**Spatial Scales**

# Introduction

larger geographic units such as states (Loftin and Hill, 1974), cities (Baumer et al., 1998) and neighborhoods (Bursik and Grasmick, 1993; Sampson, 1985). Recently, however, criminologists have begun to explore other units of analysis that may contribute to our understanding of the crime equation. An important catalyst for this work came from theoretical perspectives that emphasized the context of crime and the opportunities presented to potential offenders (Weisburd, 2002). In a groundbreaking article on routine activities and crime, for example, Cohen and Felson (1979) suggest the importance of recognizing that the availability of suitable crime targets and the presence or absence of capable guardians influence crime events. Researchers at the British Home Office in a series of studies examining “situational crime prevention” also challenged the traditional focus on offenders and communities (Clarke and Cornish, 1983). These studies showed that crime situations and opportunities play significant roles in the development of crime (Clarke, 1983). One implication of these emerging perspectives is that micro crime places are an important focus of inquiry (Eck and Weisburd, 1995; Sampson and Groves, 1989; Taylor, 1997). While concern with the relationship between crime and place goes back to the founding generations of modern criminology (Guerry, 1833; Quetelet, 1842), the “micro’? approach to places suggested by recent theories has just begun to be examined by criminologists.’ Places in this “micro” context are specific locations within the larger social environments of communities and neighborhoods (Eck and Weisburd, 1995). They are sometimes defined as buildings or addresses (see Green, 1996; Sherman et al., 1989), sometimes as block faces or street segments (see Sherman and Weisburd, 1995; Taylor, 1997), and sometimes as clusters of addresses, block faces or street segments (see Block et al., 1995; Weisburd and Green, 1995). Research in this area began with attempts to identify the relationship between specific aspects of urban design (Jeffrey, 1971) or urban architecture (Newman, 1972) and crime, but broadened to take into account a much larger set of characteristics of physical space and criminal opportunity (see Brantingham and Brantingham, 1975, 1981; Duffala, 1976; Hunter, 1988; LeBeau, 1987; Mayhew et al., 1976; Rengert, 1980,1981).(Weisburd et al., 2004)

We think that the use of a micro place level of analysis has allowed us to examine crime trends at places with greater precision (Weisburd et al., 2004)

These observations are of course preliminary given the nature of our data. Our more general findings must be subjected to examination in other contexts and across other micro place units (for example, see Griffiths and Chavez, 2004). To understand the etiology of crime trajectories at micro places we also need more insight into the nature of such places and their experiences across the periods of study. Nonetheless, our examination of trajectories of crime at micro places over time suggests the importance of a developmental, criminal career perspective in the study of micro crime places (Sherman, 1995; Weisburd, 1997). (Weisburd et al., 2004)

Overall, Weisburd et al. (2004) confirmed prior research showing that criminal activity is clustered. Further, it demonstrated that micro places evidenced a high degree of stability over time and that this stability was shown for both street segments with low rates of crime and street segments with high rates of crime. All three cluster groups of stable, increasing and decreasing street segments were found across the city’s landscape, emphasizing the importance of studying criminal activity at a more micro level strategy (Curman et al., 2015).

Focusing on the ‘where’ and when’ of criminal behaviour has been termed the ‘criminology of place’ (Sherman et al. 1989) and revealed that criminal activity, when viewed from a place perspective, is highly patterned and predictable (Brantingham and Brantingham 1991). (Curman et al., 2015)

The understanding of these patterns is relative to the spatial scale of analysis. As shown

by Brantingham et al. (1976), when the ‘‘cone of resolution’’ changes so may the observed patterns. The pattern changes occur, at least in part, because of the spatial heterogeneity within areal units. This is one of the reasons why there has been a trajectory of ever smaller units of analysis in spatial criminology (Weisburd et al. 2009). Generally speaking, research has shown that studies focussing on larger geographic areas mask important micro level variation in criminal activity (Groff et al. 2010) and may lead to inaccurate con- clusions about crime at the individual level, the ecological fallacy (Robinson 1950) (Curman et al., 2015)

Over the last 40 years, the question of how crime varies across places has gotten greater attention. At the same time, as data and computing power have increased, the definition of a ‘place’ has shifted farther down the geographic cone of resolution. This has led many researchers to consider places as small as single addresses, group of addresses, face blocks or street blocks. Both cross-sectional and longitudinal studies of the spatial distribution of crime have consistently found crime is strongly concentrated at a small group of ‘micro’ places. Recent longitudinal studies have also revealed crime con- centration across micro places is relatively stable over time. A major question that has not been answered in prior research is the degree of block to block variability at this local ‘micro’ level for all crime (Groff et al., 2010).

