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The effects of neighbourhood offender concentrations on the number, type and location of crimes committed by resident offenders

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Abstract

This paper examines whether criminals commit more crimes when living among other offenders. We estimate a fixed-effect, negative binomial model of individual reoffending using a quarterly panel data-set across a decade for 693 neighbourhoods in Glasgow, which provides plausibly causal relationships. The concentration of recently active offenders has positive effects upon the subsequent number of property and violent crimes committed by resident offenders both inside and outside the neighbourhood. The concentration of young males also has a positive effect upon both crime types in both locations. Further understanding of peer influences by crime type and location, and of the effects of offender concentrations on processes of social control are required. The deconcentration of offenders is justified on social equity grounds.

KEYWORDS: Offender concentrations, neighbourhoods, re-offending, violent crime, property crime.

Introduction

This paper is concerned with the link between the behaviour of prior criminals and the social structure of their neighbourhoods; specifically, the degree to which social-interactive mechanisms (Galster 2012) that may operate among criminals who co-reside affect the amount and location of reoffending. This is not often, or easily, studied. Although it is understood that criminals are spatially concentrated, the evidence for this exists mostly in relation to parolees whose location has to be monitored (e.g. Visher and Farrell 2005), rather than for prior offenders more generally, on whom data are sparse or confidential. Moreover, when neighbourhood contexts are investigated for their potential influence upon offending behaviour, this is most often in relation to exogenous and correlated effects rather than for endogenous social processes (Manski 1993).

Whilst it has been established that certain characteristics of neighbourhoods such as the level of disadvantage are associated with reoffending rates (Chamberlain and Wallace 2015), with two exceptions (Mennis and Harris 2011; Stahler et al 2013), there are no studies which examine how *individual reoffending* is related to the number of other prior offenders living in the same neighbourhood, nor whether this reoffending occurs within or outside the neighbourhood. Finally, no research employs methods yielding convincing evidence of causal relationships between offender concentrations and reoffending, as opposed to bias from unobserved characteristics. This paper begins to address these shortcomings of 'the current deficient treatments of space, time and causation' in the criminology of place (Bannister et al 2017, p.12) through a longitudinal analysis of the effects of offender concentrations on reoffending.

Offender Concentrations and the Rate and Location of Offending

There are two distinct strands of research of relevance to our inquiry; in both, ecology plays a central role. One focuses on the population characteristics of the places where potential or prior criminals live to identify the degree to which they might independently influence residents' criminal propensities. The other focuses upon whether criminals engage in their illegal behaviours within their residential neighbourhoods or beyond. Our research bridges these two strands by investigating the degree to which the neighbourhood concentration of prior offenders encourages repeat offending among residents and where such reoffending occurs.

Theoretical effects of offender concentrations

Glaeser et al (1996) suggested that geographical variations in crime might be explained by social interactions, although they could not say what form those took. Crime is a social process involving interactions between offenders and victims as well as, often, between offenders themselves. The fact that the neighbourhood is the most prominent spatial unit of social interaction, and where a lot of social learning takes place (Akers and Lee 1996), leads to the expectation that offender concentrations are most likely to have effects upon offending behaviours due to processes operative within residential neighbourhoods.

Endogenous social processes identified within the field of neighbourhood effects can help explain the impacts of offender concentrations on offending (Galster 2012). Residents may observe and learn from the behaviour of others around them in ways that can change their attitudes and aspirations as well as their skills and abilities to commit crime, a form of social learning or 'contagion'. Via collective socialisation, proximity among offenders can increase the influence of attitudes and behaviours of peers and role models within a neighbourhood (Megens and Weerman 2012),[1] leading people to engage in criminal behaviour (Esiri 2016). This may occur without approval of the behaviour (Warr 2002), but to conform to criminal norms due to factors such as

loyalty, fear and status within local social networks.   Residential concentrations of offenders may also lead to the formation of local criminal networks that convey information about criminal opportunities and on ways to minimise the costs and maximise the benefits of crime (Becker and Murphy 2000).

There may be differences by crime type. Violent crimes are interactive and reciprocal, often involving criminals, so the chances of an occurrence are greater with an offender concentration. Behaving like a violent offender may also deter predators and reduce victimisation (Fagan and Meares 2008). The mechanisms involved in any effect of offender concentrations on property offending are less clear. Bernasco et al (2017) argue for a peer or role model effect on others, for example from burglary, but it may also be the case that property crime involves more pre-planning and collaboration than violent crime and it is through this means that offender concentrations affect property offending rates.

Conversely, residents within neighbourhoods influence a community's capacity to enact 'guardianship' (Hollis-Peel et al 2011) or exert 'collective efficacy' (Sampson et al 1997; 2010). Whilst theories of social disorganisation have focused on the effects of residential mobility, ethnic diversity, low socio-economic status and lone parenthood (Sampson and Groves 1989; Bruinsma et.al. 2013), the influence of offenders is rarely considered. Yet, where concentrations of offenders are too high, informal social controls may be less effective as there are simply too many potential offenders to supervise them effectively.

Past studies of offender concentrations

Empirical research is suggestive but hardly definitive that concentrations of criminals encourage more crime. Hipp and Yates (2009) found that the number of people recently released from prison living in a neighbourhood In Sacramento had a positive relationship with the monthly crime rate for

assault, burglary and robbery recorded in that neighbourhood. A similar study in Chicago by Bernasco and Block (2011) showed a positive correlation between the number of robbery offenders living in a city block and the number of robberies recorded per block. These aggregate studies cannot identify who is committing the crimes, so research using individuals as the unit of observation offers advantages.

Case and Katz's (1991) Boston investigation found a strong relationship between the probability that a youth would commit a crime and the share of criminal youth on neighbouring blocks. Mennis and Harris (2011) studied individual juvenile male offenders in Philadelphia and showed that the probability of reoffending was strongly related to the concentration of male juveniles who reoffended in the similar crime category living within a kilometre of the individual. Stahler et al. (2013) also provided evidence that the odds and speed of reoffending in Pennsylvania was associated with the concentration of offenders living within a one-mile radius of the individual. Bernasco et al (2017) report significant associations between offender concentrations in The Netherlands and offending by residents in a single year, both for all crimes and separately for violent and property crimes.

