Spatial Economics of Crime

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spatial design factors and the total social cost of crime against individuals and property in London

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Abstract
Combining two original pieces of research, the first on the spatial attributes of two types of crime and the second on the total social cost of the same crime, this paper proposes a methodology to evaluate the total socio-economic cost of spatial attributes related to robbery and burglary. Only recently have studies started to focus on particular types of crime, and extract their built environment characteristics. Most of these studies focus on burglary and robbery as it is the type of crime with the best record of location. Re-using the extensive amount of data from a case study area in London which demonstrates the link between street robbery and property burglary occurrences and spatial design factors, this paper sets out to evaluate burglary and robbery risk as a cost in spatial planning and design.

Introduction and background

In the UK, in recent years there has been growing interests in the analyses of the relationships between crime occurrences, population socio-economics profiles with a particular focus on burglary and robbery. For burglary; the literature ranges from decision making by house burglars (Hearnden 2004), to the distribution of property crime (Hope 2007), to assessing the impact of prevention strategy or burglary reduction initiative (Bennett, 1999, Millie 2004, Hope 2004). The research interests lie in understanding the macro-sociological dynamics of burglary crime, via the analysis of crime trends, the micro-level dynamics of crime victimisation and offending, via the modelling of survey data and spatial distribution and devising intervention strategies that are effective and efficient. Usually the spatial unit of analysis remains relatively aggregated to be meaningful to spatial designer and spatial design policy maker (Osborn 2005); yet some research gives risk level according to dwelling type (Hope 2000).

For robbery, from understanding the nature of personal robbery (Smith 2003), to tackling robbery (Home Office 2006), and street crime problem solving (Tilley 2004). Spatial analysis researches that focus on street robbery are rare (Alford 1996, Smith 2003).

In the space syntax's literature, controlling for social variables, the research is mostly focused on micro to macro spatial design conditions which are relevant to spatial design intervention, spatial designer and spatial design prevention policy maker (Baran 2007, Jones 1997, Hillier 2008, 2007, 2005, 2004a, b, 2000, 1999, Lopez 2007, Nubani 2005, Sahbaz, 2007, Shu 2003, 1999, Smith

2006, van Nes 2007, 2005).The research shows the many viewpoints by which the spatial patterns can be assessed: built environment feature and scales, spatio-temporal differentiation, and relationship to activities distributions and victimisation risk. The aim of this paper is not to review, challenge or augment this literature, but rather to use it as a starting point in asking whether a methodology of estimation of total social cost can be derived from risk levels linked to spatial design factors having adverse or positive impact. This is particularly important if we want to evaluate the cost-effectiveness or cost-benefit study of a crime reduction intervention or to understand what could be the economic implication of spatial design policy aiming at mitigating or preventing crime. The starting point for a cost-effectiveness or cost-benefit study of a crime reduction intervention is just the same as the starting point for a study of whether the intervention 'works', in the widely accepted sense of having a significant impact in reducing crime rates (Sherman 1997, Petrosino, 2001). An intervention that does not work cannot be cost effective or cost beneficial since it will show no benefits. An intervention or a policy are not cost-effective simply because it 'works' in the sense of producing a reduction in burglaries. An intervention that 'works' will not normally be implemented if a cheaper way can be found of delivering the same outcome. The purpose of cost effectiveness and cost-benefit analyses is to bring into the sharpest possible relief the relationship between the amounts alternative types of intervention cost to implement and what they deliver by way of crime reduction benefits (Bowles 2004, HM Treasury 2003). To this end it becomes important to firstly evaluate the risk impact of spatial design features, in term of total social cost and secondly to estimate what would be the cost of mitigating these spatial design features in relation to crime reduction intervention or prevention. This paper is focussed on the first point.