Scholars have long been interested in how crime varies over space and the topic has received increasing attention over the last 40 years.1 Seminal studies examining crime across larger geographic units such as states (Guerry 1833; Loftin and Hill 1974; Quetelet 1831[1984]), cities (Baumer et al. 1998), and even neighborhoods (Boggs 1965; Bursik and Grasmick 1993; Bursik and Webb 1982; Byrne and Sampson 1986; Chilton 1964; Kornhouser 1978; Reiss and Tonry 1986; Schuerman and Kobrin 1986; Skogan 1986; Stark 1987) establish the foundation for the continuing interest. More recent studies point to the potential theoretical and practical benefits of focusing research on micro crime places (Eck and Weisburd 1995; Sherman 1995; Sherman and Weisburd 1995; Taylor 1997; Weisburd 2002). Cross-sectional micro level studies suggest that significant clus- tering of crime at place exists, regardless of the specific micro unit of analysis defined (Brantingham and Brantingham 1999; Crow and Bull 1975; Groff and LaVigne 2001; Pierce et al. 1986; Potchak et al. 2002; Roncek 2000; Sherman et al. 1989; Weisburd and Green 1994; Weisburd et al. 1992). Longitudinal work examining the developmental trajectories at micro levels (Weisburd et al. 2004a, 2009b) has consistently identified tremendous crime concentration at specific places. These micro level findings provide evidence of significant intra-neighborhood variance in crime that is lost when neighbor- hoods are examined as homogenous units (Groff et al., 2010).

In other words, ‘bad neighborhoods’ may contain ‘good streets’ and ‘good neighborhoods’ may be home to ‘bad streets’. As a whole, these studies point toward the existence of bad places in good neighborhoods as well as good places in bad neighborhoods. Our research takes the next step and provides a direct, quantitative examination of that question (Groff et al., 2010).

The concentration and stability of micro crime places suggest they are an important unit of study for understanding crime at place. But those characteristics do not put to rest a key concern in assessing the importance of such small geographic units in the crime equation. If the focus on micro places adds to our study of crime, then it should represent a type of ‘reductionism’; the understanding of small parts will lead to an explanation of the whole which is not provided by higher units of analysis. While prior studies have shown that crime is concentrated at micro units of analysis, they have not examined whether this variability is distinct from what would be observed had they focused on higher geographic units such as communities or neighborhoods. For example, do macro level studies simply mask concentrations of crime that are found in high crime communities? More specifically, is there street to street variability in crime trends at micro places, or do examinations of micro crime places simply divide up larger area trends? The answers to these questions have implications for both theory and crime prevention policy. If geographically proximal street segments have the same or similar temporal crime patterns, it would suggest there is no need for micro-level examination of places. It would also provide support for neighborhood-level crime prevention initiatives rather than micro level ones. If, however, street segments of the same trajectory are spread throughout the city and/or street segments spatially adjacent to one another vary in their temporal crime pattern, then further examination of micro level patterns is supported. In this case, more narrowly focused efforts on individual street segments may provide more crime prevention impact. Our focus in this study is on providing more comprehensive evidence of the variation in crime across micro level places (Groff et al., 2010).

Given the above, our work would propose the importance of recognizing commonalities

among micro level places that stem from consistency in the built environment. However, while our data suggest the importance of recognizing crime trends at micro places, they do not necessarily reinforce the importance of community level influences. This is especially the case in our finding of clustering of similar trajectories in certain areas. For example, the clustering of chronic segments near one another may reflect important similarities in social and built environment characteristics. In this context it would be the street segment characteristics that are important to understanding the concentration in crime at place (Groff et al., 2010).

Criminological evidence on the spatial concentration of crime suggests that a small number of highly active micro places in cities—frequently called ‘‘hot spots’’—may be primarily responsible for overall citywide crime trends (Sherman, Gartin, and Buerger 1989; Weisburd et al. 2004). In fact, roughly 8 percent of street segments and intersections in Boston are responsible for nearly 66 percent of street robbery incidents between 1980 and 2008 even when controlling for prior levels of robbery and existing trends. Using the same controls, slightly more than 1 percent of street seg- ments and intersections in Boston are responsible for nearly 50 percent of commercial robbery incidents between 1980 and 2008. (Braga et al., 2011).

However, due to limited analytical capacities, little empirical research has examined this variance beyond the community or neighbor- hood level of analysis, with the most common units of analysis for research being the census tract or block group. With the advent ofpowerful computer systems and software packages in the late 1980s, analysts began to further hone their focus on even smaller geographic units of analysis. In Minnea- polis, a well-known cross-sectional study found that some 5 percent of city addresses and intersections generated over 50 percent of citizen calls for service to the police (Sherman et al. 1989) (Braga et al., 2011).