Several observations can be made about past studies of offender concentrations. Firstly, none of the studies is longitudinal, using between one and three years' of data in cross-sectional analysis. The studies use a relatively large definition of the neighbourhood, typically a US census tract or its Dutch equivalent, with populations of 4,000. Whether these form the appropriate arena of local social interaction posited for the neighbourhood is uncertain and likely to vary between societies. The studies do not identify whether the crimes are committed within the neighbourhood of residence and offender concentration, or elsewhere. Furthermore, no distinctions are usually made between types of offenders, although Glaeser et al (1996) had discussed the difference between 'die-hard' offenders and those who whose behaviour is less consistent and might be influenced by

others, and Bernasco et al (2017) mentioned the potential relevance of crime frequency for offenders, though did not use this in their analysis. We would expect concentrations of more-active, recent offenders to have a greater effect upon offending than concentrations of lapsed or less active offenders; in neighbourhoods with long histories of criminality, historic offenders may have a cultural effect, but this may be less immediate than the effects of currently active offenders. Many studies examine either a single offence (e.g. robbery) or all crime; only the Bernasco et al (2017) study contrasts two crime groupings, finding the effects of offender concentrations to be stronger for property than violent crime, contrary to expectations. Although the contrast between the social interactive effect on violent and property crime is not well explained, it is plausible that the effects of offender concentrations would be different for the two crime types, as the authors contend.

Crime Location

Crime pattern theory (Brantingham and Brantingham 2008) suggests that offenders commit crimes within areas they are aware of or familiar with, and particularly where this coincides with the location of attractive targets. It is within their activity spaces and awareness spaces that offenders select the location of their targets (Brantingham and Brantingham 1981; Bernasco and Nieuwbeerta 2005). Offenders are also more likely to commit crimes in areas where they have offended previously. Whilst most crimes take place a short distance from offenders' homes, usually within one or two miles (Pyle 1974), both violent and property crimes display a distance-decay from home and previous offence location, somewhat attributable to a reduction of familiarity and comfort with distance (Reid et al 2014; Lammers et al 2015). It has also been recognised that criminals are likely to commit crimes both in their own and adjacent neighbourhoods, though proximate neighbourhood crime, and crime in particular streets or blocks, is also influenced by the street accessibility and social composition of the areas concerned, with social similarity making a difference (Hirschfield et al 2014; Bernasco et al 2013). In relation to burglary, offenders are said to be most likely to commit crimes in their own neighbourhoods, their former neighbourhoods, and near

'anchor points' such as current location of family members, friends' homes and leisure locations (Menting et al 2016; Wiles and Costello 2000; Hirschfield et al 2014), with this also influenced by the duration and timing of previous residence (Bernasco 2010).

It could be argued that offender concentrations would help to contain crime within certain neighbourhoods, particularly where distance-decay operates, and therefore might be in the wider public interest. Alternatively, there may be neighbourhood spillover effects from areas of offender concentration with crimes committed in adjacent or nearby areas to avoid conflict with other co-resident offenders, to the detriment of the wider locality. Lastly, living within a concentration of offenders could serve to expand the individual offender's awareness space of suitable crime locations so that one of the social interactive effects of offender concentrations is to expand the awareness and activity space for an increasing number of offenders. On this basis, we would expect offender concentrations to have a greater effect upon crime in other neighbourhoods than in the resident-offender's own neighbourhood.

Research Aims

The aim of our research is to investigate whether the residential concentration of offenders affects the rate at which offenders living in the same neighbourhood commit crimes. This tests the notion that the neighbourhood is an important arena for social-interactive processes in crime. Past studies have examined the crime rate (number of crimes committed in an area, irrespective of the spatial origin of the offenders) or the offender rate (proportion of residents who commit crimes) but none have considered the *offending rate*, i.e. whether criminals commit more crimes when living in the presence of other offenders. Lastly, theories of social endogeneity tend to focus their discussion on neighbourhood effects upon young people or on social influences upon 'new' offenders (Livingston et al 2014a) or deviants of one sort or another, but here we study social effects upon a different group - existing offenders.

We also consider the following subsidiary questions:

- Crime location: is any effect greater in respect of crimes committed elsewhere (non-local) than for crimes committed within the neighbourhood of residence (local)?

- Crime type: is any effect greater for violent crime than for property crime?

- Offender type: is the influence of recently-active offenders greater than the influence of recently-inactive offenders?

Methods

Study site

This study is conducted in Glasgow, UK, with a population of approximately 600,000 (Freeke 2013). Glasgow contains 30% of the most deprived neighbourhoods (worst 15%) in Scotland, comprising 42% of the city's spatial area (Scottish Government 2012). Glasgow has a crime rate 40% higher than the Scottish average (www.understandingglasgow.com).

Spatial unit

The geographical unit used in this research is the datazone, used for assembling Census and other government data. Officially, "…data zones meet tight constraints on population thresholds (500 – 1000 household residents), they all nest into local authorities and are built up from 2001 Census output areas. The aim was also to build data zones by grouping together output areas with similar social characteristics, for data zones to have a fairly compact shape, and to take account of physical boundaries" (Scottish Government 2006, p.1). Glasgow has 693 datazones with a mean population of 865 persons. Datazones are the closest available approximation to neighbourhoods, and are capable of being walked across in around ten minutes. Datazones are a quarter of the size of census tracts used in much US spatial crime analysis and are not subject to frequent changes in boundaries, having been designed as a 'stable and consistent small area geography'.