The relationship between crime and the built environment is well identified in the UK planning system. Part of the national Planning Policy Statement 1: Delivering Sustainable Development (PPS1) is the design guidance: "Safer places: the planning system and crime prevention", which lists seven attributes that are particularly relevant to crime prevention:

1. Access and Movement: places with well-defined routes, spaces and entrances that provide for convenient movement without compromising security
2. Structure: places that are structured so that different uses do not cause conflict
3. Surveillance: places where all publicly accessible spaces are overlooked
4. Ownership: places that promote a sense of ownership, respect, territorial responsibility and community
5. Physical Protection: places that include necessary, well-designed security features
6. Activity: places where the level of human activity is appropriate to the location and creates a reduced risk of crime and a sense of safety at all times
7. Management and Maintenance: places that are designed with management and maintenance in mind, to discourage crime in the present and the future

The guidance is qualitative and often unclear on how to make decisions on how best to design out crime. For example it is said "Too few connections can undermine vitality, too many — and especially too many under-used or poorly thought out connections — can increase the opportunity to commit crime. The right level and type of access, resulting in places that are both well connected and secure, is achieved through careful and creative design based upon local assessment." (p. 16).

Given that in the UK the built stock is replaced or created at a rate of about 2% a year, unless catastrophic event, 80% of the built stock of the next 50 years already exists. Yet the spatial distribution of these replacement or creation is spatially heterogeneous. For large new developments and spatial policy, an Integrated Impact Assessment (IIA) is statutorily required that will seek at evaluating adverse impact on the three "pillars" of sustainability: social, economic and environmental. Some of the impact will be monetised and some of the impacts will be qualitatively assessed, as their tangible value might be too difficult to ascertain. In the overall IIA performance and best value will be considered. This is the stage where the non-monetised impacts that have the greatest potential to be lost, as they do not have defined economic values, will be judged against other economic or monetised aspects of the IIA assessment. Our aims were to develop a methodology to assess the monetary value of the relationship between the built environment characteristics and victimisation risk. Two components were required: the relationship between the built environment and victimisation risk and the monetisation of victimisation for burglary and robbery, essentially the cost of crime. The objective is to use spatial design parameters already identified in the literature which have prominent adverse impact to assign cost over a lifetime of a building or to place spatial characteristics in relationship to burglary and street robbery. For burglary, dwelling type is an important spatial design variable. Two other spatial design issues are of importance yet still much contested (Hillier 2008); the spatial grouping of dwelling and their density.

For robbery, a large number of personal robberies occur in open public spaces, primarily a street (50%), but also footpaths, alleyways, subways and parks. This is not particularly surprising since personal robbery is synonymous with the 'street'. Almost 40 per cent of personal robberies occurred either in or around locations other than a street, such as commercial premises or while the victim was using some form of transport. Commercial premises, which included retail premises and leisure complexes, pubs, night-clubs, and fastfood outlets, provided the back drop for 16 per cent of personal robberies (Smith 2003).

Crime risk estimation and consequences

Risk is either an unwanted event which may or may not occur or the cause of an unwanted event which may or may not occur. It is the likelihood of a specific undesired event occurring within a specified period or in specified circumstances. It may be a frequency or a probability. Frequency is usually expressed as events per year and probability is a number between 0 and 1. Consequence is usually measured in either money or fatalities. If we constrain ourselves to consider consequence in terms of a single fatality then risk becomes a function of frequency or probability since consequence is a constant.

For example, there is a known relationship between social conditions and crime with estimates based on reliable group averages. Given victimization rate, social conditions, economic conditions and other contextual characteristics a statistical discrimination can be made to estimate risk. The British Crime Survey shows there is a considerable class/income bias in most forms of security behaviour. Access to the means of security depends upon access to economic and related forms of social capital – as crime rates reduce to a new social equilibrium, they are likely to produce or reinforce inequalities in risk and risk-avoidance, which are correlated closely with inequalities in the distribution of income and wealth. If for example the risk of property crime closely tracks the ratio of poor to rich in a community, then risk avoidance may take the form of a strategic positional spatial game between the social classes (Hope 2001, 2007). As Beck argues not only has contemporary society produced new forms of risk – those 'manufactured' from our social relations - but that as these risks emerge as a predictable and expected feature of social relations so they become embedded in the structure of everyday life. As a result, people come to acquire social risk positions in relation to such risks (Beck 1992). Yet these new risk positions may reproduce nevertheless existing, structural divisions in society. A more overlooked but equally important social process - how the risk of crime drives the pursuit of safety by the more affluent to the extent that it creates a greater inequality in access to security from crime (Hope 2000). Spatial justice concerns to achieve an equal geographical distribution of society's wants and needs, such as job opportunities, access to health care, good air quality, security etc. In free, developed economies, access to many places is limited. The mass privatization of once-public land is a common example of spatial injustice (Mitchell 2003). We could extend spatial justice to access to good and appropriate spatial design, a concerns to achieve an equal access to security good via appropriate spatial design. Uncovering spatial design risk cost aims to laterally contribute to this debate.