Even within high-crime neigh- borhoods, these studies found that crime clusters at a few discrete ‘‘hot spot’’ micro places, leaving blocks of areas within these neighborhoods relatively crime-free. Put another way, not every block or corner in high-crime neighborhoods experience high levels of crime and violence. Rather, certain blocks or addresses experience high levels of crime and violence, while others experience comparatively little. Furthermore, research by Taylor and Gottfredson (1986) linked this spatial variation to the physical and social characteristics of particular blocks and multiple dwellings within a neighborhood (Braga et al., 2011).

In other words, crime remained concentrated in a small number of micro places in Seattle rather than spread across the city over time. Weisburd et al. (2004) also found that a relatively small proportion of places belonged to groups with steeply rising and or declining trajectories and that these places were primarily responsible for overall crime trends in Seattle between 1989 and 2002. In a similar longitudinal analysis, Braga, Papachristos, and Hureau (2010) found that 74 percent ofgun assault incidents remained concentrated in only 5 per- cent of street segments and intersections in Boston between 1980 and 2008 (Braga et al., 2011).

Certain high-risk facilities, such as bars, conveni- ence stores, and banks, at particular places also tend to experience a disproportionate amount of robbery (Clarke and Eck 2007). For instance, Sherman, Gartin, and Buerger (1989) reported that all robbery calls for service to the police were generated by just 2.2 percent ofaddresses and inter- sections in Minneapolis. Further analysis (summarized in Sherman 1995) found that 90 percent of robbery hot spots were found on a mere 8 streets in Minneapolis, which were the busiest boulevards and also had the most bars in the city. In fact, the most violent bar in Minneapolis had a robbery call rate of83 per 1,000 persons (based on a daily population ofno more than 300 peo- ple), which was seven times higher than the call rate of12 per 1,000 persons for for the city’s entire 1986 estimated population of 362,000 (Braga et al., 2011).

Our analyses suggest that city-level robbery trends may best be understood by the analyses of trends at a very small number of micro places, such as street segments and intersections, rather than analyses of trends at larger areal units such as neighborhoods, arbitrarily defined policing districts, or Census tracts. These levels of aggregation may obscure important place-based dynamics that vary within larger geographic boundaries. Supporting the findings ofWeisburd et al. (2004) in Seattle, our findings sug- gest that the strong robbery decline in Boston and many other American cities during the 1990s can be understood not as a general process that occurred across city landscapes but one that was generated in a relatively small group of urban micro places with strong declining robbery trajectories over time (Braga et al., 2011).

Despite our growing understanding of the processes that may underlie property crime reductions, there have been relatively few investigations of the changing spatial crime patterns associated with falling crime in general, and property crime and burglary in particular. As such, it remains unclear to what extent a global burglary reduction is a widespread spatial process that manifests itself across many micro places, or instead a spatially concentrated process limited to sharp reductions in burglary in just a few micro crime concentrations. Identi- fying changing micro-spatial patterns of crime is a first step towards a better understanding of the mechanics behind a drop in any particular crime (Farrell et al. 2014), because the causal processes behind a widespread reduction in crime across micro places may be entirely different from those behind a crime drop that is concentrated in a small number of places (see, e.g., Fujita and Maxfield 2012; Mielke and Zahran 2012) (Vandeviver & Steenbeek, 2019).

Despite overall reductions in crime, crime is strongly concentrated in a few micro places and crime concentrations are stable over time (Andresen et al. 2017; Andresen and Mal- leson 2011; Curman et al. 2015; Hodgkinson et al. 2016; Weisburd et al. 2004; Wheeler et al. 2016). There are less consistent findings, however, about the spatial patterns of crime concentration. Some authors suggest that strong reductions in relatively few micro-places are responsible for the overall crime drop (Andresen et al. 2017; Groff et al. 2010; Weisburd et al. 2004), whereas others find evidence of a more widespread phenomenon, with many places experiencing relatively similar crime reductions (Andresen and Malleson 2011; Curman et al. 2015; Hodgkinson et al. 2016; Wheeler et al. 2016) (Vandeviver & Steenbeek, 2019).

First, in most previous studies, scholars have examined offender location choice at the area level (for the exceptions, see Bernasco, 2010b, and Vandeviver et al., 2015). Here, consistent with contemporary theory (Weisburd, Groff, and Yang, 2012) and the research questions at hand, we do so at the street segment level (Frith et al., 2017).

