31 August 2009 (4 years and 8 months) in the heart of the city centre of a large Metropolitan area in the UK. The data related to a relatively small physical area; a  $700 \times 750$  m grid ( $525,000$  m<sup>2</sup>). Notwithstanding its physical size, the study area contains many bars, restaurants, shops and commercial facilities and attracts

high on street populations during the daytime, comprising shoppers, commuters and tourists and a high volume of night-time visitors to the bars and entertainment facilities. The area experienced high volumes of theft (on average approximately 6 incidents occurred per 100 m<sup>2</sup> over the period of 4 years and 8 months), meaning that there were sufficient numbers of events to enable a robust analysis at a fine level of spatial resolution.<sup>3</sup> Furthermore, as demonstrated later, the facilities were not equally distributed; some regions of the grid contained many more than others, helping to ensure the analysis was applied in an area with a range of different contexts.

Theft from person was the only type of crime available and used in this analysis. Whilst it would have been useful to have access to other types of crime (for example assaults), as a proof of concept, theft appears to be an appropriate category. It happens in high volume and is certainly a concern in the study area given the nature of the land use. One possible characteristic of this crime is that, since it is often opportunistic in nature, it could be more likely to be generated in an area than it is to attract offenders to a particular locale. The implications of this possibility are re-visited in the discussion.

The crime data constituted three different sub-categories of theft from the person; snatches, in which the offender is seen taking an item but runs away quickly to avoid capture ( $n = 941$ , 3.1 % of the thefts); pick-pocketing which involves offender stealth ( $n = 7,080$ , 23.5 % of the thefts) and other theft which comprises theft of personal property outside the home, such as thefts of unattended property in the workplace and theft of property while at licensed premises, cafes or in open spaces ( $n = 22,123$ , 73.4 % of the thefts). It excludes robbery, which involves violence or the threat of violence.

Aside from crime classification, each record also included details of the time and date of the offence, an address for the incident location and geo-coded co-ordinates. Using the free text address field, thefts were categorised to identify those that happened internally and externally. Whilst this could be partly automated, much manual coding and checking was still necessary. A theft was categorised as ‘external’ if there was an ‘outside’ reference in the incident location address field. The different types of reference, along with the variations on spelling and coding found in the address field are shown in Table 1. For example, a location might have been coded as opposite a building or feature—this implies that it is not within the building itself but this reference helps pin-point an outside location. Likewise, a reference to a road junction is an attempt to pin-point an external location. Other types of reference can also place a theft to an external location—such as when a crime occurs on public transport.

To categorise a theft as ‘internal’ the theft needed to be clearly referenced to a particular property or facility. Since it was important to know how many crimes occurred within each individual property or facility each one was given a unique identifier. So, ‘Brown’s Bar’ at an exact address on ‘High Street’ was given a unique ID that was used every time the bar was identified. Other locations with the same easting and northing were then checked to assess whether they were the same property. Various typing errors and misspellings were discovered in the data. Alphabetical sorting was also used to check for incidents that could have been geo-coded incorrectly. Offences with similar  $x$  and  $y$  co-ordinates were also compared. Some common problems identified included different pubs from the same company being allocated the same spatial co-ordinates in the theft data and pubs or bars that had changed names during the period or were referred to with different names by different victims. In the majority of cases (68 %) it was possible to categorise the facility

<sup>3</sup> Note for example that this sample is 40 % of the size of the robbery data set used by Bernasco and Block (2011) in their large scale analysis of 25,000 census blocks in Chicago.

**Table 1** References used to identify ‘external thefts’

Type of reference	Variations	Number of cases
Outside	O/S, o/s, outside	2,566
Near	NR, nr, NEAR	1,149
Opposite	OPP, opposite	383
Other outside references notable from the data	(e.g. bus route, underground)	115
Road junction	J/W, junction, JUNCTION, JCT	49

type. Where it was not possible to categorise this was because there was no information in the address reference that could identify the building type (e.g. 12 the High Street). The number of unique facilities of different types identified in the data is shown in Table 2.<sup>4</sup>

In addition to the thefts categorised as ‘internal’ and ‘external’ there was a third category where the location of the crime was more ambiguous. This happened in two cases; where the theft occurred in an unspecified location in a shopping centre and where a theft was assigned to a street, but not a specific address. In both cases, it is hard to say whether the crime was internal or external. A theft assigned to a street probably happened outside since it is not associated with a particular address and equally, a crime in a shopping centre but without a shop location being specified probably happened external to any one business (i.e. in shared public space) but both these arguments are based on assumptions. Hence the analyses described below were conducted twice; once with a looser definition of external crime which included these ambiguous incidents and once with a stricter definition of this which omitted these incidents. As this sensitivity analysis did not reveal any striking differences, results are reported for the stricter definition only.

In the final categorisation 21,969 thefts (72 %) were classified as internal crimes, occurring in the 4,649 facilities shown in Table 2; 4,262 thefts (14 %) were classified as external thefts, and the remaining 3,913 (12 %) were assigned to a street or a shopping centre. Given the nature of the crime of theft, and the high density of facilities in the study area, it is unsurprising that so many of them occurred internally. An alternative study focused on the crime of assault might reveal a different distribution of internal and external crime.

As a final stage in the data preparation process, the internal and external thefts were plotted using a geographic information system (GIS). To measure spatial variation, a grid of 50 × 50 m squares was overlaid, and each theft was assigned to an individual grid square. Aggregation of the data resulted in a count of internal and external theft for each grid square ( $n = 210$ ). The unique facility ID code meant that it was also possible to generate a count of the number of victimized facilities<sup>5</sup> in each grid square that had 1 crime, 2 crimes, 3 crimes and so on. The unit of analysis chosen for micro-level spatial crime analysis is an important issue (Weisburd et al. 2009) and I return to this topic in later sections.

<sup>4</sup> It is possible that a number of uncategorised ‘facilities’ were in fact private residential properties. However, for a large number of these, this seems unlikely for two reasons. First, the theft types involved: snatches, pick pocketing and other theft are by definition supposed to occur outside the home, so any of these crimes would be a misclassification. Second, the study area was located in a central business district, and hence did not contain many residential properties.

<sup>5</sup> Here, for convenience ‘victimized facilities’ are those properties that had one or more recorded thefts in the data set time scale.

**Table 2** Number of risky facilities of each type in the data

Facility type	Frequency	Percent
Bar or pub	1,487	32.0
Unknown	1,476	31.7
Cafe or restaurant	908	19.5
Shop or retail	515	11.1
Leisure	132	2.8
Banking	83	1.8
Other services	48	1.0
Total	4,649	100.0

### Land-Use Data

Data regarding land-use category came from the national land use data base ('Nlud' data. Crown copyright 2003). These data can be mapped in a GIS and for each 'parcel' of land-use (building footprint, road segment, outdoor space) in the study area providing basic information on land-use function. Hence it is possible to discern whether a locality was used for the following purposes: transport, residential, retail, industry and business, recreation and leisure or utilities and infrastructure. To gain some measure of the land-use make-up of each grid square, the number of 'land-parcels' of each of the following categories was counted for each grid square: retail, recreational, service and other commercial use. This is far from an ideal denominator because it doesn't differentiate, for instance, between types of retail establishment, and in fact many restaurants and cafes appear to be classified as 'retail' whereas 'recreational facilities' appears to be generally reserved for movie theatres and very large clubs. There are problems in using land parcels to count facilities in grid squares (e.g. to which square do you attribute a large nightclub falling over two or a number of boundaries). However, it was useful to incorporate these data, in the analyses that follow, as they provide an estimate of the entire population of facilities in each grid square, rather than just those that were victimized.