Cost of crime

Cost of crime can help us to prioritise and to focus on built environment characteristics that have the biggest impact on increasing victimization levels rather than simply the number of crimes. 'Costs of crime' refers to the full range of impacts of crime stated, where possible, in monetary terms though this does not suggest that it is either straightforward or always right to reduce the consequences of any crime into purely financial terms. Costs from crime are incurred in anticipation of crimes occurring (such as security expenditure and insurance administration costs), as a consequence of the criminal events (such as property stolen and damaged, emotional and physical impacts, and health services), and responding to crime and tackling criminals (costs to the criminal justice system). In 2000, the Home Office (UK) published its first estimates of the costs of crime (Brand & Price, 2000). This represented the first serious and comprehensive attempt to place a monetary value on the costs of crime to victims, businesses, the taxpayer and society more generally. The purpose of the exercise was to provide an overall measure of the cost of crime to society and one which could be tracked over time. It also allowed an assessment to be made of the relative seriousness of different types of crime on the basis of the severity of impact rather than just numbers of offences. It provided estimates of the costs associated with individual crime incidents, which could then be used to assess the cost-effectiveness of crime reduction policies and interventions. Costs have been measured using surveys of victims, such as the British Crime Survey and Commercial Victimisation Survey, and estimates of industry turnover and costs, such as the security and insurance industries. Resource cost estimates for the criminal justice system have been derived from a model developed by the Home Office to track flows and costs through the criminal justice process. Emotional and physical impacts of crime were estimated in 2000 using figures for people's willingness to pay to avoid road traffic accidents. Some costs, such as the fear of crime or the impacts of crime on victims' families, have not been estimated due to lack of data or the lack of appropriate techniques through which to gather data.

In 2004 (Dubourg 2004) a first update was published and presented of the cost of crime estimates. These focused on a number of areas for improvement, including:

1. changes to the way the emotional and physical costs of violent crime against individuals are valued;
2. an updated methodology for estimating the criminal justice system costs of responding to crime, especially relation to police and prison costs; and
3. revised 'multipliers' for estimating the total number of offences from British Crime Survey (BCS) and recorded crime figures.

The total cost of crime to England and Wales in 1999/2000 is estimated at around £60 billion, although this figure is still far from comprehensive as it does not include important costs such as fear of crime or quality of life impacts. The cost of burglary in a dwelling and robbery amounted to about £4.7 billion in 2000 and £5.3 billion in 2003-04. In both years, burglary and robbery represented respectively 7% and 8% of recorded crimes.

In 2000, the average cost in anticipation of crime and cost from the consequence of crime were £6,000 for robbery and £2,626 for burglary. In 2003-04 these costs were respectively £7,282 and £3,268 with an added third cost component: costs in response to crime which were £2,601 and £1,137 bringing the average cost of robbery to £9,883 and burglary to £4,405. The 6 highest costs from crime are: homicide, sexual offense, serious wounding, robbery, theft of vehicle, and burglary in dwelling. Robbery has a higher rate of occurrence than sexual offence while burglary, as a level of occurrence, is 75% of theft of vehicle. Homicide and serious wounding have very low level of occurrences.

In this exploratory paper a selection of key design parameters was used to assign this cost. Other parameters could be added.

The key spatial design questions for residential burglary were:

1. Are some kinds of dwellings safer than others?
2. Is density good or bad?
3. Does it matter how we group dwellings?

The key spatial design questions for street robbery were:

1. are residential and pedestrian density important?
2. does the ratio of residence to non-residential (mixed uses) matter?