The second undisputed observation about crime locations is that crime is geographically concentrated at and around crime generators, micro-places where many people converge on a regular basis to pursue similar or complementary activities (Brantingham and Brantingham 1995). Crime generators include transit stations, shopping centers, schools, sports venues, entertainment areas and other types of facilities. Crime genera- tors produce crime for two reasons. First, because they are popular destinations for many legal activities, they are known to a large proportion of the population, including poten- tial offenders. They are an element of their activity space. Second, these micro-places often provide specific opportunities for crime, especially when they are being visited by large crowds of people. For example, shops provide opportunities for shoplifters, distracted passengers at subway stations are easy targets for pickpockets, and intoxi- cated patrons leaving bars are vulnerable for robbery (Bernasco and Block 2011). In sum, crime generators produce crime because they are widely known and because they provide abundant opportunities. Empirical evidence thus demonstrates that offenders generally commit crimes around busy places located within at most a few miles from their homes, depending on the crime type, the size of the city and the convenience of available transportation (Song et al., 2019)

Several dec- ades later, research documenting the non-random distribution of crime across smaller units (e.g., Sherman et al. 1989)—such as addresses, intersections, and street blocks— prompted scholars to draw upon environmental criminological theories to identify the characteristics of microgeographic places that create criminal opportunity by shaping potential offenders’ perceived risks, efforts, and rewards of crime (Brantingham and Brantingham 1999; Eck and Weisburd 1995; Felson 1987). Though these perspectives represent distinct traditions, they are implicitly compatible. For example, while envi- ronmental criminologists focus on crime patterns at micro-spatial units of analysis, they also often recognize the underlying importance of the broader locale in which micro-places are situated—the “backcloth,” so to speak (e.g., Brantingham and Brant- ingham 1993). (Skubak et al., 2020)

The findings reported here largely support the PIN propositions that particular place types do not generate crime similarly across varying neighborhood contexts. Rather, the crimi- nogenic nature of micro-places appears to be exacerbated in neighborhoods with exten- sive criminal opportunity and tempered in neighborhoods with less criminal opportunity. Beyond direct support for PIN propositions regarding cross-level interactions (Wilcox and Tillyer 2018), such findings comport with various lines of inquiry upon which such PIN propositions were built, all of which present a nuanced view of the crime-generating poten- tial of particular place types. Such lines of inquiry include: (1) theoretical work that empha- sizes that crime hot spots form at the intersection of various “layers”—where, for example, busy place types sit near major transportation routes within disadvantaged or commercially dense areas (Brantingham and Brantingham 1999); (2) literature that underscores the mul- tilevel nature of offenders’ search for crime targets, with targets embedded within variable opportunity contexts (Brantingham and Brantingham 2013; Clarke and Cornish 1985); (3) empirical research that highlights the multilevel nature of indicators of opportunity for criminal victimization (Miethe and Meier 1994; Sampson and Wooldredge 1987; Wilcox et al. 2007; Wilcox Rountree et al. 1994); and (4) the scant yet growing research suggesting that characteristics of micro-places interact with broader neighborhood-level indicators of opportunity in the production of crime incidents (Contreras and Hipp 2019; Deryol et al. 2016; Jones and Pridemore 2019). Overall, then, the present study challenges a surprisingly common refrain within environmental criminology literature—to focus on micro-place units as opposed to broader neighborhood influences or to treat place and neighborhood units as competitors in the search for determining “where the action is” when it comes to the spatial distribution of crime (Steenbeek and Weisburd 2016; see also Groff et al. 2010; Schnell et al. 2017; Weisburd et al. 2012). Such a “micro versus macro” approach has been valuable in drawing attention to the long-ignored pronounced clustering of crime at small-scale places, often for the admirable purpose of guiding efficient use of scarce crime prevention and policing resources (e.g., Telep and Weisburd 2012). However, we believe that imploring a micro- spatial focus (rather than a macro-spatial one) is no longer necessary, as the field of crimi- nology has embraced the reality of micro-spatial hotspots and situational approaches to understanding and preventing crime. Thus, a particularly fruitful direction moving forward would be to progress from the discourse of “micro versus macro” toward one with a focus on better understanding “micro within macro.” Neighborhood characteristics may explain, directly speaking, less overall variation in crime incidents than small-scale units such as street blocks. Yet, the offender decision-making models upon which environmental crimi- nology is built recognizes that determinations of effort, risk, and reward involve considera- tion of multiple, embedded spatial units, including neighborhoods. Further, PIN proposi- tions and related empirical work—including the findings reported here—suggest specific ways in which neighborhood characteristics work in conjunction (statistically) with charac- teristics of small-scale units in the co-production of crime. Taking a “micro within macro” approach may be useful in understanding what Eck (2002 p. 95) refers to as the “context sensitivity” of crime prevention strategies, or “the variation in effectiveness caused by implementing the same intervention in different social, temporal and physical settings.” In other words, place-based interventions aimed at reducing the rewards and increasing the risk and effort associated with crime generators may be more or less effective depend- ing on the overall neighborhood crime market (Tillyer 2015). The PIN framework has the potential to serve as a theoretical and methodological guide in anticipating such differences across contexts when designing place-based interventions and understanding variations in evaluation findings across settings (Skubak et al., 2020).