### Estimating the On-street Population

It is notoriously difficult to gain access to directly quantify the on-street or 'ambient' population (Andresen and Jenion 2010). This is particularly the case for studies, such as the current one, requiring the data at a fine level of resolution. The on-street population is, however, of particular relevance here as an explanation for levels of external theft. It should also provide some indication of the potential for trade within the facilities considered. Here, a proxy measure for the on-street population, derived using the space syntax mapping system developed by Bill Hillier and colleagues (Hillier 2004) is used. The particular measure used, termed 'choice', is quantified for each street segment in the study area and measures the degree to which each segment lies on least angle routes between all pairs of segments within a specified radius (in this case 800 m—the advised radius to use to approximate local movement). This approximates the 'through-movement potential' of each segment—or the 'passing trade' (Hillier 2004). Whilst not a direct measure of the on-street population, this is a useful proxy that can be estimated at the small area level. Indeed, research has shown correlations between space syntax measures and the population in public urban space in a number of places (e.g. Hillier et al. 1993). The choice measure was



**Table 3** Descriptive statistics for all variables (50 × 50 m grid squares)

N = 210 in all cases	Mean	SD	Minimum	Maximum
External theft from person	19.84	38.36	0.00	386.00
External theft in nearby grids	20.38	16.90	0.88	95.88
Internal theft from person	101.40	130.46	0.00	702.00
Internal theft in nearby grids	106.13	61.00	11.13	295.25
Number of facilities with 1 theft only	15.20	12.60	0.00	74.00
Number of facilities with 2+ thefts	6.94	6.98	0.00	49.00
Number of facilities with 2–3 thefts	3.75	3.90	0.00	25.00
Number of facilities with 3+ thefts	4.44	4.74	0.00	34.00
Number of facilities with 4+ thefts	3.19	3.62	0.00	24.00
Number of other commercial use land parcels	19.38	12.31	0.00	65.00
Number of recreational land parcels	0.91	2.25	0.00	18.00
Number of retail land parcels	14.30	11.54	0.00	61.00
Number of service land parcels	0.87	2.44	0.00	19.00
On street population proxy	46.53	41.24	0.11	255.09
Total number of risky facilities	22.14	18.91	0.00	123.00

calculated for each segment or part-segment within each grid square, and a summed total used to estimate the on-street population in each cell.

Table 3 presents descriptive statistics for the variables used in the analysis (in all cases  $n = 210$ ). It shows that whilst the count variables often have fairly large means (20 for external theft from person; 101 for internal theft) the standard deviations are large and often exceed the mean. This point will be re-visited later. There is also considerable variation in the on-street population proxy (minimum 0.11; maximum 255.09; mean 46.53; standard deviation 41.24) suggesting that this variable may discriminate between busier and less busy regions of the study area.

## Methods

Regression models were used to examine the relationship between internal crime, external crime and land-use. The unit of analysis was the 50 × 50 m grid square ( $n = 210$ ). For each grid square the following information was analyzed:

- Count of external theft.
- Count of internal theft.
- Count of victimized facilities (number with 1 crime, 2 crimes... N crimes).
- Available features of land-use (from 'Nlud' data: split into retail, recreation, services and other commercial use).
- The on-street population proxy.

For some analyses, the dependent variable was internal theft, but more commonly it was external theft. Reasons for this will be explained in the “Results” section.

As there was spatial dependency in the units of analysis, it was necessary to account for spatial autocorrelation. For this reason, spatial error models implemented in the software package GeoDa (Anselin et al. 2006) were used. A first order ‘queen’ contiguity weight

matrix was created. So the analyses and diagnostics accounted for spatial dependence in the 8 squares immediately surrounding each grid square.

Diagnostic tests were used to explore spatial dependency. A Moran's  $I$  of 0.1074 ( $p = 0.004$ ) and Local Indicators of Spatial Association (LISA) statistics suggested evidence of spatial clustering. To establish whether a spatial regression model was necessary an example ordinary least squares regression (dependent variable: external thefts, independent variable; internal thefts and number of victimized facilities) was run with diagnostics for spatial dependence. This gave a significant robust Lagrange multiplier indicator for the spatial error indicator (value = 4.51,  $p = 0.036$ ) but not the spatial lag indicator (value = 0.43,  $p = 0.51$ ). This suggested that a spatial error regression model would be the most appropriate. The same regression was re-run using a spatial error model and the log likelihood ratio test, that compares model fit, demonstrated a slight but significant improvement over the basic ordinary least squares model (value = 5.19,  $p = 0.02$ ). Hence, spatial error models were used for all the analysis described in the "Results" section.<sup>6</sup>

## Results

### Descriptive Statistics

As shown in Table 2, the 4,649 facilities that had experienced one or more internal thefts experienced 21,969 thefts between them. On average therefore, a facility experienced 4.7 thefts over the entire period—almost exactly one theft per year. However, Fig. 2 shows that the risk was far from equally distributed across the facilities. In fact, the crime concentration curve conforms almost exactly to the 80–20 rule; 20 % of the facilities account for 80 % of the crime. The most troublesome facility was a bar that experienced 306 thefts in the study period (equivalent to 66 per annum). As a group, the top ten high volume facilities accounted for 11 % of the entire theft problem within facilities but constituted only 0.22 % of the facilities, demonstrating the high concentration of the problem.

The relationship between levels of internal and external theft at the grid square level is illustrated visually in Fig. 3. On average, grid squares contained 101 internal thefts and 20 external thefts. It appears from visual inspection that there is a correlation between those grids that have high levels of internal theft and those with high levels of external theft. High theft grids appear to cluster into the bottom right and top right of the study area. To the west of the study area, there appears to be a region which has lower levels of both internal and external theft. This clustering of cells is also indicated by the maps shown in Fig. 4 which indicate significant local high–high and low–low theft LISA statistic clusters.

### The Relationship Between Land-Use and Internal/External Crime

Table 4 shows the results of spatial regression analyses that examine the relationship between levels of theft and the amount of land-uses (measured) in the grid squares. Model 1 uses the amount of internal theft as the dependent variable while Model 2 uses external theft.

<sup>6</sup> As an additional precaution, the test regression was also re-run for two transformed versions of the dependent variable (the square root of the count of external crime and the logarithm of 0.1+ the external crime count). This was to check that the use of raw crime count data didn't affect the results of analysis. Similar results, with the same independent variables demonstrating significance in the same direction, were found using these alternatives.

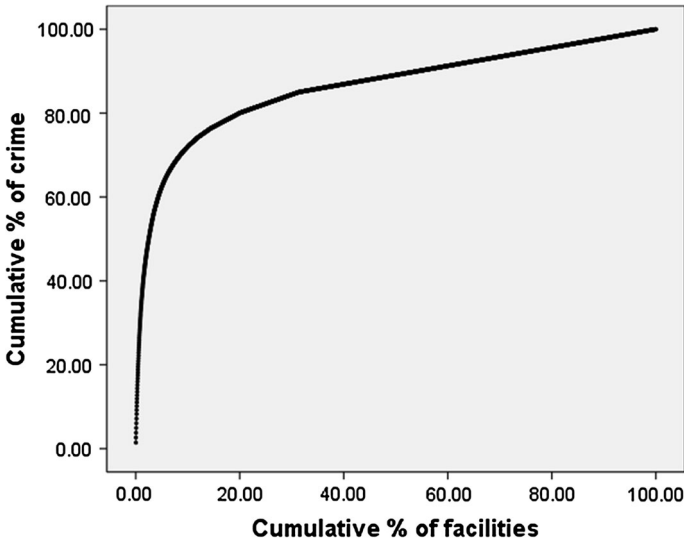


Fig. 2 Crime concentration curve and table for all risky facilities in the dataset

Interestingly, other than the spatial error term, the only significant independent variable in the models is the number of retail land ‘parcels’ in prediction of levels of *internal* theft (see Model 1). This suggests that as the amount of land dedicated to retail use increases, so does the amount of internal theft. One interpretation of this finding is that the presence of retail facilities generally increases opportunities for internal thefts and these are exploited by offenders. This is *not* true of external theft; general increases in the number of retail parcels are not associated with higher