In the next sections we briefly describe the data sets, the methodology used to assess victimisation risk, and the results before concluding.

Crime sample and variables definitions

The crime sample is identical to the case studies analysed for burglary and robbery (Hillier, 2005, Sahbaz 2007). The geographic extent is a Borough of north London with an overall population of 263,000 according to the 2001 census. The borough covers an area of approximately 43 km^2, over 100,000 dwelling units in 65,459 buildings, 21 Underground and 11 train stations, and includes a movement network (road and street) of approximately 536 km in total distance which makes 7,102 street segments supported by detailed land use and property Council Tax Bands. There are many centres ranging from major to district and local. The recorded crimes are over 5 years with over 13,000 burglaries and 6,000 street robberies.

Burglary

Contributing spatial design parameters in risk band analysis of burglary The aim is to relate the pattern of crime to the micro design properties and, to do this, a unit of analysis and a rate must be established. Once the spatial unit of analysis is fixed the main issue is to control for the opportunity level for each crime in relation to the spatial unit. For burglary, Hillier proposes that the dwellings are aggregated into sets made of segments having the same number of dwellings (1, 2, 3, etc.) or within a certain band of residential units and then calculate a burglary rate for the whole band as the total number of burglaries over the total number of opportunities for that band. Then different spatial variables can be tested against this banding to evaluate it as a contributing factor. This process is called risk band analysis (Hillier, 2005).

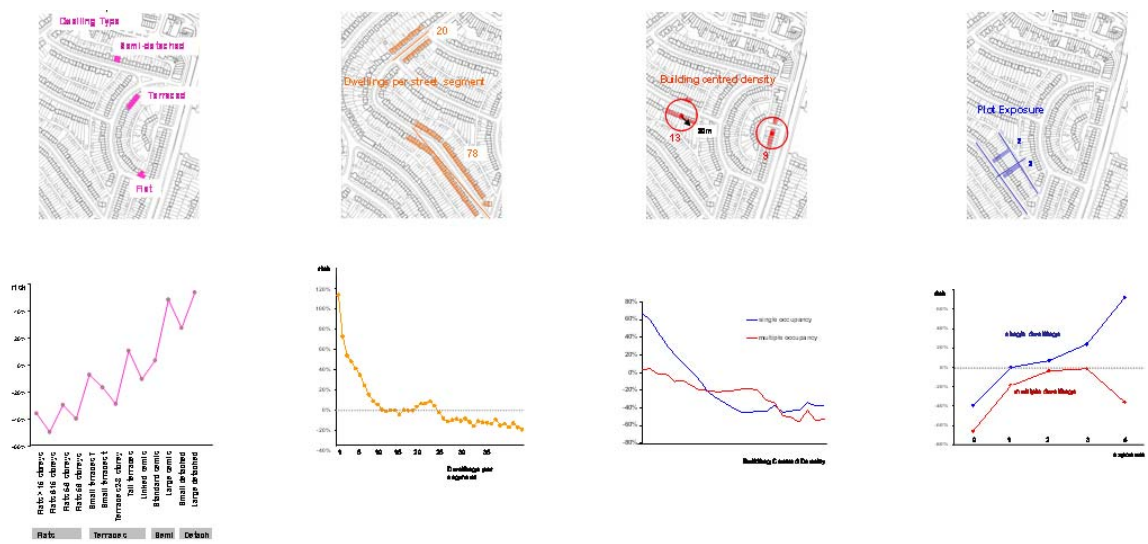

Figure 1

Contributing design parameters in risk band analysis of burglary: from left to right dwelling type, dwelling per segment, plot exposure and building centred density. For each parameters and each risk band associated risk levels above and below background derived from z-score.

The following design parameters have been chosen as they relate mostly to burglary risk

- Dwelling type: flat, terraced, semi detached, detached
- Dwelling per street segment: for a given segment, the number of dwellings located on a street segment and indication of opportunity level
- Plot exposure: for a given plot, the number of faces of a plot that are exposed to the public realm. A corner building may have 3 faces of its plot exposed to the public domain. A back to back terrace house will have only one face of its plot exposed. A terrace house with a back alleyway will have 2 faces of its plot exposed.