In geographic criminology, it is increasingly recognized that the appropriate spatial unit of analysis needs to be explicitly considered and carefully cho- sen (Weisburd, Bruinsma, and Bernasco 2009). This decision should not primarily depend on the availability of data or statistical models but must be based on theory: A spatial unit of analysis should match the theoretical perspective that guides the analysis. Indeed, most theories that inspire geographical criminology apply to small-scale spatial structures. It is not surprising, therefore, that recent work generally advocates the use of small spatial units of analysis, such as face blocks (Taylor 1997) or street segments (Weisburd et al. 2004) in the U.S. context, and ‘‘output areas’’ (comprising 300 residents on average) in the United Kingdom (Oberwittler and Wikstro¨m 2009). When the analysis is performed on small units ofanalysis such as census blocks, the size of the relevant environment is relatively large, so that the potential influence of nearby units is comparatively large (Bernasco 2010). Therefore, when analyzing small spatial units, close attention must be paid to the effects of nearby places. The First Law of Geography, which states that ‘‘everything is related to everything else, but near things are more related than distant things’’ (Tobler 1970:236), warns us not to analytically isolate spatial units from their geographical environment, and the urgency of this warning increases, the smaller the size of the spatial unit of analysis. Except for an early study in the area (Heitgerd and Bursik 1987), in criminology, the recognition of the importance of spatial interdependence emerged only during the last two decades. Since the turn of the century many studies have addressed the issue of spatial interdependence and have applied statistical methods and techniques to deal with it, either as a poten- tial source of bias or as a substantive hypothesis (Andresen 2006; Baller et al. 2001; Hipp 2007; McCord and Ratcliffe 2007; Mears and Bhati 2006; Messner et al. 1999; Smith et al. 2000). Proximity of a place to a crime attractor or generator may increase the amount of crime in that place because it is located on the paths that lead toward and from the crime attractor or crime generator. For example, if a subway station attracts passengers, many of these passengers exit to the streets. From the station exit they travel further, often by foot, to their des- tination. This can be their parked car, a bus stop, their workplace, a store, or a friend’s home. Thus, there will be a strong concentration of transient pas- sengers in the block near the subway station exit, and this concentration will spill over and dilute over adjacent blocks as people start walking toward their destinations. It is also possible that the presence of a crime attractor or generator in a block increases the amount ofcrime in that block, but thereby decreases the amount of crime in nearby blocks. Offenders who would otherwise commit crime in the nearby block are being ‘‘pulled away’’ toward the block where the crime attractor or crime generator is located. For example, if a robber moves his ‘‘territory’’ to a nearby area after a new crime attractor emerges in that area, then the crime attractor in the nearby area effectively reduces crime in the robber’s former territory. In the spatial economics literature and marketing literature, these two opposing spatial mechanisms are referred to as the spatial agglomeration and the spatial competition effect (Fotheringham 1985). (Bernasco & Block, 2011).

Although the measurement and analysis of census blocks as spatial units of analysis is much more precise, and much better grounded theoretically than the use of aggregates such as block groups or census tracts, it should be noted that a face block, the two sides of a street between two junctions, is an even more natural spatial unit, not only because it is even smaller than a block but also because it is characterized by intervisibility (Smith et al. 2000; Taylor 1997). Furthermore, not all census blocks in Chicago are on a perfect grid. Some ofthe most important commercial streets are diagonals. Therefore, census blocks along these streets are triangles. Furthermore, cen- sus blocks are not only bounded by streets but also by railways and natural barriers such as rivers and Lake Michigan. Future analyses using more detailed geographic features than census block boundaries could provide a deeper understanding of how spatial patterns of robbery are influenced by the urban geography and land uses (Bernasco & Block, 2011).