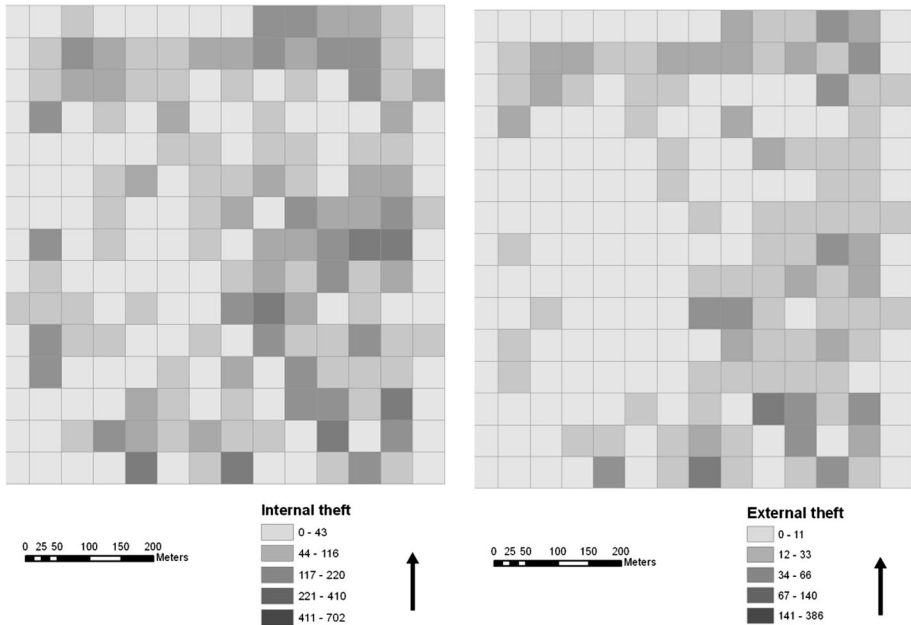
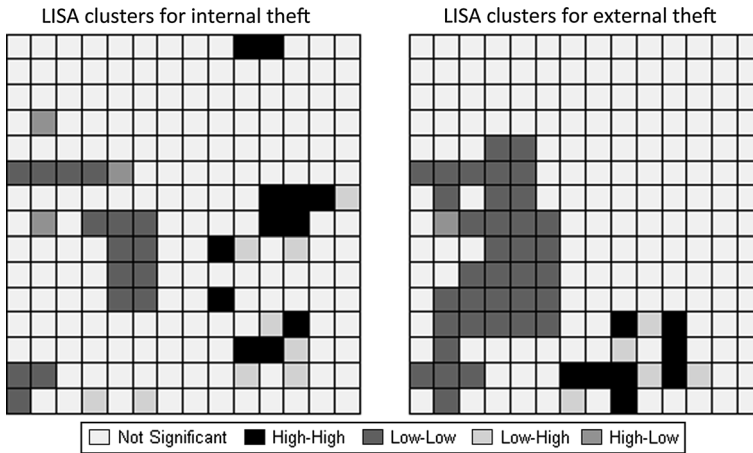


Fig. 3 Levels of external and internal theft for 50 × 50 m grid squares in the study area



**Fig. 4** LISA statistic cluster map for external and internal theft for  $50 \times 50$  m grid squares in the study area

levels of on street theft. One possible explanation is that thieves might not necessarily perceive specific areas with a high presence of retail land-use as places offering good on-street (external) opportunities; but the retail properties themselves (internally) are potentially a good draw. If indeed this is the case then it makes sense to examine the internal theft as more of a driver of the external theft problems than vice versa. Put differently, external theft might be seen as a potential ‘by-product’ of internal theft.

Table 5 explores the relationship between crime and the on-street population proxy. Interestingly, the proxy was not a predictor of either external or internal theft problems. It was however, positively related to both the number of retail land parcels and to the number of victimized facilities in the area. The latter relationships feel intuitively reasonable—a higher density of facilities should lead to higher on-street populations and a greater number of at-risk facilities. This is in line with the space syntax approach (Hillier 2004). The non-significant relationship with external theft might again indicate that external theft is explained through another mechanism other than purely the number of presenting external opportunities—a possibility to which I now turn in more depth.

#### The Directionality of the Relationship Between External and Internal Theft

The results presented suggest that external crime might have a less direct relationship with general retail land-use and variation in the on-street populations than might be expected. One explanation for this is that the mechanism in which external crime is driven-by, or is a by-product of, internal crime is more likely. Unfortunately, the nature of the data, which cannot track temporal offence patterns of individual offenders, precludes direct testing of the causal direction of the relationship. However, it is possible to examine some temporal trends in the data to help throw some further light on this issue.

One potential method for investigating this is to determine the extent to which one kind of crime problem has a tendency to precede or follow the other. For example, we might speculate that an internal theft problem, if it is at least to some degree a driver of the external theft problem should peak before it. This relates to the idea of temporal precedence discussed by Cook and Campbell (1979).

**Table 4** Relationship between land-use and internal/external crime

Dependent variable	Model 1 Internal	Model 2 External
Number of retail land parcels	4.30 (2.71)**	0.77 (1.62)
Number of recreational land parcels	−3.89 (−0.92)	−1.63 (1.27)
Number of service land parcels	−3.48 (−0.94)	−0.58 (−0.51)
Number of other commercial use land parcels	−2.18 (−1.43)	−0.57(−1.26)
Constant	86.36 (3.95)**	21.67 (3.34)**
Lambda	0.33 (3.09)**	0.28 (2.55)*
Log likelihood	−1,307	−1,057

Beta (t value)

\*  $p < 0.05$

\*\*  $p < 0.01$

**Table 5** Relationship between theft, land-use and the on street population proxy

Dependent	On street population proxy	Lambda	Constant	Log likelihood
External theft	0.04 (0.72)	0.29 (2.68)**	17.44 (3.69)**	−1,059
Internal theft	0.28 (1.30)	0.39 (3.81)**	85.39 (4.97)**	−1,312
All theft	0.11 (1.87)	0.47 (4.96)**	28.26 (7.01)**	−1,001
No of retail land parcels	0.04 (2.03)**	0.60 (7.58)**	12.65 (6.58)**	−790
No of risky facilities	0.12 (3.8)**	0.35 (3.38)**	16.19 (6.88)**	−902

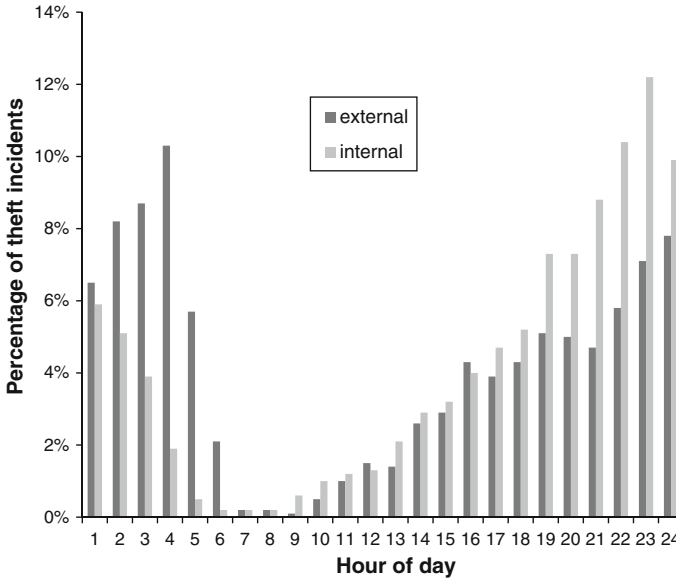
Beta (Z value)

\*  $p < 0.05$

\*\*  $p < 0.01$

To examine this, temporal patterns for both types of problem were explored. Figure 5 summarises the hour of the day that theft incidents occurred. Information on the timing of offences was available for 2 years only (2005 and 2006). Hour of the day information was thus available for 11,653 theft incidents (1,409 external and 10,232 internal crimes). Despite this limitation, and the fact that this is examined at the aggregate level (across the 2 year time span and across all grid squares) a very noticeable trend is evident. The peak in internal crime occurs some hours before that in external crime. Furthermore, the peak in internal crimes occurs during traditional open hours of shops and bars in the area, whereas the peak for external theft occurs later. This implies that there is a particular relationship between the two types of crime—and although it does not test causality—it seems plausible to suggest that the crime problems experienced in the bars and restaurants earlier in the day could lead to the problems experienced on the street later. Opportunistic offenders targeting the internal spaces at one time point might take advantage of the external ones later—as the suitable targets transverse from one to the other. It is interesting to note that the external problems are exaggerated after the facilities have closed and not before, this raises the possibility that alcohol plays a part in providing a supply of particularly vulnerable on-street targets in the early hours of the morning.