- Building centred density: for a given dwelling, the number of other dwellings located within 30m

For each variable and each band the burglary frequency is turned into a standardized variable derived by subtracting the band mean from the individual raw score and then dividing by the band standard deviation. Using a standard normal distribution table we can establish for each of the contributing variables the risk probability of given bands, the z scores. We are evaluating the sum of excess risk and below average risk from background risk; this is an additive model of risk. Figure 1 shows the risk values for each of the contributing variables.

Burglary - from risks factors to cost

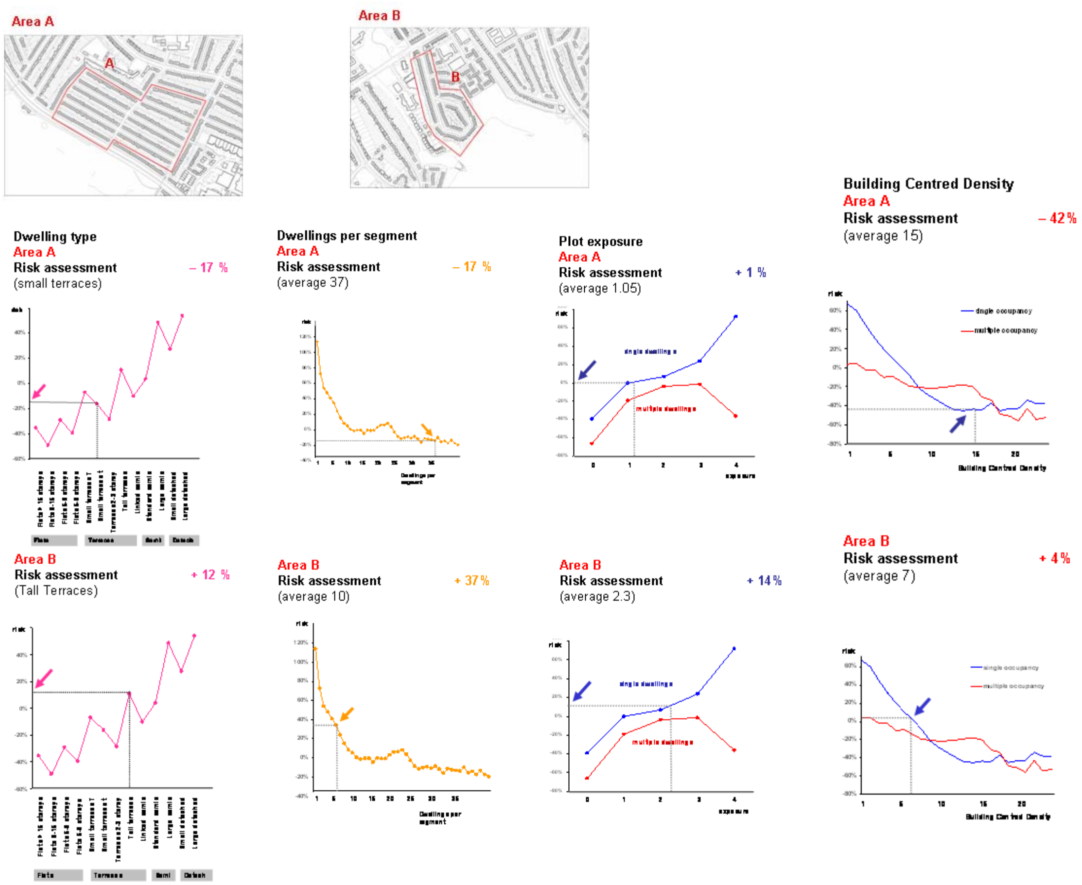

Figure 2

Burglary, from design parameters risk factors to costs evaluation. Area A and B are taken as example.

Area A has a regular grid layout, 482 single dwellings in small Victorian terraces, 22 Burglaries over 5 years with an annual burglary rate 0.0091/household.

Area B has a loop layout with short cul-de-sacs, 157 dwellings in medium sized terraces, 38 burglaries over 5 years, annual burglary rate 0.0484/household.