Crime Data and Dependent Variables

Police Scotland provided geo-coded crime data for the period 1998/99 to 2008/9, including all crimes committed in the city other than crimes of a sexual nature. The date and exact location of the crime are given, though in a minority of cases the police beat location is given (allocated to the datazone at the centre of the beat). Crimes are categorised into a large number of types: we have focused on twenty types of violent crime and twenty-six types of property crime, the former mostly comprising murder, assaults and weapons offences, and the latter mostly theft, burglary and vandalism. Through a linkage to the offender data, we compute, separately for violent crime and property crime, two dependent variables for each datazone (693), for each quarter (35) of the data-set:

> *Local Crimes:* number of crimes committed within the datazone in the quarter, by prior offenders living in the datazone in the previous quarter (see below);
>
> *Non-Local Crimes:* number of crimes committed outside the datazone in the quarter, by prior offenders living in the datazone in the previous quarter.

Offender data

Police Scotland also provided details of all known offenders in the city for each of the eleven years, constituting a cumulative record of offenders over time. Offenders can be aged from 8 years old (the minimum age of criminal responsibility in Scotland) or over. The offender data includes their address at the time of their last offence. To record someone as an offender, the police must satisfy evidential criteria set by the local public prosecutor's office such that the case is capable of prosecution. Offenders include people cautioned or charged by the police for particular crimes, although they may not all be subsequently prosecuted or convicted; this is not dissimilar to Dutch 'arrestee' data on 'criminal suspects' who receive a range of sanctions from prosecution, to fines, to none (Gerben et al 2013; Bernasco et al 2017). It may be the case that some offenders are absent

from their neighbourhood on a regular or temporary basis for social reasons or indeed due to incarceration, although the proportion of convictions (itself a sub-set of offenders) resulting in custodial sentences is stable and relatively low at 14 percent (Scottish Government 2018), thus the share of offenders in custody is even lower.

Unique identifiers enable us to link the crime and offender data-sets, and through this means establish the date at which each offender's address was last recorded, i.e., when they committed their last known crime. We allocated offenders to their datazone of residence for each three-month period within the study period, and use the number of offenders per datazone in our models. In doing this, we go back two years from the quarter in question to identify offenders with addresses recorded in the data-set. This period enables us to be more certain that the offenders identified are still at the location recorded. examination of the entire offender dataset showed that 88% of offenders had reoffended over a two-year period, thus ensuring that we are able to locate the vast majority of offenders across such an interval. From the perspective of local criminal social networks, and based on previous work, we would expect those residents who have recently offended to be more powerful stimulants for future criminal activity than those who have been less active recently, although both may be influential, particularly for violent crime (Livingston et al 2014a).

We thus distinguish two types of prior offenders for each datazone, for each quarter:

> *Recently Active:* number of offenders who had committed a crime in the previous quarter.

> *Recently Inactive:* number of offenders who had committed a crime in the past two years, but not in the immediately preceding quarter.

Neighbourhood deprivation and population data

One of the main influences on local crime rates is the level of deprivation in a neighbourhood (Livingston et al 2014b).   Deprivation was measured by the percentage of people in a datazone who were income deprived, officially based on receipt of working-age benefits. These data were

extracted from the Scottish Index of Multiple Deprivation (SIMD) for the years 2002, 2005, and 2008. For quarters that fell within these years, deprivation was given the same value as the year in question; for other years, values were imputed and assigned on the basis that change in the percentage of income deprived was linear over the intervening period.

The demographic composition of neighbourhoods may affect the crime rate through two routes. First, the number of adults versus children and young people, and the number of grandparents in an area may affect the exercise of informal social control. Second, younger people are more susceptible to peer influences than older people. We included the age and gender profiles for each datazone, extracted from the General Register for Scotland (GROS) for each year of the study and assigned to each datazone for each quarter of the year in question. We also used the annual GROS population data as the source for the offset in our models (see below).

Analysis

We begin by describing the location of offenders and of offending. The average offender concentration per datazone, i.e., number of offenders per 100 residents is calculated using data across the four quarters of 2008/9 in the panel data-set. We then examine the linked crime and offender data-sets for two separate years, 2000/1 and 2007/8. In each case, we look at the number of crimes committed by offenders living within a datazone both within their own datazone, and across all other datazones in the city, and present the mean number of offences per offender, per annum for the year in question. For each year, we also present the proportion of datazones where resident offenders commit more crimes within their own datazone than elsewhere, and vice versa. This analysis is done separately for violent crimes and for property crimes.

For addressing our main research questions, we have constructed a panel data-set for the 693 datazones in Glasgow over 35 quarters of time, giving crime, offender and neighbourhood

characteristics per datazone per quarter. We estimate the effects of offender concentrations of both types (active and inactive prior offenders) within a neighbourhood in any one quarter (three month period) upon the number of crimes (by type) committed by those same offenders in the *subsequent* quarter, both inside and outside of the neighbourhood. We construct linear models using the active and inactive offender concentration variables as separate predictors. A fixed-effects modelling approach is used to control for time-invariant, unobserved heterogeneity across datazones. Parameters of interest are estimated by modelling within-datazone changes over time.

We estimate four models involving the quarterly numbers of: violent crimes committed within the neighbourhood by resident offenders; property crimes committed within the neighbourhood by resident offenders; and both types of crimes committed elsewhere by offenders living within each neighbourhood. The distributions of quarterly counts of violent and property crimes in the datazone have a positive skew, and thus we have used a negative binomial algorithm for analysing the impacts of the independent variables on the dependent variable in a fixed effects model using the NBREG Stata software package.[2] The models were scaled (using Stata's offset command) for the total population residing in the datazone in the year in question. This enables us to interpret the dependent variables, or crime counts, as crime rates (per resident population).

Given that crime in one neighbourhood may be affected by crime in nearby areas, and to take account of this spatial autocorrelation (Anselin 1998), we identified contiguous datazones around each datazone and calculated the equivalents of the dependent variable, i.e. the average number of violent and property crimes within this buffer zone, for each quarter, similar to the approach taken by Hirschfield et al (2014) and Raleigh and Galster (2014). The relevant adjacent-area variable is included in our models to account for spatial autocorrelation. The full list of variables used in the models is given in Table 1.