Since there appears to be reasonable evidence to suspect that internal crime might be a driver for external crime, the following analyses use external theft as the dependent variable and internal theft as a potential explanatory variable to explore this possibility further.



**Fig. 5** Percentage of incidents occurring in different hours of the day for *external* and *internal* crimes

### The Relationship Between External Theft, Internal Theft and Risky Facilities

Table 6 shows the results of five different spatial regression models. The first simply looks at the relationship between external and internal theft, controlling for the busyness of the street using the on-street population proxy. As suggested by Fig. 3, there is a strong significant positive relationship between these two variables; as levels of internal theft increase so do levels of external theft (Beta = 0.21,  $t = 14.13$ ,  $p < 0.01$ ). Model 2 adds the total number of victimized facilities (all facilities that had one or more thefts in the data set time scale) as a further independent variable. Here, we see that the total number of victimized facilities is also positively and significantly related to the level of external theft (Beta = 0.75,  $t = 5.25$ ,  $p < 0.01$ ). Note that this is true *after* the total level of internal theft and the on-street population has been accounted for. Adding the further independent variable also improves the overall model fit, reducing the log likelihood from  $-989$  to  $-975$ . So, it appears that the concentration or distribution of internal theft across facilities matters to the level of external theft as well as the total amount of crime that happened indoors.

To explore this further, three other spatial regression analyses were undertaken (Models 3, 4 and 5: Table 6). Across these three models, an increasingly more ‘risky’ group of victimized facilities is used as the second independent variable. In all cases, internal theft volumes overall remain a significant predictor of external theft. Furthermore, the on street-population is included in all models and remains non-significant. What is interesting about these three models is that as the group of facilities gets more risky (is limited to those with 2+, 3+ and 4+ thefts) the associated Beta coefficients become more significant, the internal theft volume coefficient becomes slightly less significant, and the overall model fit seems to improve. This effect seems to diminish by Model 5.<sup>7</sup> However, the results suggest

<sup>7</sup> Note there is fairly large attrition in the number of facilities that can be included in the analyses as riskier facilities are chosen.

**Table 6** Relationship between external theft, internal theft and risky facilities

Dependent: external theft from person	Model 1	Model 2	Model 3	Model 4	Model 5
Internal theft from person	0.21 (14.13)**	0.12 (5.79)**	0.10 (4.86)**	0.08 (3.61)**	0.08 (3.53)**
Total number of risky facilities		0.83 (5.67)**			
Number of facilities with 2+ thefts			2.58 (6.49)**		
Number of facilities with 3+ thefts				4.33 (7.00)**	
Number of facilities with 4+ thefts					5.47 (6.45)**
On street population proxy	-0.01 (-0.26)	-0.09 (-1.93)	-0.06 (-1.51)	-0.05 (-1.09)	-0.01 (-0.33)
Constant	-0.57 (-0.17)	-6.32 (-1.77)	-5.42 (-1.61)	-5.28 (-1.66)	-5.17 (-1.57)
Lambda	0.18 (1.56)	0.31 (2.83)**	0.23 (2.06)*	0.22 (1.92)	0.25 (2.19)*
Log likelihood	-989	-975	-971	-968	-971

Beta (Z value)

\*  $p < 0.05$

\*\*  $p < 0.01$

that as a greater number of higher risk facilities are present in an area, external theft increases even when the total amount of internal crime within facilities is accounted for. Note that model fit for Models 3, 4 and 5 are slight improvements over Model 2 suggesting that concentration into victimized facilities matters over the mere presence of them.

### The Relationship Between External Theft, Internal Theft and Level of Riskiness of Facilities

This last point can be explored further by unpacking the data in a slightly different way. In Table 7, victimized facilities are separated into three different categories—those that had only 1 theft, those with 2–3 thefts and those with 4 or more thefts.<sup>8</sup> Entering these into a single spatial regression model with total level of internal theft reveals that of these variables, the variable that represents victimized facilities with 4 or more thefts has the most explanatory power, as this is the only one that is significant (Beta = 4.28,  $t = 4.29$ ,  $p < 0.01$ ). This suggests that it is not just having a high number of victimized facilities in general, but having a larger number of particularly risky facilities that seems to drive up levels of external theft, after internal theft is accounted for.

### The Possibility of a Non-linear Relationship with Risky Facilities

To this point, the models presented have assumed a linear relationship between the number of facilities of a certain level of risk and levels of external theft. In other words, they assume that a doubling in the number of, say, facilities with two or more crimes within them will increase the external risk as a linear function. This might not be the case, and it is

<sup>8</sup> These were used rather than the cumulative categories in Table 4 so that the variables would be independent of each other.

**Table 7** Relationship between external theft, internal theft and level of riskiness of facilities

Dependent: external theft from person	Model 1
Internal theft from person	0.08 (3.32)**
Number of facilities with 1 theft only	0.14 (0.53)
Number of facilities with 2–3 thefts	1.25 (1.51)
Number of facilities with 4+ thefts	4.28 (4.29)**
On street population proxy	−0.05 (−1.09)
Constant	−6.11 (−1.80)*
Lambda	0.26 (2.36)*
Log likelihood	−968

Beta (Z value)

\*  $p < 0.05$ \*\*  $p < 0.01$ 

possible that non-linear relationships exist. Table 8 therefore presents analyses that include squared terms to explore potential quadratic relationships. These suggest that there are important non-linear trends in the relationships explored. Graphing the results reveals that as the number of facilities increase the coincident increase in the external theft is positive and disproportional. This increase is more exaggerated as the level of riskiness of facilities increases from 2 or more thefts to 4 or more thefts (compare functions  $f(x)$  and  $h(x)$  Fig. 6). This adds further evidence to the strong influence of risky facilities on external theft.

#### The Relationship Between Levels of Theft, Riskiness of Facilities and Land-Use

Two final analyses re-visit the role of land-use and the issue of directionality concerning the internal/external theft relationship. Table 9 shows the results of two models using internal and external theft respectively as the dependent variable, along with variables that have been shown to have explanatory power in the analyses above; number of retail land parcels, the number of facilities with 4 or more thefts (including a squared term). For balance, a final variable is also entered here—which is a dummy variable indicating grid squares that are in the top 20th percentile for external theft. In essence, this indicates the presence of a chronic concentration (a hotspot) of external theft problems, and parallels the identification of the more risky internal facilities.<sup>9</sup>

The results for external theft shown in Model 1 are in line with those described above, the concentration of crime into risky facilities is significant over and above levels of internal theft per se; and predicted numbers of external theft rise dramatically with increasing numbers of risky facilities. In contrast, Model 2 predicts internal theft. Here concentration of risky facilities does make a difference; internal theft is higher overall in squares where there are more risky facilities. The level of external crime is also a predictor of higher internal crime. However, being located in an area where there are particularly chronic levels of external crime does not influence the amount of internal crime expected when levels of external crime are controlled for. One way of conceptualising this is that there is no extra risk to facilities being located on a ‘notorious street segment’ which is not in proportion to general increases in volumes of crime. This indicates an asymmetry between the drivers of the two different types of crime.