We assume an additive risk model and sum up the negative or positive risk. By comparing and calculating the risk level of two areas to an average rate of burglary over 5 years and a projected rate of burglary over an estimated lifecycle of 60 years through using the risk increase or decrease it is possible to monetise the impact of the design parameters described above. Figure 2 and Table 1 give an example how this is calculated for two different areas.

Area A	
Dwelling type	– 17 %
Plot exposure	+ 1 %
Building centred density	– 42 %
Dwellings per segment	– 17 %
total	– 75 %

Area B	
Dwelling type	+ 12 %
Plot exposure	+ 14%
Building centred density	+ 4 %
Dwellings per segment	+ 37%
total	+ 74 %

	dwellings	predicted burglary number	predicted cost per household (5 years)	actual burglary (5 years)	actual cost per household (5years)	excess cost per household (5 years)	excess cost per household (60 years lifetime)	excess total cost per area (60 years lifetime)
Area A	482	62	£424	22	+£149	-£275	-£3,300	-£1,590,000
Area B	157	20	£424	38	+£795	+£376	+£4,400	+£691,000

Table 1
Burglary: risks and costs: risk; minus is better, costs; minus is better.

Robbery

Street robbery is listed among the violent crime types in BCS and this class of crime is causing more worry among people than the property crime types such as burglary or car crime.

Contributing spatial design parameters in risk band analysis of robbery

Four basic facts about street robbery:

1. sensitive to socio-economic conditions (poor = more)
2. concentration around schools, transport interchanges, post offices in lower socio-economic scale
3. spatial pattern changes throughout the day
4. concentration in and around a foreground network of linked centres fading into the background network of residential areas

Whereas burglary is a crime against a fixed opportunity, whose number on segments remains constant, robbery is against a moving opportunity: a person. The spatial unit and opportunity need to be defined and controlled differently. Two primary risk factors are identified (Hillier, 2005). The first is the length of time a moving person spends on a segment and it is assumed that on average it will be a function of its length. The second is the number of potential opportunities for crime while moving on the segment. The risk of being selected as a target reduces with an increased number of people on the segment.

The segments are aggregated into 45 segment length bands with moving interval increments (5m up to 100m, 10m up to 250, etc). The bands are normalized to robbery by metre. Segments with non-residential uses are separated from segments without. Local integration is used as a proxy for local movement.

The following parameters have been chosen as they relate most to robbery risk

Socio-economic condition: use of Council Tax Bands

Council Tax Bands reflect social-economic standing through the housing market sorting. Council Tax is a form of local taxation which is used to help pay for the services that the Local Council provides. It is payable in respect of each domestic property and the amount payable depends on the capital value of the property. The capital value is divided in bands which are in turn used to calculate the Council Tax. The valuation is undertaken by the Valuation Office Agency (VOA), an executive agency of the UK government.

The VOA's main functions are to compile and maintain the business rating and council tax valuation lists for England and Wales, value property in England, Wales, and Scotland for the purposes of taxes administered by the UK HM Revenue & Customs, provide statutory and non-statutory property valuation services in England, Wales, and Scotland and give policy advice to Ministers on property valuation matters

The VOA values a home on the basis of its value on 1 April 1991. Even new homes are valued on the basis of what they would have been worth in 1991. In undertaking valuations, the VOA take account of the characteristics of a home and everything that goes to make up its value - positive or negative. This is just what any other valuer would do. When valuing a property for council tax purposes VOA consider the physical state of the property and its locality at a specific date on or after 1 April 1993 and then consider what its value would have been on 1 April 1991. This is the common valuation date for all council tax valuations in England. The VOA assumes that any dwelling that they are valuing for council tax is in a 'state of reasonable repair'. This does not mean that VOA will assume that all properties are in 'good' state of repair. Instead, VOA decides what state it would be reasonable to expect for a dwelling having regard to its age, character and locality. For example, one house in a terrace of ten otherwise identical properties has not been maintained but allowed to deteriorate. However, its basic character is likely to remain the same as that of its neighbours. In such instances, VOA assume a 'state of reasonable repair' which is the same as actually exists for most of the nearby properties. Therefore, the property's disrepair is not reflected in its banding. Very occasionally a dwelling, whilst being of the same age and design as other properties in the neighbourhood, may be wholly different in character (for example: due to a specific structural defect). Here the state of repair that VOA assumes is not that of the majority of its neighbours but other dwellings which have similar defects. In such instances VOA will reflect the structural defect in the value of the property and we may band it differently to neighbouring properties which have no such defect.