Strengths and limitations

Our study offers five major strengths that advance the literature. First, we use a fine grained spatial and temporal structure, as advocated by Hipp and Yates (2009). We consider that our use of the datazone as a surrogate for 'neighbourhood' avoids the risk of adopting an administrative entity that bears no relation to lived realities (Bursik and Grasmick 1993), but rather fits well with many crime theories. Datazones are small enough to offer variation in the presence of crime attractors a la opportunity theories (e.g. Frank et al 2012). They are also meaningful enough to not only bring offenders and targets together (Brantingham and Brantingham 2008) but also to bring offenders together for interaction in functional residential spaces as well as other residents capable in theory of exercising collective efficacy (Sampson et al 1997). Since deprivation is officially measured for datazones, they further enable us to take into account the relationship between poverty and crime (Hipp and Yates 2011). Second, rather than examine aggregate neighbourhood crime rates, i.e., crimes committed in that neighbourhood by people who may reside anywhere, we consider the effects of offender concentrations on the rate at which crimes are committed by the offenders living in the area in question (who may or may not have been in custody) . Third, the few studies which examine offender concentration effects look at burglary alone or a small number of serious offences, but we include a wide range of crimes, divided into violent and property crime. Fourth, we distinguish effects upon local and non-local crime and parse the influence of previous offenders who have not been active recently. Lastly, most previous studies on this, or similar topics, have used data-sets for a particular city covering either one year (e.g. Hirschfield et al 2014, for Leeds) or up to three years (e.g. Bernasco and Block 2011, for Chicago), though in almost all cases offender concentrations are counted over one year at a time, not two as we have done. We also test for offender concentration effects over a period of more than a decade in the case of Glasgow. Our longitudinal model enhances our ability to interpret observed correlations as plausibly causal effects and the inclusion of temporal lags skirts the "reflection problem." Our use of neighbourhood fixed effects control for all the time-invariant formal and informal social control, reputational, land use,

and built and natural environmental features that might both affect the number of crimes being committed in a locale and the selective in- and out-migration of resident offenders, thereby confounding the independent offender density effect.

The limitations to our work mainly stem from the available data. There can never be a full record of all offenders, as some people do not get caught and some crimes go unreported and/or unattributed. However, two-thirds of the crimes in the data-set have an identified offender, making our offender data reasonably representative of all offenders, particularly when it is crimes of property damage and crimes against vehicles that have lower detection rates. In our case, to be classified as an offender the police must have assembled a level of evidence sufficient to satisfy the local public prosecutor that a prosecution could proceed. In Scotland, no continual monitoring of offenders' residences is undertaken, so we are reliant on point-in-time address information, which is absent for a fifth of offenders. Other research has used offender addresses updated on an annual or six-monthly basis, whilst also acknowledging that tracking offender residence remains challenging and insufficient (Chamberlain 2016). Nonetheless, we believe the data-set we have used is better than that available to researchers in many other places, although we have not been able to examine co-offending; while this would be a desirable addition, it is less essential given that we are not inferring anything about crime rates, and in any case, co-offending is less significant for chronic, long-term offenders (Hodgson and Costello 2006; McGloin and Stickle 2011). There is also a limited amount of data available on a regular basis about other characteristics of the neighbourhoods. Along with our panel data-set, we wished to use data that were available on an annual basis or similar, which limited us to basic demographic information and a measure of deprivation available at three time points. This means, for example, that we have not been able to take into account the residential turnover in neighbourhoods, bearing in mind that the effect of parolee concentrations has been found to be moderated by neighbourhood stability, with higher rates of re-offending in areas with lower levels of stability (Chamberlain and Wallace 2016).

Selection bias related to unmeasured, *time-varying* neighbourhood characteristics may affect the estimated coefficients in our models. Crime-prone offenders may move to/from neighbourhoods which within our analysis period have offered more enhanced/degraded opportunities for criminal activity. This potential residential selection effect based on time-varying unobservable factors could produce an impact that is indistinguishable from that produced by a social-interactive mechanism operating in the neighbourhood (Galster 2012). However, we think the impact from such selection is likely minimal. Larger concentrations of offenders in our study may be less prone to selection bias given the dominance of social rented housing in those locales, and thus offenders may have less choice in their areas of residence (Hedman and van Ham 2012). Moreover, to the extent that most neighbourhood features that tend to attract or repel prior offenders do not vary over the period of our study, our use of neighbourhood fixed effects becomes a powerful vehicle for avoiding geographic selection bias.

Results

The location of offenders and offending

All datazones have some resident offenders, although the distribution of offender concentrations is negatively skewed (Figure 1). Two-thirds of datazones had offender densities in 2008/9 of 10 per 100 or less; half of these had 6 per 100 or less. However, a third of datazones had concentrations of offenders greater than ten percent of residents, of which thirty datazones had offender densities of 20 per 100 or more.

Table 2 shows that across both years examined (2000-1 and 2007-8), more crimes were committed in areas other than the offenders' own neighbourhoods. For violent crimes, the ratio of non-local to local crimes committed by resident offenders was approximately 3-to-1 in both years. For property crimes, the ratio of non-local to local crimes was higher: approximately 8-to-1 in the earlier year and

7-to-1 in the later year. Thus, a considerably higher proportion of violent crime was committed in the offenders' home neighbourhoods than was the case for property crime. In only 1 percent of datazones did resident offenders commit more property crime locally than elsewhere in either year, whereas this was true of 5-6 percent of datazones for violent crime.

The effects of offender concentrations

Table 3 shows that the concentration of recently active prior offenders was associated with both the number of local property and violent crimes committed by resident offenders in the subsequent quarter. An increase of one in the concentration of recently active prior offenders in a neighbourhood was associated with an approximate 2 percent increase in the following quarter's local property and violent crime rates, as committed by offenders residing within the neighbourhood (coefficients of 0.020 and 0.022, respectively). The concentration of recently inactive prior offenders was not associated with the number of local property crimes subsequently committed, and had only a small effect on the number of local violent crimes committed, thus answering our fourth research question, i.e. recently active offenders have a greater effect than recently inactive offenders.