<sup>9</sup> The cut-off point for identifying the most risky grid squares as those in the top 20<sup>th</sup> percentile for external theft was chosen because it sits well with the 80-20 rule which is often applied when discussing risky facilities



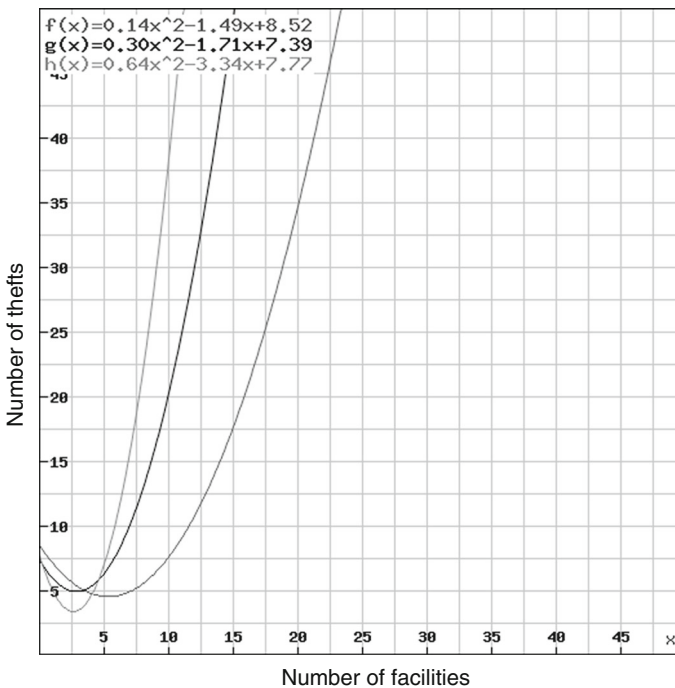
**Table 8** Relationship between external theft, internal theft and risky facilities—non-linear models: 50 × 50 m grid squares (n = 210)

Dependent: external theft from person	Model 1 f(x)	Model 2 g(x)	Model 3 h(x)
Internal theft from person	0.11 (6.62)**	0.10 (5.62)**	0.09 (5.40)**
Total number of risky facilities			
Number of facilities with 2+ thefts	-1.49(-3.04)**		
Square of no. facilities with 2+ thefts	0.14 (10.85)**		
Number of facilities with 3+ thefts		-1.71 (-2.38)*	
Square of no. facilities with 3+ thefts		0.30 (11.45)**	
Number of facilities with 4+ thefts			-3.43 (-3.67)**
Square of no. facilities with 4+ thefts			0.64 (12.91)**
On street population proxy	-0.07 (-2.00)*	-0.05(-1.63)	-0.03 (-0.96)
Constant	8.52 (2.97)**	7.39 (2.70)**	7.77 (2.90)**
Lambda	0.21 (1.85)	0.23 (1.99)*	0.27 (2.39)*
Log likelihood	-924	-917	-909

Beta (Z value)

\*  $p < 0.05$

\*\*  $p < 0.01$



**Fig. 6** Relationship between external theft and risky facilities—non-linear models. Key: f(x): facilities with 2+ thefts, g(x): facilities with 3+ thefts, h(x): facilities with 4+ thefts. Figure produced using <http://rechneronline.de/function-graphs/>

**Table 9** Relationship between land-use, internal/external crime and level of riskiness of facilities/high risk external environments

Dependent variable	Model 1 External	Model 2 Internal
Number of retail land parcels	0.04 (0.34)	0.54 (1.27)
Number of facilities with 4+ thefts	-3.49 (-3.67)**	30.04 (9.56)**
Square of no. facilities with 4+ thefts	0.64 (12.73)**	-0.81 (-3.20)**
Constant	7.4 (2.55)*	-14.61 (-1.52)
External theft from person	-	1.13 (4.32)**
Internal theft from person	0.09 (5.35)**	-
Eightieth percentile for external theft	-	18.58 (1.16)
Lambda	0.27 (2.41)*	0.04 (0.35)
Log likelihood	-909	-1,180

Beta (t value)

\*  $p < 0.05$ \*\*  $p < 0.01$ 

### Does High Internal Theft Predict Levels of External Theft in Nearby Grid Squares?

If risky facilities influence crime in the direct external environment, they might additionally have an influence on that in neighbouring external environments. Bernasco and Block (2011) demonstrate a significant spatial influence of some facilities in nearby blocks on levels of robbery in Chicago and link this to the routine activities and paths taken by offenders. In a similar way, offenders might offend ‘en-route’ to or from their (in this case) internal destinations. To explore this, two new independent variables were produced which were the weighted means of the external and internal levels of theft in the eight adjacent grid squares (see Table 3 for descriptive statistics). Table 10 shows analyses using these two new variables and reveals interesting results. These suggest that the internal theft volume in nearby grid squares does indeed have a significant influence on levels of external theft. However, there is no significant influence of the external theft volume in nearby grids on the level of internal theft. This asymmetric finding strengthens the evidence concerning the direction of causality. It demonstrates that internal theft has wider ranging spatial influence over external theft than vice versa.

### Sensitivity Analysis

In this section, two potential methodological weaknesses are explored. The first relates to the unit of analysis chosen. As stated above,  $50 \times 50$  m grids were used throughout. This was to some degree a fairly arbitrary selection; it enabled analysis at the micro-level with a decent sample size ( $n = 210$ ) whilst moderating the number of zero count cells. As this is the first study to examine the relationship between internal and external crime, there is no quantitative evidence to suggest the spatial scale over which such relationships should be explored. Further research will be necessary to answer this question, but as an initial exploration, the analysis in Table 6 was re-run using  $100 \times 100$  m grid squares instead. This reduced the sample size to  $N = 49$ . The results, shown in Appendix 1 demonstrate very similar patterns to those shown in Table 6. Again, an increasingly more ‘risky’ group of victimized facilities is used as the second independent variable. In all cases, internal

**Table 10** Predicting surrounding squares

	Dependent variable	Model 1	Model 2
		External	Internal
	Constant	2.43 (0.43)	64.39 (3.51)**
	On street population proxy	0.04 (0.75)	0.28 (1.29)
	External theft—nearby squares		1.12 (1.91)
	Internal theft—nearby squares	0.14 (3.42)**	
Beta (Z value)	Lambda	−0.02 (−0.15)	0.20 (1.75)
* $p < 0.05$	Log likelihood	−1,057	−1,312
** $p < 0.01$			

theft volumes overall remain a significant predictor of external theft. Once more, as the group of facilities gets more risky (is limited to those with 2+, 3+ and 4+ thefts) the associated Beta coefficients become more significant and the internal theft volume coefficient becomes slightly less significant. However, this does not hold to the same degree for facilities with 4+ thefts. Generally however, this initial exploration indicates that the results found above could well hold at a number of different spatial scales. At the very least, the general conclusions appear not to be sensitive to the spatial units selected.

The second potential weakness relates to the use of OLS spatial regression rather than event-based regression models. As indicated in Table 3, whilst the mean counts of external and internal counts are fairly large, the large standard deviations suggest over-dispersion in the data and hence the OLS spatial method might give atypical results. To address this concern, the analysis was re-run a further time using a non-spatial negative binomial model. The results are shown in Appendix 2 and once again show the same pattern of results to those in Table 6. Internal theft level remains a significant predictor of external theft, but becomes less so as the groups of facilities get more risky. The models that are limited to more risky facilities show that they are strong predictors of external crime over and above the general level of internal crime.