The unit of analysis in the present study is the face block,as in Smith et al. (2000). As discussed above,a face block is defined as both sides of a street located between two intersections (i.e.,one side ofa city block,but including the locations on both sides of the street). Most ecological studies tend to use standard metropolitan statistical areas (SMSAs),cities,counties,census blocks,or city blocks as their units of analysis (Bursik and Grasmick 1993), but these units are quite large and consequently include a variety of different physical and demographic structures that may confound the interpretation of effects (Blalock 1989; Janson 1993; Robinson 1950; Sampson 1987). Census blocks,for example,may contain neighborhoods of vastly different socio- economic character,and even a single block may contain drastically varying micro environments. This phenomenon is called “spatial heterogeneity” or “geographic heterogeneity” in the literature (Janson 1993; Smith et al. 2000). For instance,one side of a block may easily be of an intensive commercial nature,whereas the opposite side of the block may be of a residential or industrial character. Of all the units discussed,the use of face blocks is most likely to minimize the degree to which dissimilar ecological environments are lumped together within a single unit and therefore better enables us to analyze neighborhoods as they are experienced by a city’s residents. Presum- ably,offenders familiar with one side of a face block are familiar with the other such that both sides are part of the “awareness space” of offenders (Brantingham and Brantingham 1984) Even within the Seattle data that Miethe and McDowall (1993) and Rountree et al. (1994) used,heterogeneity within the unit of analysis may be a substantive issue,because survey respondents were asked to report on neighborhood traits within three or four blocks oftheir ownhousehold.This form of data collection establishes units inclusive of up to a 64-block area. “Busy places” or incivilities within a three- or four-block radius may be irrel- evant to crime at a particular location if the awareness space of motivated offenders does not extend to the location in question (Brantingham and Brantingham 1984). Similarly,it maybe that heterogeneity within crime categories is responsible for the results. That is,different types of street crimes may exhibit differ- ent patterns of distribution,and these differences may have a muting or con- founding influence on results. Miethe and McDowall (1993) proposed that such a process might have been occurring within their violent crime category. Heterogeneity both within the unit of analysis and between crimes is addressed within the current study. Heterogeneity within crime categories is cir- cumvented by simply focusing on a single type of street crime. Meanwhile, heterogeneity within analytic units is minimized by the use of face blocks, which are presumably a more spatially homogeneous unit of analysis than typically used. Moreover,spatial heterogeneity within a face block may be irrelevant,because awareness space on a face block is likely to include the entire expanse (Brantingham and Brantingham 1984). Motivated offenders present on a face block are more likely to have an awareness ofany place on a face block than they are ofa place located only a block away,where they may (Rice & Smith, 2022)

In this article, we introduce three major advances over prior work on crime location choice. The first applies to spatial scale. While classic studies on the geography of crime (Shaw and McKay, 1942; Sampson et al., 1997) have used large urban areas as their spatial units of analysis, recent research suggests that often crime concentrations are not larger than a street segment (Smith et al., 2000; Weisburd et al., 2004) or street corner (McCord and Ratcliffe, 2007). To improve our understanding of the fine-grained spatial decisions of street robbers, we zoom in to the level of census blocks. The second advance over prior work in this field of inquiry is our direct test of spatial spillover effects. Census blocks are not independent observational units. Just crossing the street means moving into another block and thus moving from one spatial unit into the next. To assess spatial spillover, we test whether a robber’s preference for a census block depends on characteristics of adjacent blocks. Rather than treat spatial effects as nuisance factors to be accounted for in the model disturbance term, they are included in the structural part of the model. The third innovation is our detailed measurement of a large variety of small-scale cash-dominated economic activities, both legal and illegal, to assess their effect on where robbers choose to attack. Whereas we previously also investigated spatial spillover effects and used data from the same sources to analyze aggregated robbery counts per census block (Bernasco and Block, 2011), the current analysis improves the prior analysis in two ways. First, it is solidly grounded in random utility maximization (RUM) theory and the discrete choice framework (Ben-Akiva and Lerman, 1994). Second, whereas the prior analysis used aggregated data, the current analysis utilizes disaggregated crime data. These improvements allow us to simultaneously assess the influence of characteristics of offenders and of census blocks, whereas the previous study could only scrutinize the atter. Combining these two types of characteristics, this study yields new findings on how distance and racial/ethnic barriers affect individual crime location choices.(Bernasco et al., 2013)