Table 4 shows the results of our modelling of non-local (outside the neighbourhood) crimes. Once again, we see that the concentration of recently active prior offenders is associated with the number of non-local property and violent crimes committed by resident offenders, with similar sized effects as for local crimes. An increase of one in the concentration of recently active prior offenders is associated with approximately a 2 percent increase in the subsequent quarter's non-local property and violent crime rates, as committed by resident offenders (coefficients of 0.021 and 0.20, respectively). The concentration of recently inactive prior offenders also had a statistically significant relationship with the rate of non-local property and violent crime rates, though the effects were much smaller than for recently active offenders (coefficients of 0.004 and 0.002, respectively).[3]

Socio-demographic factors

The level of income deprivation in a neighbourhood bears a positive association with the number of local and non-local crimes (both property and violent crimes) committed by resident offenders. The effect is similar in all models: a one percentage point increase in neighbourhood income deprivation is associated with an increase in the number of subsequent crimes of each type committed per resident offender of between 1.6 and 2.0 percent (Tables 3 and 4).

Resident males have a stronger association with crime than females, with two relationships in particular standing out. The number of teenage males is associated with all four types of crimes: a one percentage point increase in resident males aged 13-15 is associated with a ten percent increase in the number of local property and violent crimes committed by offenders (coefficients of 0.116 and 0.094, respectively), and with smaller increases in non-local property and violent crimes subsequently committed (coefficients of 0.056 and 0.037, respectively). The number of resident males aged 65 or over is similarly associated with local and non-local property crimes committed by offenders (coefficients 0.136 and 0.038 respectively). Resident females were not associated with the number of local crimes, but the number of young female adults aged 16-19 and 20-24 was associated with the number of non-local property crimes: a one percentage point increase in the number of such resident females was associated with a 3 percent increase in non-local property crimes (coefficients of 0.027 and 0.035, respectively). The interpretation of these socio-demographic covariates is problematic due to the ecological fallacy, since they may reflect characteristics of the resident offender or non-offender populations.

Discussion

This paper is concerned with the effects of offender concentrations on reoffending behaviour. Its key findings are that: (1) offenders are spatially concentrated; (2) this concentration is positively

associated with the number of property and violent crimes that resident offenders subsequently commit both inside and outside of their neighbourhood; (3) the effects of offender concentrations are similar for both property and violent crimes; (4) recently active offenders have a greater effect in these respects than offenders who have not been active during the previous three months; and (5) a higher proportion of violent crimes are committed within the neighbourhood compared with property crimes, where a higher proportion are committed non-locally, irrespective of offender concentrations. In all this, we consider it to be a strength not a weakness that our data is based on police assessments that offences have been committed rather than on convictions, which are the product of a criminal justice system.

Our findings for active offenders, though of greater magnitude, are in accord with recent research on the effects of parolee concentrations upon rates of recidivism (Chamberlain and Wallace 2015) and on neighbourhood crime rates (Hipp and Yates 2009), and similar to cross-sectional findings from The Netherlands for a social interaction effect of offender concentrations on offending by neighbourhood residents (Bernasco et al 2017). However, our use of panel data over a ten year period, with a temporal lag structure and fixed-effects specification, provides stronger evidence that causal social processes among neighbouring offenders are operative, not reflection or selection effects.

With regard to location, our evidence does not appear to exemplify the operation of anchor points within criminals' home areas (Bernasco and Block 2011), insofar as we found the vast majority of crime committed by offenders to occur outside their own neighbourhood. Although it could be argued that the greater opportunity space that lies outside the offenders' own neighbourhoods might indicate a bias towards their home areas, we do not think this is the case, and it would need knowledge of the offenders' awareness space in order to be proven. Our information on offenders' whereabouts is static rather than dynamic. Since we do not know how much time offenders spend

at home versus staying with friends or relatives elsewhere, there is a degree of uncertainty about the identification of someone's home neighbourhood, although the assumption that a registered address is meaningful is reasonable.

The bias towards crime outside the neighbourhood was much stronger for property crime than violent crime, albeit that we can be less certain that this is true for low level property damage, where fewer offenders are identified by the police. Nevertheless, the finding raises the possibility that violent crime is more closely associated with local anchor points. Within Glasgow, violence (particularly youth violence) has been found to stem from cultural and sociological inheritance within families and communities, with violent attitudes and behaviours being adopted for belonging and identity reasons (Bannister et al 2013). To be certain about the role of anchor points in violent crime, we would have to study the location of violent crimes more closely, and examine the relationship between perpetrators and victims. Our findings would support the claim that distance decay (Rengert et al 1999) operates more strongly in relation to violent than property crime. Furthermore, there is a question of whether 'non-local' crimes are committed in adjacent neighbourhoods (Hirschfield et al 2014); this type of issue is very pertinent in deprived, post-industrial cities like Glasgow where clusters of deprived neighbourhoods exist.

Social theories of crime posit that offender concentrations will raise the local crime rate for example due to social learning about criminal norms and values (Hipp and Yates 2009), socialisation process that transmit attitudes and behavioural expectations (Megens and Weerman 2012), or due to weakening perceptions of deterrence (Clear 2007). We have further refined past analyses by showing that the number of crimes committed by a defined group of resident offenders is positively associated with the *concentration* of resident offenders. That we found no difference in the effects of offender concentrations between property and violent crime rates raises questions about whether shared intelligence, peer influence and co-offending (McGloin and Stickle 2011) operate

evenly across these different crime types.   Had we been able to examine co-offending rates, particularly by crime type, we might have been able to provide some insights on this issue.