## Discussion

To date, research that explores the relationships between crime and land-use has investigated internal or external crime in isolation. Perhaps this is unsurprising as the data cleaning and manipulation process associated with exploring the link between them is demanding. To address this gap in the literature and to begin characterizing this relationship theoretically, this represents the first empirical study of the relationship between internal and external crimes, using theft data for a Metropolitan area in the UK. Two pertinent findings warrant discussion. First, controlling for the on-street population at risk, there is a strong positive relationship between the amount of theft within facilities and the amount of theft committed in the surrounding area. Second, controlling for the total volume of theft happening within them and for the size of the on-street target population, as the risk becomes more concentrated into facilities, the risk of on-street theft increases in a non-linear fashion. Taken together, these two findings have a number of scholarly and practical implications. I will also argue that they support the idea that risky facilities act as radiators of risk to the external locale, as suggested in 3(a) in the “Introduction” section.

To do this it is necessary to first return to the issue of the direction of causality in the internal/external theft relationship. The fact that concentration of theft matters over and above volume seems to add weight to the suggestion that it is more likely that internal

crime affects external crime than vice versa. If an offender chose to visit a street first, and then dipped in and out of retail properties seeking opportunities more as a by-product—why would he or she do this to a greater or lesser extent in certain facilities? To an extent, this could be due to the size of establishments; even if places are randomly chosen there may be a larger number of available opportunities in the bigger bars. However, I would assert that this is unlikely to be the sole explanation for this strong and significant relationship.

First, it is apparent that there is still risk variation when similar properties of similar sizes are compared or footfall is approximated. For example, a study on bag theft by Sidebottom and Bowers (2010) used the number of seating opportunities across 26 bars to approximate capacity. They found no significant correlation between the number of seating opportunities and the number of recorded bag thefts. They also found that some bars that had large seating capacity and still had low volumes of theft. These variations might be due to different clientele or different security practices across bars. It could be that the high risk bars, independent of size, are crime enablers (Clarke and Eck 2005) and do not sufficiently enforce regulations. Further to this, the current study has accounted for on-street population that is likely to reflect footfall in the facilities as well as feet-on-the-street and has demonstrated that concentration of crime into facilities is a more important factor in explaining external theft levels.

Second, when predicting internal crime using external crime, the relationships appear linear and the ‘reputation’ of the street segment as having a chronic external crime problem does not disproportionately increase internal theft problems. However, after controlling for the overall internal theft volume, there is still a sharp non-linear increase in external risk as the number of victimized facilities increases; and the more chronically victimized these facilities are the more dramatically the external risk increases.

Third, it is apparent that external theft is influenced partly by the amount of internal theft in nearby areas, whereas the reverse is not true. This chimes with the idea of offenders taking opportunities on the paths that they take between nodes. They commit offences whilst travelling to their intended (internal) destinations. However, there is no supporting evidence of offenders dipping into facilities en-route to a street they are targeting. Presumably then, offenders are around because the *risky facilities* are theft generators or attractors (Brantingham and Brantingham 1995) but it seems the latter also have another function—acting as crime radiators. It appears that theft radiates out from these ‘particularly risky’ facilities and perhaps nearby thefts can be seen as a by-product of their internal theft problem.<sup>10</sup> Further support for this comes from the suggestion from Fig. 5 that the internal theft problems precede the external theft problem temporally. Logically this radiation could be at least in part due to displacement of vulnerable targets from the facility to the external environment at closing time. The conclusion of a likely radiation of risk perhaps involves a small leap of faith from the empirical evidence presented here but it is interesting to state the implications that this possibility raises.

The evidence appears to be in agreement with Wilcox and Eck’s (2011: 475) proposal that ‘many facilities provide criminal opportunity and it is the contextual clustering of public-use facilities, especially along or near major roads that is related to area crime’. We can now add that, clustering in particular of the *heavy weight high theft* facilities appears to create riper conditions for crime in nearby locations. Furthermore, their influence is non-linear. This finding sits very well with Gladwell’s conceptualization of area ‘tipping points’

<sup>10</sup> The ability of a risky facility to radiate risk is presumably unaffected by whether it is a crime attractor or a crime generator.

(Gladwell 2002). There could very well be a point at which the further addition of a bar or restaurant could send an area into a spiral of decline in terms of crime risk. This suggests that the agglomeration of these types of place may cause a problem greater than the sum of its parts. This is perhaps a lesson for town planners—it would seem wise not to allow the larger crime attractors or generators to be located too close to one another and it would also be sensible to mix different types of land-use where possible. As Ekblom (1997, 2002) proposes, a crime impact assessment process would be a useful tool to add to environmental impact assessment undertaken in advance of placing large new facilities. Ekblom also proposes that such exercises should be split into consideration of crime risk (that is incoming risk to new development from existing sources of potential crime in its environment) and crime impact (the export of new crime risk from the new development to the existing locale), chiming well with the concept of considering both internal and external risk.<sup>11</sup> Of course, this idea is tempered by the fact that the real impact of any combination of facilities in the environment is only known for certain when they have been in place for a while. Further, looking at facility placement from a security perspective alone is unrealistic. Cohen and Felson (1979) rightly question whether crime prevention should limit ‘factors which increase the opportunity to enjoy the benefits of life’.

Another issue that this discussion logically raises is that of corporate responsibility. If the riskiness of a facility affects the level of safety of not only the patrons that choose to visit it but also that of (at least some of) the passers-by, they have even more of an obligation to take steps to reduce levels of risk. Research by Roman and Farrell (2002) has proposed that some businesses or processes might cause crime ‘pollution’ as a result of their activities. They see crime as an externality of some of these activities. For example, manufacturing unsafe products (for instance mobile phones or credit cards) will inevitably lead to a ‘crime harvest’ (Felson and Clarke 1998; Pease 1997) where offenders will cash in on the vulnerability of a valuable product. As a solution, they propose the use of market—based pollution control strategies (Farrell and Roman 2006), where manufacturers are incentivised to make their products safe. One way of achieving this is by increasing public pressure, by making sure public awareness is good. This sits well with the current discussion. The crime generating properties of large facilities should be a high concern of business owners, so that there is more investment in prevention strategies and technologies.

Two final, potentially more positive points can be made here. First, if business owners do invest in effective prevention measures, their effectiveness could well diffuse beyond the door of the establishment. By treating the internal theft problem, they could also, as an unanticipated side effect, help to reduce the external theft problems nearby. This phenomenon, where there are positive side effects of crime prevention interventions is known as a ‘diffusion of benefit’ (Clarke and Weisburd 1994). Diffusion of benefit has been found in many situations and recent reviews indicate that this added crime reduction benefit is often a more likely outcome of prevention interventions than its alternative, crime displacement (Barr and Pease 1990; Eck 1993; Guerette and Bowers 2009; Hesseling 1994). The current research falls neatly in line with the evidence that treating risky places could have a positive influence on neighbouring places and proposes one possible mechanism for why this might be the case. It advocates the use of effective place management as a crime prevention strategy. Place managers are individuals that are responsible for overseeing

<sup>11</sup> Ekblom’s commentary on this can be found in ‘Crime Risk Assessment/Crime Impact Assessment’ available at: [http://www.designagainstcrime.com/files/crimeframeworks/Crime\\_risk\\_assessment\\_EKBLOM.pdf](http://www.designagainstcrime.com/files/crimeframeworks/Crime_risk_assessment_EKBLOM.pdf). Last accessed on 19 oct 2011.

security issues through surveillance in specific settings as part of their employment (Eck 1995). One implementation difficulty with place management is resourcing it and making it effective in ‘un-owned’ public spaces. However, this research suggests that looking after the ‘owned’ spaces nearby can make a contribution.