Due to the increasing availability of detailed spatial crime data, and in order to minimize the risk of aggregation bias (Openshaw, 1984), contemporary studies on crime and law enforcement generally advocate the measure- ment of crime at small spatial units of analysis, such as face blocks (Taylor, 1997; Braga et al., 2011) in the USA context, and ‘output areas’ in the UK (Oberwittler and Wikstro¨ m, 2009). We use data that are disaggregated to the level of census blocks. In Chicago, with anaverage surface of 140m?140m (460 ft?460 ft) and an average population of 118 residents, census blocks are approximately 30 times smaller than census tracts. Zooming in to block level allows us to analyze in a detailed way the location choices of robbers. In 2000 there were 24,594 census blocks in Chicago from which a robber chooses a single one when committing a robbery. When performing the analysis on units as small as census blocks, spatial spillover effects are plausible (Bernasco, 2010). For example, a retail store that attracts robbers will not only pull robbers to the block where it is located, but also to adjacent blocks that are just across the street and around the corner. A robber may follow a customer from a store in one block to a more isolated place in an adjacent block before s/he attacks, implying that the store in the former block originally attracted the offender that perpetrated the robbery in the latter block. Spatial influence will probably not extend far beyond the length of a single block or maybe two blocks, because generally most potential victims will be vulnerable for the duration of a short walk (to their home, the next store, parking lot, public transport hub). Thus, we suggest the spillover effect will follow a steep distance decay function (Bernasco et al., 2013).

# For miro units

Why Small Spatial Units of Analysis? In the abovementioned five applications of the discrete choice framework to crime location choice, relatively large spatial units were used, census tracts, suburbs, and neighborhoods with average residential populations ranging between 3,500 and 5,000 residents. These areas are much larger and much more heterogeneous than the areas usually referred to in contemporary theoretical notions of offender behavior and target attractiveness, and also much larger than what is useful from the perspective of crime prevention. Many contemporary scholars in geographic criminology advocate the use of much smaller spatial units of analysis (Groff et al. 2009; Oberwittler and Wikstro ̈m 2009; Smith et al. 2000) and prior research has indeed identified census blocks, street segments (Weisburd et al. 2004), street blocks (Kurtz et al. 1998; Taylor 1997), street corners (McCord and Ratcliffe 2007) and even single parcels (Kinney et al. 2008) or addresses (Groff and La Vigne 2001; Sherman et al. 1989) as meaningful spatial units of analysis. But why precisely would we need smaller spatial units? There are various reasons that underlie the plea for small units. The first reason to favor small spatial units is the generic principle in all sciences that to understand the characteristics and behavior of an object of inquiry, it is helpful to understand the characteristics and the behavior of its constituting elements, as well as the nature of the relations between these constituting elements. Another reason to favor small units is that the relevant boundaries between units may not be known to the researcher. The definition of spatial objects, such as neighborhoods, is often a result of arbitrary administrative decisions, but may not correspond to the perceptions of the area by those who use it (Coulton et al. 2001). In the absence of well-defined boundaries between spatial units, the measurement of small entities is to be preferred, even if the mental maps of the users are less fine-grained. In that case the small entities are just replicated observations, whereas all relevant differences between small entities will remain unobserved if the entities are aggregated before measurement. An empirical justification of the use of small spatial units of analysis is the observation that larger spatial units are often heterogeneous with respect to crime itself and many related variables. One study showed that only three and a half percent of the addresses in Minneapolis generated half of all calls for service to the police (Sherman et al. 1989). In another study (Weisburd et al. 2004), it was found that less than 5% of the street segments in Seattle accounted for half of all crime incidents. In a recent ethnographic study (St. Jean 2007), it was noted that even within a single high-crime Chicago police beat comprising 3386 residents, crimes occurred much more frequently on some neighborhood blocks then on others that remained free of crime. These skewed distributions imply that as the spatial unit of analysis decreases, the variation within units of analysis decreases, which results in more precise measurement, and both the number of units and the variation between the units of analysis increase, which results in an improved capability to detect differences (statistical power). Ultimately, the main criterion for choosing a particular unit of analysis is the theory to be tested. The unit of analysis should match the theory (Weisburd et al. 2009b). The ecological fallacy (Robinson 1950) is the reasoning error by which conclusions about small units are made on the basis of empirical findings at higher levels of aggregation. The best way to prevent this fallacy is to measure and analyze the data at units of analysis that match the theory. Many theoretical notions that relate to spatial crime patterns, including propositions about offender behavior, informal social control and the nature of crime settings, apply to units of analysis that are arguably much smaller than neighborhoods, census tracts or block groups. Social disorganization theory, for example, posits that lack of social control and lack of cohesion in an area make it difficult for residents to take action against crime in their area. Social control and cohesion involve processes (e.g., knowing each other, keeping an eye on each other’s properties or children) that take place between close neighbors, but not between people who live many blocks apart. For this reason, Taylor (1997) argued that the street block be considered the appropriate spatial level for testing social disorganization theory. Street blocks fit many of the criteria of what ecological psychologists refer to as ‘behavior settings’: small scale natural units of interaction between people and objects that are characterized by predictable and habitual patterns of behavior and are contained within a place that is often physically bounded (Barker 1968; Wicker 1987). An elegant definitional solution to how small or large a place must be to be considered a setting (is the setting a school, or rather a classroom?) is Wikstro ̈m’s definition of a setting as ‘‘the social and physical environment (objects, persons, and events) that the individual, at a particular moment in time, can access with his senses (e.g., what he can see, hear and feel)’’ (Wikstro ̈m 2006: 86–87) (Bernasco, 2010).