The positive effect of resident offender concentrations upon offending rates could also be the result of co-offending, i.e., committing more crimes together with neighbours than would otherwise be the case for an isolated offender. Alternatively, it might be due to the sharing of information, skills and resources among criminal networks that aids the committing of crimes without actually involving co-offending (McCarthy et al 1998). The fact that we did not find any non-linear effects (when testing quadratic functional forms) in the relationships between offender concentrations and the number of crimes offenders committed suggests that if collaboration of either sort increasingly occurs as offender concentrations in neighbourhoods increase, that collaboration does not appear to produce exponential gains in criminal productivity among existing offenders, at least not within the range of offender concentrations studied here (up to 30 percent). It is worth noting that, at lower offender concentrations, evidence of social multiplier effects similarly was not found in the Netherlands (Bernasco et al 2017). In these terms, further theoretical and empirical consideration of whether different levels of offender concentration have different effects on the crime rate is required, and again were this to include measurement of co-offending, the potential insights would be greater.

If peer pressure from criminals upon others plays a role, it has been argued that this is a stronger factor for adolescents than adults (Warr 2002). In all our models, we found that the male population aged 13-15 years old was associated with higher crime rates, though we cannot tell if this group are perpetrators or victims. However, the rate of criminal convictions for younger males in Scotland has been falling faster than for other groups, possibly indicating a weakening of peer pressure effects (Scottish Government 2013). The highest conviction rate for males in Scotland is currently in the 21-30 age group (*op. cit.*), consistent with the effect we found for resident males aged 25-29 for non-

local property crime, and potentially reflective of the operation of criminal associational networks, although co-offending practices among co-resident offenders has yet to be studied in Scotland.

A third set of explanations for offender concentration effects is the negative impact offenders may have upon informal social control within a community (Rose and Clear 1998; Hipp and Yates 2009). However, these theories imply that at some point the number of resident offenders will come to overwhelm the forces of control within a neighbourhood. Yet, we did not find any non-linear or threshold effects, suggesting that the idea of offending breaching a barrier of informal curtailment does not operate in Glasgow's neighbourhoods.

We should not lose sight, however, of the potential interplay between offender concentrations and mechanisms of control. With regard to informal social control, we found some factors pertaining to social disorganisation theory to be important (Sampson and Groves 1989). We found that the number of teenage males living in a neighbourhood had a ten-fold impact on the number of local property and violent crimes committed by resident offenders. This may reflect their involvement in crime and antisocial behaviour as well as issues of social control. Furthermore, the rate of lone parent households was higher in those neighbourhoods with higher offender densities, reaching nearly twice the city average in those neighbourhoods with the highest offender densities. In our models for non-local property crime, the percentage of females in their teens and twenties living in the area had a positive association with the rate of crimes committed by offenders. In all these cases, it is possible that the size of the effects on offending of vulnerable groups such as teenagers, young adults and lone parents might be attenuated to some degree were we able to measure residential turnover in neighbourhoods with higher numbers of such younger residents.

Although we do not know how many of these young adult females are lone parents, our results are consistent with earlier findings from Glasgow and elsewhere associating lone parents with crime

rates (Bernasco et al 2017; Livingston et al 2014a; Hipp 2007; Rountree and Warner 1999). These findings are suggestive of the role that weak informal social control may play in enabling those involved in crime to continue their activity. Our findings also suggest that the important role of lone parents is in respect of their relationship with the number of offenders in an area, and their ability to exercise influence and control over adolescent deviance (Dornbusch et al 1985) rather than in respect of their effectiveness as 'social guardians' of criminal targets such as property (Tseloni et al 2004). It is worth noting that as well as having the highest crime rates in Scotland, Glasgow also has the highest rate of lone parent households, at one-and-a-half times the national average.[6] Further, young adult females may also have a direct impact upon crime rates: the peak age group for female convictions in Scotland has been aged 26-30 for the past five years, which is consistent with the effects found in our models (Scottish Government 2013).

At the other end of the age spectrum, our finding that the number of resident males of retirement age (65+) is associated with substantial increases in the number of local and non-local property crimes committed by offenders is also interesting. One thing we cannot rule out since we are unable to measure it, is the extent to which older residents include long-term or historic offenders. But it is generally understood that the elderly are more likely to be victims of property than violent crime (Lindesay 1996), so our findings may reflect risk and victimisation. However, we might also have expected the elderly population to act as a 'brake' on offending by younger local residents, through their role as grandparent guardians and mentors. However, recent American evidence has indicated that in situations where one or more parent is absent, grandparents often report an inability or unwillingness to supervise their grandchildren, so that youth in grandparent-headed households are at greater risk of re-offending (Campbell et al 2006). Thus, our findings may reflect an informal social control issue as well.

Policy implications

There are two main areas of policy implications arising from our findings. The first concerns the (re)location of offenders. The absence of evidence for non-linear effects in our results means that a deconcentration of offenders cannot be justified on grounds of net social gain (Galster 2002; 2007); the linear relationships indicate that the gain (lower crime) in neighbourhoods with lowered offender concentrations would be offset by the loss (higher crime) in neighbourhoods with higher offender concentrations. However, there is a case for more dispersal of offenders on social equity grounds, so that no longer is it only a minority of communities that experience the negative effects of offender concentrations on increased crime rates both locally and elsewhere, albeit often not far away since "distance does matter" in criminal behaviour (Rengert et al 1999, p.439).

This has implications for the operation of the private housing market, but more particularly for the distribution of social housing, where higher numbers of offenders live. Social housing in the UK is predominantly the preserve of low-income groups, and thus the dispersal and dilution of offender concentrations depends in large part upon housing and planning policies that result in the diversification of social housing estates, and the wider provision of social housing across a city's neighbourhoods. Recent evidence from Atlanta and Chicago indicates that it is possible to get a net citywide reduction in crime from a deconcentration of social housing residents brought about by changing a number of factors in the origin locations at the same time as dispersing low-income groups (Popkin et al. 2012). Similarly, previous research in Glasgow found the effects of housing tenure mixing upon crime rates in advantaged neighbourhoods to be small, and that the greater potential of tenure mixing to reducing crime may come via its contribution to reducing area deprivation in the most disadvantaged (origin) areas (Livingston et al 2014b).