Second, it illustrates the potential crime reductive power of the business community working together. The possibility of businesses collaborating in an attempt to reduce crime problems on the street as well as against their own establishment, paints a hopeful picture. By collectively securing their own premises and therefore acting in a way where self-interest is maintained, they might help towards the elimination of a neighbourhood crime issue as well as gaining individually. In fact, the business improvement districts initiative (BIDs) that has seen success in parts the USA (Cook and MacDonald 2011) fits in neatly with these ideas. When the majority of property owners approve a BID in an area, state law makes budget contributions mandatory. As a result, the community is highly motivated to act collectively. An evaluation of BIDs in Los Angeles demonstrated reductions in crime of between 6 and 10 % (Brooks 2008).

A final remark is warranted on how the results speak to conceptual differences between crime attractors and crime generators. In the introduction I noted the suggestion that theft was more likely to be relevant to generators and that the internal environment of facilities (or at least those that are openly accessible to the public at large) could also have a tendency to be generators. The findings give general support to both of these ideas. It seems likely that the clientele of restaurants, clubs and shops in these areas are those that generate the problem as both offenders and victims. What does this say about crime attractors? To answer this question, more research is necessary. A good starting point would be to investigate types of crime that would be more linked to such places—drug dealing and prostitution being good examples. It could, for example, be the case that such places drive up crime in external spaces first.

### Limitations and Future Research

This research has looked at the relationship between internal and external theft empirically for one dataset in one geographic area. This represents the first study of its kind, and obviously the extent to which the relationships seen here would be found elsewhere requires further empirical testing. The reason that the testing of the crime radiation hypothesis was at all possible was due to the existence and preparation of novel data sets for the study area. The physical area of study was small, but it contained an exceptionally high density of facilities and enabled the analysis of grid squares with a large degree of variation in terms of their criminogenic profile (the study area containing 4,649 victimized facilities in all and between 0 and 123 victimized facilities at the grid square level, with a mean of 22 and a standard deviation of 18.9). Recorded crime data is used here and has the usual drawbacks; it is not a true measure of all theft and it is subject to recording errors such as inaccurate address information.

A further issue is that of the grid square as a fairly arbitrary unit of analysis. As with many other spatial studies, the results are potentially sensitive to the size of the areal unit chosen and the physical location of the boundaries: the modifiable areal unit problem (Openshaw 1984). Sensitivity analysis did indicate that the relationship holds at a larger unit of analysis (100 × 100 m grid squares)—however many other possible units exist. It could also be the case that the grid squares do not reflect natural units for which there is a strong relationship between the properties and the street. Perhaps street segments would be a more appropriate unit for example, but there would equally be associated complications;

in assessing which segment a property has influence over and in dealing with segments of different sizes, presumably many with zero crime, in a spatial regression analysis. Whatever the exact unit, it is useful to examine crime at the micro-level, as has been done here (see Weisburd et al. 2012).

The use of theft data is logical here in that theft can happen both within establishments and on the street outside. The findings suggest that while this is the case, incidents of this particular crime type ('theft other') tend to occur to a larger degree inside than outside. It would be useful to test the internal/external crime volume relationship for other appropriate crime types. As suggested earlier, assault might be a useful starting point for comparison. In this case, given the employment of security guards and the existence of licensing laws, there might be more on street crimes that could potentially have been facilitated or 'radiated' from risky facilities. There is also the further possibility of taking the facility type into account in this sort of analysis.

There is the need for more research looking at the influence of footfall or potential usage of the various facilities. Here I use the space syntax measure of choice as a proxy for the on street population. Other recent work explores the use of novel datasets in producing better estimates of temporal variations in footfall. Andresen and Jenion (2010) used freely available spatially referenced population data (LandScan) to estimate the ambient population and find that using this in risk calculation gives a very different picture to using residential population. Such datasets do not currently exist at fine enough scales of resolution to approximate footfall at the facility level and research on risky facilities continues to deal with the volume of crime rather than the rate. Gaining direct access to facility footfall data is notoriously problematic: it is often commercially sensitive and footfall levels often change dramatically over time. Finding a better estimate to capture the available opportunities for specific crime types would be beneficial. Finally, there is more scope to collect information on the nature of facilities other than just footfall from a qualitative perspective. Criminogenic risks associated with certain types of facilities are likely to vary by type of clientele, by management practices and by the particular services and goods that are on offer. Understanding the way that these factors may affect external and internal theft and the relationship between them was beyond the scope of this initial study but would be a useful avenue for future research.

## Conclusion

To conclude, this research has demonstrated that there is a strong relationship between the amount of theft within facilities and the amount of on-street theft. Additionally, as the internal risk becomes more concentrated into facilities, the risk of on-street theft increases. This suggests that risky facilities might act as 'crime radiators', transmitting risk outwards onto the street. Therefore there seems to be a benefit in conceptually and empirically integrating risky facilities research with that which examines the implications of certain types of land-use to risk in the immediate external environment. There may also be benefit in collective crime prevention activities that extend beyond addressing internal theft problems and in careful consideration of the placement of facilities with the potential to generate high volumes of crime.

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## Appendix 1

See Table 11.

**Table 11** Relationship between external theft, internal theft and risky facilities: 100 × 100 m grid squares (n = 49)

Dependent: external theft from person	Model 1	Model 2	Model 3	Model 4	Model 5
Internal theft from person	0.21 (7.07)**	0.15 (3.61)**	0.11 (2.95)**	0.09 (2.05)*	0.11 (2.04)*
Total number of risky facilities		0.50 (1.83)			
Number of facilities with 2+ thefts			2.09 (3.24)**		
Number of facilities with 3+ thefts				3.69 (3.51)**	
Number of facilities with 4+ thefts					3.81 (2.38)*
On street population proxy	0.04 (0.42)	0.02 (0.22)	0.02 (0.30)	0.02 (0.23)	0.04 (0.42)
Constant	-12.01 (-0.56)	-30.13 (-1.22)	-31.45 (-1.47)	-27.00 (-1.30)	-19.57 (-0.95)
Lambda	0.35 (1.75)	0.45 (2.52)*	0.43 (2.32)*	0.44 (2.36)*	0.34 (1.68)
Log likelihood	-266	-265	-261	-260	-263

Beta (Z value)

\*  $p < 0.05$

\*\*  $p < 0.01$

## Appendix 2

See Table 12.

**Table 12** Relationship between external theft, internal theft and risky facilities: negative binomial regression (n = 210)

Dependent: external theft from person	Model 1	Model 2	Model 3	Model 4	Model 5
Internal theft from person	0.0080 (10.68)**	0.0049 (5.78)**	0.0046 (5.18)**	0.0043 (4.42)**	0.0044 (4.26)**
Total number of risky facilities		0.0308 (5.20)**			
Number of facilities with 2+ thefts			0.0852 (5.04)**		
Number of facilities with 3+ thefts				0.1281 (4.77)**	
Number of facilities with 4+ thefts					0.1462 (4.14)**
On street population proxy	0.0188 (2.77)**	0.0004 (0.61)	0.0006 (0.89)	0.0009 (1.48)	0.0015 (2.38)*



**Table 12** continued

Dependent: external theft from person	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	1.4270 (10.31)**	1.1832 (8.56)**	1.2805 (9.62)**	1.2991 (9.78)**	1.3322 (10.04)**
Lambda	N/A	N/A	N/A	N/A	N/A
Log likelihood	-737	-724	-724	-725	-728

Beta (Z value)