Dwelling per street segment: as before

Low radius Integration: is normally the best predictor of pedestrian movement

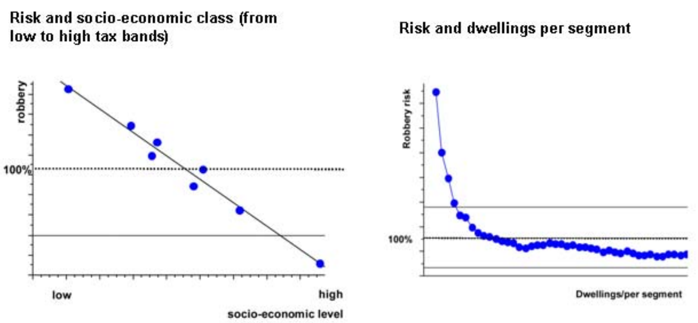

Figure 3
Contributing parameters in risk band analysis of robbery: socio-economic level (Council Tax bands), dwellings per street segment, local spatial integration.

Figure 3 shows the risk values profile for each of the contributing variables. To illustrate these factors affecting robbery risk, two areas in close proximity are examined. As we are dealing with residential areas, so the likelihood is that the victims live in those areas, we will take our measure of robbery as being the number of robberies in the area over the number of households.

Between these two areas, robbery falls off from the tube station in the areas behind one side of the road (Area B) but does not in the area behind the other side (Area A).

Robbery - from risks factors to cost

As previously we assume an additive risk model of spatial design parameters and sum up the negative or positive risk. By comparing the calculated risk level of two areas to an average rate of robbery over 5 years it is possible to monetize the impact of the design parameters described above. Figure 4 and Table 2 give an example how this is calculated for two different areas.

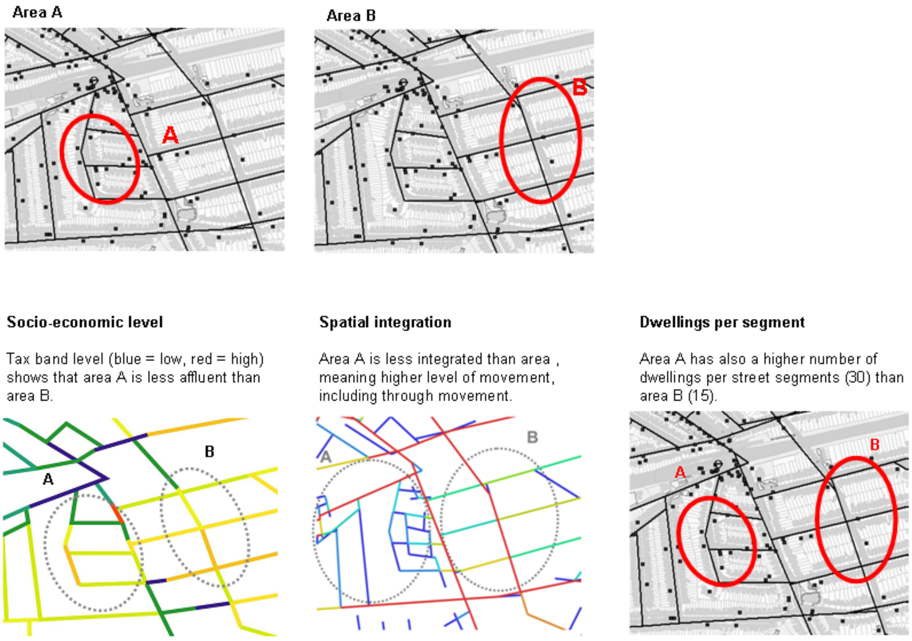

Figure 4

Robbery, from parameters risk factors to costs evaluation. Two Areas A and B in close proximity are taken as example. Area A is a segregated area (no through movement), small block size, 120 dwelling, 17 robberies (rate of 0.142). Area B is an integrated (good through movement), regular grid with large block size, 90 rather bigger dwellings, 7 robberies (rate of 0.078).