The second area of policy implications, and the more feasible in political and practical terms, lies in finding ways to intervene to reduce or preclude the co-offending and peer influence that contribute to more crime as offenders concentrate. In considering this, interventions may need to identify and

distinguish between chronic and non-chronic or 'transient' offenders (McGloin and Stickle 2011)

within areas of offender concentration. If chronic offenders are engaging in collaborative crime

primarily because it presents more opportunities through sharing of crime targets, tasks and joint

enterprises (McAndrew 2000), this would suggest that more traditional intelligence-led policing to

combat criminal endeavours may be appropriate. On the other hand, if transient offenders are

motivated to engage in offending/co-offending more by peer pressure and the influence of large

groups (Warr 2002), then non-traditional approaches that help shape individuals' personal choices

and development to prevent criminal and group involvement becomes more relevant. This may

apply, for example, to the teenagers we found influential upon the crime rate; there are youth

diversionary programmes in operation in Glasgow but they are only temporarily funded, and while

mixing offenders with non-offenders is found to be beneficial, not all the programmes target known

offenders (Aston et al 2010).

Conclusion

For the first time, we have shown that offender concentrations have robust positive linear effects

upon the rates at which co-resident offenders commit crimes, both locally and non-locally.[7] To

comprehend the effects of offender concentrations in space, we need to understand better who the

offenders are, what crimes they are involved in committing, how they commit those crimes with or

without others, and what stage they are at in their criminal careers. Whilst Hollis-Peel et al (2011)

argue for more research on the relationships between guardianship and physical and public space,

we would argue that the relations between offender concentrations, guardianship and social space

are equally worthy of attention.

In policy terms, the fact that offender concentrations have been found to have effects upon crime

rates both locally and elsewhere, suggests twin approaches to combating this. First, 'responsible

relocation' motivated by social equity (Popkin et al 2012) should make structural changes in areas of

offender concentration (especially in social housing) alongside relocation of some offenders where

they are most concentrated. Second, a combination of traditional and non-traditional policing and

prevention approaches should intervene with chronic and transient offenders in distinct ways.

Notes

1. Peer influence is taken to be more important for non-chronic offenders (McGloin and Stickle (2011) and late-starting offenders (Patterson 1995).
2. This is standard procedure in the recent criminological literature; see e.g. Hipp and Yates (2009) and Raleigh and Galster (2014).
3. We also tested for non-linear relationships by adding the quadratic terms for the key offender concentration variables to all models. No substantively important relationships were found.
4. http://www.understandingglasgow.com/indicators/population/households/projections
5. Our findings from longitudinal analysis of panel neighbourhood data are strongly indicative of the operation of causal processes and an endogenous neighbourhood effect, but do not rule out the possibility that contextual effects are also at play (Manski 1993).

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Figure 1 Distribution of Neighbourhoods by Offender Concentrations, Glasgow 2008/9
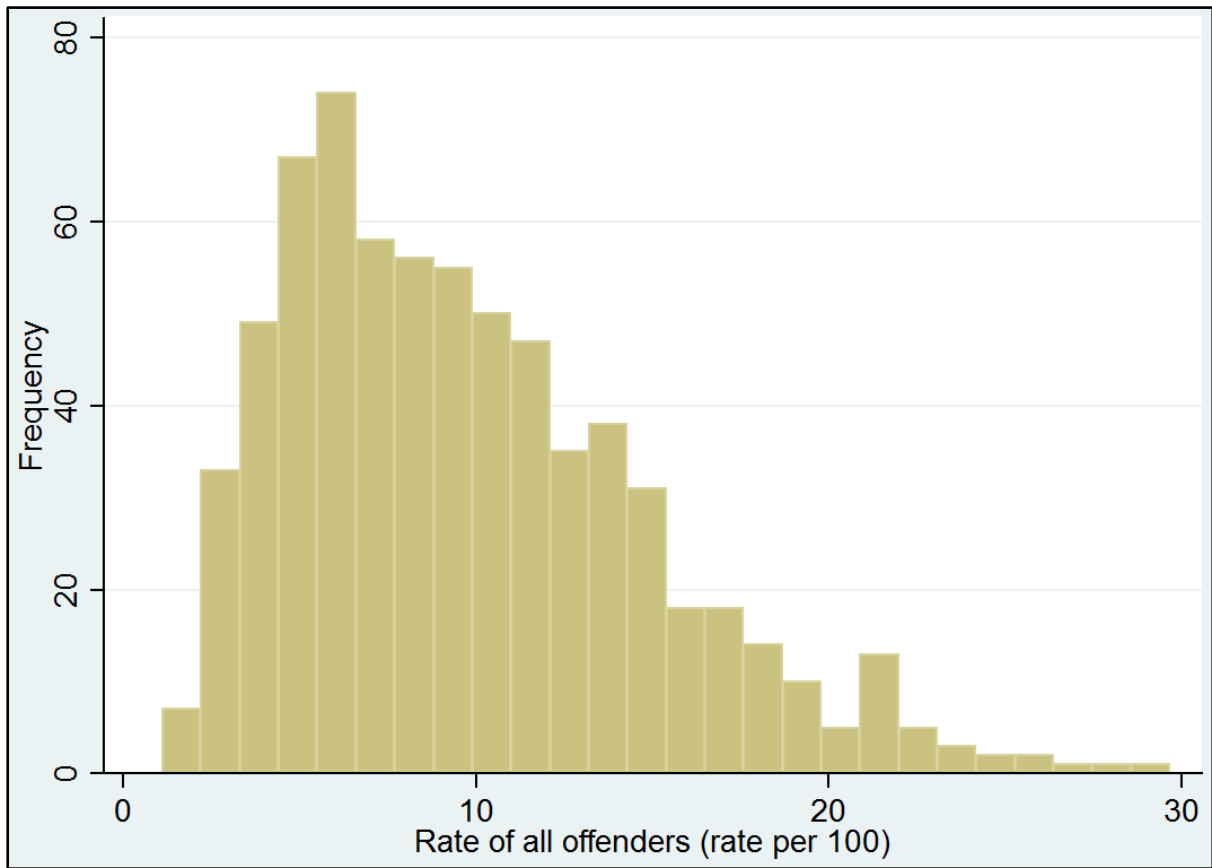
Table 1 Variables Used in the Modelling of Offender Concentration Effects