\*  $p < 0.05$ \*\*  $p < 0.01$ 

## References

- Andresen MA, Jenion G (2010) Ambient populations and the calculation of crime rates and risk. *Secur J* 23:114–133
- Anselin L, Syabri I, Kho Y (2006) GeoDa: an introduction to spatial data analysis. *Geogr Anal* 38(1):5–22
- Barr R, Pease K (1990) Crime placement, displacement and deflection. In: Tonry MH, Morris N (eds) *Crime and justice: a review of research*, vol 12. University of Chicago Press, Chicago, IL
- Bernasco W, Block R (2011) Robberies in Chicago: a block-level analysis of the influence of crime generators, crime attractors, and offender anchor points. *J Res Crime Delinq* 48(1):33–57
- Block R, Block CR (1999) The Bronx and Chicago: street robbery in the environs of rapid transit stations. In: Goldsmith V, McGuire PG, Mollenkopf JB, Ross TA (eds) *Analyzing crime patterns: frontiers of practice*. Sage, Thousand Oaks, CA
- Brantingham PL, Brantingham PJ (1981) Notes on the geometry of crime. In: Brantingham PJ, Brantingham PL (eds) *Environmental criminology*. Sage, Beverly Hills, CA
- Brantingham PL, Brantingham PJ (1984) Burglar mobility and crime prevention planning. In: Clarke RV, Hope T (eds) *Coping with burglary*. Kluwer-Nijhoff, Boston, MA, pp 77–95
- Brantingham PL, Brantingham PJ (1993) Nodes, paths, and edges: considerations on the complexity of crime and the physical environment. *J Environ Psychol* 13:3–28
- Brantingham PJ, Brantingham PL (1995) Criminality of place: crime generators and crime attractors. *Eur J Crim Policy Res* 3:5–26
- Brooks Leah (2008) Volunteering to be taxed: business improvement districts and extra-governmental provision of public safety. *J Public Econ* 92:388–406
- Clarke Ronald V, Cornish Derek B (1985) Modeling offenders' decisions: a framework for research and policy. In: Tonry M, Morris N (eds) *Crime and justice: an annual review of research*, vol 6. University of Chicago Press, Chicago
- Clarke RV, Eck JE (2005) *Crime analysis for problem solvers in 60 small steps*. Office of Community Oriented Policing Services, US Department of Justice, Washington, DC
- Clarke RV, Weisburd D (1994) Diffusion of crime control benefits: observations on the reverse of displacement. In: Clarke RV (ed) *Crime prevention studies*, vol 2. Criminal Justice Press, Monsey, NY
- Cohen LE, Felson M (1979) Social change and crime rate trends: a routine activity approach. *Am Sociol Rev* 44(4):588–608
- Cook TD, Campbell DT (1979) *Quasi-experimentation: design and analysis for field settings*. Rand McNally, Chicago, Illinois
- Cook PJ, MacDonald J (2011) Public safety through private action: an economic assessment of BIDS. *Econ J* 121:445–462
- Cornish D, Clarke RV (1987) Understanding crime displacement: an application of rational choice theory. *Criminology* 25(4):933–947
- Eck JE (1993) The threat of crime displacement. *Crim Justice Abstr* 253:527–546
- Eck JE (1995) A general model of the geography of illicit retail marketplaces. In: Weisburd D, Eck JE (eds) *Crime and place*. Crime prevention studies, 4th edn. Criminal Justice Press, Monsey, NY
- Eck JE, Clarke RV, Guerette RT (2007) Risky facilities: crime concentration in homogeneous sets of establishments and facilities. In: Farrell G, Bowers K, Johnson SD, Townsley M (eds) *Crime prevention studies*, 21st edn. Willan, Devon

- Eklblom P (1997) Gearing up against crime: a dynamic framework to help designers keep up with the adaptive criminal in a changing world. *Intl J Risk Secur Crime Prev* 2(4):249–265
- Eklblom P (2002) Future imperfect: preparing for the crimes to come. *Criminal Justice Matters* 46 Winter 2001/02:38–40. London: Centre for Crime and Justice Studies, Kings College
- Fagan J, Garth D (2000) Crime in public housing: Two-way diffusion effects in surrounding neighbourhoods. In: Goldsmith V, McGuire PG, Mollenkopf JB, Ross TA (eds) *Analyzing crime patterns: frontiers of practice*. Sage, Thousand Oaks, CA
- Farrell G, Roman J (2006) Crime as pollution: Proposal for market-based incentives to reduce crime externalities. In: Moss K, Stephens M (eds) *Crime reduction and the law*. Routledge, London
- Felson M, Clarke RV (1998) Opportunity makes the thief: practical theory for crime prevention. *Police research series paper 98*. Home Office, London
- Gladwell M (2002) *The tipping point: how little things can make a big difference*. Little Brown, Boston
- Guertel RT, Bowers KJ (2009) Assessing the extent of crime displacement and diffusion of benefit: a systematic review of situational crime prevention evaluations. *Criminology* 47(4):1331–1368
- Hesseling R (1994) Displacement: a review of the empirical literature. In: Clarke RV (ed) *Crime prevention studies*, vol 3. Criminal Justice Press, Monsey, NY
- Hillier B (2004) Can streets be made safer? *Urban Des Int* 9:31–45
- Hillier B, Penn A, Hanson J, Grajewski T, Xu J (1993) Natural movement: or, configuration and attraction in urban pedestrian movement. *Environ Plan B Plan Des* 20:29–66
- Holloway SR, McNulty TL (2003) Contingent urban geographies of violent crime: racial segregation and the impact of public housing in Atlanta. *Urban Geogr* 24:187–211
- LaGrange TC (1999) The impact of neighbourhoods, schools, and malls on the spatial distribution of property damage. *J Res Crime Delinq* 36:393–422
- McCord ES, Ratcliffe JH (2007) A micro-spatial analysis of the demographic and criminogenic environment of drug markets in Philadelphia. *Aust N Z J Criminol* 40:43–63
- McCord ES, Ratcliffe JH (2009) Intensity value analysis and the criminogenic effects of land use features on local crime patterns. *Crime Patterns Anal* 2:17–30
- Newton A, Bowers KJ (2007) The geography of bus shelter damage: the influence of crime, neighbourhood characteristics and land-use. *Internet J Criminol*. <http://www.internetjournalofcriminology.com/Newton%20and%20Bowers%20-%20The%20Geography%20of%20Bus%20Shelter%20Damage.pdf>. Accessed Sept 2013
- Openshaw S (1984) *The modifiable areal unit problem*. Geo Books, Norwich
- Pease K (1997) Predicting the future: the roles of routine activity and rational choice theory. In: Newman G, Clarke RV, Shoban S (eds) *Rational choice and situational crime prevention: theoretical*. Dartmouth, Ashgate
- Rengert GF, Ratcliffe JH, Chakravorty S (2005) Policing illegal drug markets: geographic approaches to crime reduction. *Criminal Justice Press*, Monsey, NY
- Roman CG (2005) Routine activities of youth and neighbourhood violence: spatial modeling of place, time, and crime. In: Wang F (ed) *Geographic information systems and crime analysis*. Idea Group, Hershey
- Roman J, Farrell G (2002) Cost-benefit analysis for crime prevention: opportunity costs, routine savings, and crime externalities. In: Tilley N (ed) *Crime prevention studies*, 14th edn. Willan, Devon
- Roncek DW, Bell R (1981) Bars, blocks, and crime. *J Environ Syst* 11:35–47
- Roncek DW, Maier PA (1991) Bars, blocks, and crimes revisited: linking the theory of routine activities to the empiricism of hot spots. *Criminology* 29:725–753
- Shaw CR, McKay HD (1942) *Juvenile delinquency in urban areas*. University of Chicago Press, Chicago
- Sidebottom A, Bowers KJ (2010) Bag theft in bars: an analysis of relative risk, perceived risk and modus operandi. *Secur J* 23(3):206–224
- Weisburd D, Bruinsma GJN, Bernasco W (2009) Units of analysis in geographic criminology: historic development, critical issues, and open questions. In: Weisburd D, Bernasco W, Brujinmsa G (eds) *Putting crime in its place*. Springer, New York, pp 3–31
- Weisburd D, Groff ER, Yang S (2012) *The criminology of place: Street segments and our understanding of the crime problem*. Oxford University Press, New York
- Wilcox P, Eck JE (2011) Criminology of the unpopular Implications for policy aimed at payday lending facilities. *Criminol Public Policy* 10(2):473–482