	dwellings	predicted robbery number (5 years)	predicted cost per household (5 years)	actual robbery number (5 years)	actual cost per household (5 years)	excess cost per household (5 years)	excess cost per household (60 years lifetime)	excess total cost per area (60 years lifetime)
Area A	120	7	£428	17	+£1,031	-£603	-£7,236	+£14,500
Area B	90	5.3	£428	38	+£566	+£138	+£1,656	+£3,200

Table 2

Robbery: risks and costs: risk; minus is better, costs; minus is better.

Conclusions

The aim of this methodological investigation was to take some of the design parameters affecting residential burglary and street robbery and show that they can be expressed as an economic cost, either to households or to areas. In doing this we have shown how an economic value, positive or negative, can be assigned to spatial layout design and spatial design features of the built environment. This is the first step towards a better understanding of monetizing the interlinking design parameters and crime in residential and central areas.

Five main questions will need further research to be answered.

First, do these parameters change according to area? While the sample is very large and diversified in terms of socio-economic and spatial situations, the design parameters may change according to different areas. For example, it can not be predicted from the existing study if the London central activity zones (inner London) may have the same intervening design parameters.

Second, we have assumed an additive model of risk whether this is the case or not. In clinical research theoretical considerations predict that additive models greatly underestimate the risk for the higher risk cases and clinical data confirms this fact.

Third, so far the social cost of crime does not include yet the economic impact of fear of crime or impact on relatives.

Fourth, in order to decide whether the risk presented is acceptable or not, we must have acceptance criteria against which to judge the activity. Between the levels of tolerable risk and negligible risk lies the region where it is ensured that risk is kept as low as reasonably practicable. In determining what is reasonably practicable the benefit of mitigating activities will need to be weighed against the risk. There will always be a level of risk which is intolerable under any circumstances and a situation presenting an intolerable level of risk should not be allowed. Equally there is always a level below which risk is negligible, even if this level is difficult to quantify. Acceptability of risk is inevitably bound up with perception of risk since acceptable risk levels are ultimately set on political as well as scientific grounds and political decisions must be influenced by public opinion. Perception of risk is a complex matter that is studied by psychologists, sociologists and anthropologists and it is possible to draw up a list of things that increase the perceived risk associated with any activity:

- involuntary exposure
- lack of personal control over outcome
- uncertainty of outcome
- lack of personal experience of hazard
- delayed effects
- genetic effects
- low frequency/high consequence events
- human rather than natural causes

Most of these perceived risks are associated with the experience and design of the built environment.

Fifth, we will need to estimate what would be the cost of mitigating these spatial design features in relation to crime reduction intervention or prevention. This is about bringing the relationship between the amounts alternative types of intervention cost to implement and what they deliver by way of crime reduction benefits. Possibly there are marked differences between the estimation for existing built stock retro-fitting and new developments.

Two possible uses of these methodologies are:

1. The case of adverse selection where people with a reasonable level of income can chose a housing area that they perceive as safe whereas people with low income will be allocated housing they do not chose. One of the challenges would be to answer the following question: given a similar low income socio-economic profile by what multiplier factors is the risk of crime increased due to spatial design factors? What would be the cost of remedial/mitigating design transformation over the saving in total social costs?
2. The additional wider economic benefits of urban design and agglomeration. Through showing the importance of building centred density, plot exposure, type of dwelling and local spatial integration it is possible to derive spatial design benefits that are not usually taken into account when weighting the value of cost and welfare benefits. It is important to try and incorporate all welfare impacts to ensure that we get the best investment choices for society, rather than just for particular users or sectors.

Appendix

Space Syntax spatial configuration analysis of the street network is showed with residential burglary (top) and street robbery (bottom); burglary seems to have no pattern while the robbery is highly linear and follow the spatial foreground (red and orange), the street network of linked centres.

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