Variables	Mean	SD
Dependent Variables*:		
Number of Local Property Crimes per datazone per quarter	0.19	0.71
Number of Local Violent Crimes per datazone per quarter	0.30	0.85
Number of Non-Local Property Crimes per datazone per quarter	1.58	3.02
Number of Non-Local Violent Crimes per datazone per quarter	1.13	1.80
Independent Variables:		
% of recently inactive prior offenders in nhd.	7.45	3.80
% of recently active prior offenders in nhd.	1.71	1.12
% of pop in male age 13-15	1.82	0.93
% of pop in male age 16-19	2.68	1.33
% of pop in male age 20-24	4.04	2.56
% of pop in male age 25-29	3.99	2.46
% of pop in male age 30-64	21.76	3.95
% of pop in male age 65+	5.81	2.86
% of pop in female age 13-15	6.97	2.60
% of pop in female age 16-19	1.74	0.87
% of pop in female age 20-24	2.69	1.57
% of pop in female age 25-29	4.38	3.14
% of pop in female age 30-64	4.18	2.32
% of pop in male age 65+	23.16	3.41
% Income deprivation in population	26.91	15.64
Years and quarter dummies	N/A	N/A
Fixed effects: dummies for each datazone	N/A	N/A
Spatial Lags:		
Property Crime spatial lag variable (during quarter)	8.97	5.34
Violent Crime spatial lag variable (during quarter)	7.91	4.13

* Crimes committed by prior offenders living within the datazone.

Table 2 Number of Local and Non-Local Crimes in Years 2000/1 and 2007/8 by Datazone

	Crimes	2000/1		2007/8	
		Violent	Property	Violent	Property
Local Crimes	Total Crimes per year	2261	1291	2806	1080
	Crimes per Datazone:				
	Mean per year	3.3	1.9	4.0	1.6
	Min	0	0	0	0
	Max	22	30	29	28
Non-Local Crimes	Total Crimes	7945	10910	8186	9332
	Crimes per Datazone:				
	Mean per year	11.5	15.7	11.8	11.5
	Min	0	0	0	0
	Max	51	161	69	88
%Datazones: local crimes > non-local crimes		4.9%	1.15%	6.5%	1.4%
%Datazones: non-local crimes > local crimes		89.3%	95.5%	87.0%	94.8%

Table 3   Linear Negative Binomial Models of Offender Densities and Rates of Crime Committed within the Neighbourhood by Resident Offenders

Independent Variable	Coef.	Sig. $P>|z|$	Std.Err.
Property Crime:			
Average property crime rate in adjacent areas (spatial lag)	**0.012**	**0.043**	**0.006**
Concentration of recently inactive prior offenders in nhd.	0.002	0.079	0.001
Concentration of recently active prior offenders in nhd.	**0.020**	**0.000**	**0.003**
Percent income deprived	**0.017**	**0.000**	**0.003**
(Ref: male 0-12):			
Males aged 13-15	**0.112**	**0.002**	**0.035**
Males aged 65 or over	**0.136**	**0.000**	**0.029**
Violent Crime:			
Average violent crime rate in adjacent areas (spatial lag)	0.012	0.069	0.007
Concentration of recently inactive prior offenders in nhd.	**0.002**	**0.033**	**0.001**
Concentration of recently active prior offenders in nhd.	**0.022**	**0.000**	**0.003**
Percent income deprived	**0.018**	**0.000**	**0.003**
(Ref: male 0-12):			
Males aged 13-15	**0.094**	**0.001**	**0.031**
N (datazone quarters)	(24,948)		

Non-significant age-sex group variables, datazone fixed effects, and all quarter dummy variables not shown.

Table 4   Linear Negative Binomial Models of Offender Densities and Rates of Crime
Committed Outside the Neighbourhood by Resident Offenders

Independent Variable	Coef.	Sig. $P>\|z\|$	Std.Err.
Property Crime:			
Average property crime rate in adjacent areas (spatial lag)	0.003	0.286	0.003
Concentration of recently inactive prior offenders in nhd.	**0.004**	**0.000**	**0.001**
Concentration of recently active prior offenders in nhd.	**0.021**	**0.000**	**0.001**
Percent income deprived	**0.020**	**0.000**	**0.001**
(Ref: male 0-12):			
Males aged 13-15	**0.056**	**0.000**	**0.016**
Males aged 25-29	**0.038**	**0.000**	**0.009**
Males aged 30-64	**0.012**	**0.024**	**0.005**
Males aged 65 or over	**0.038**	**0.002**	**0.012**
(Ref: female 0-12):			
Females aged 16-19	**0.027**	**0.016**	**0.011**
Females aged 20-24	**0.035**	**0.000**	**0.009**
Violent Crime:			
Average violent crime rate in adjacent areas (spatial lag)	**0.008**	**0.026**	**0.004**
Concentration of recently inactive prior offenders in nhd.	**0.002**	**0.000**	**0.001**
Concentration of recently active prior offenders in nhd.	**0.020**	**0.000**	**0.001**
Percent income deprived	**0.017**	**0.000**	**0.002**
(Ref: male 0-12):			
Males aged 13-15	**0.037**	**0.024**	**0.016**
N (datazone quarters)	(24,948)		

Non-significant age-sex group variables, datazone fixed effects and all quarter dummy variables not shown.