# Arguments against micro units

The census unit was chosen as the spatial unit of analysis because census units have a size similar to those in comparable studies (Bernasco and Block 2009; Clare et al. 2009; Menting et al. 2016), because census units are approximately equally sized, and because in the study area they are relatively homogenous in terms of population composition. In addition, a practical advantage is that the use of census units does not force us to estimate spillover effects (effects of attributes of nearby units on crime in a focal unit) which is a requirement if small units of analysis are used, such as census blocks or street blocks (Bernasco et al. 2013; Groff and Lockwood 2014) (Song et al., 2019).

It has been argued that census tracts provide less to the understanding of the variability of crime compared to smaller units such as street segments (Steenbeek & Weisburd, 2016; Weisburd, Groff, & Yang, 2012). However, data for smaller units (especially for transportation surveys and crime) are difficult to find. Various laws compel agencies collecting data in Canada to protect privacy; consequently, most agencies do not provide more precise data. Furthermore, using a smaller unit of analysis in conjunction with GWR may be problematic. Distributions tend to become more skewed toward zero values as spaces become smaller and smaller (Rengert & Lockwood, 2009); this poten- tially leads to a violation of the normality assumption. The relaxation/ violation of this assumption has been associated with misleading results of the modelled relationships in GWR (Yu, Peterson, & Reid, 2009). For these reasons, the spatial unit of analysis used in the current study is the census tract (Boivin, 2018).

Previous research on urban crime in the U.S. has used aggregate data at different neighbourhood levels such as census tracts (Krivo and Peterson, 1996; Harries, 1994; Kohfeld and Spraque, 1988; McClain, 1989; Martin, 2002), block groups (Cahill and Mulligan, 2003; Santiago et al., 2003), blocks (Roncek and Maier, 1991) or face blocks (Smith et al., 2000; Rice and Smith, 2002). Census tracts are recommended as the most appropriate research unit mainly because socioeconomic data are compiled for explanation of various types of crime in U.S. cities (Harries, 1994; Kohfeld and Spraque, 1988; Krivo and Peterson, 1996; McClain, 1989). An additional advantage of using census tract is that it is large enough to capture an adequate number of criminal offenses during a given period (e.g. three or five years) (Krivo and Peterson, 1996) (Zhang & Peterson, 2007).

Regarding the latter, by using (often homogeneously defined) neighbourhoods as spatial unit of analysis, lower spatial accuracy is less prob- lematic than when smaller units of analyses (e.g., street segments) would have been used. In fact, we explicitly asked respondents how accurately they had reported geo- graphic locations at the end of each subdomain (Menting et al., 2020).

# Street Segments

The geographic unit of interest for this study is the street segment (sometimes referred to as a street block or face block) defined as the two block faces on both sides of a street between two intersections. We chose the street segment for a number of reasons. Scholars have long recognized its relevance in organizing life in the city (Appleyard, 1981; Jacobs, 1961; Smith et al., 2000; Taylor, 1997). Taylor, for example, argues that the visual closeness of block residents, interrelated role obligations, acceptance of certain common norms and behavior, common regularly recurring rhythms of activity, the physical boundaries of the street, and the historical evolution of the street segment make the street block or street segment a particularly useful unit for analysis of place (see also Hunter and Baumer, 1982; Taylor et al., 1984) The choice of street segments over smaller units such as addresses (see Sherman et al., 1989) also minimizes the error likely to develop from miscoding of addresses in official data (see Klinger and Bridges, 1997; Weisburd and Green, 1994). We recognize however, that crime events may be linked across street segments. For example, a drug market may operate across a series of blocks (Weisburd and Green, 1995; Worden etal., 1994), and a large housing project and problems associated with it may transverse street segments in multiple directions (see Skogan and Annan, 1994). Nonetheless, we thought the street segment a useful compromise because it allows a unit large enough to avoid unnecessary crime coding errors, but small enough to avoid aggregation that might hide specific trends. (Weisburd et al., 2004)

Some of the most recent research in spatial criminology has shown the utility of the street block as the optimal unit of analysis in crime and place studies. The street block has been described as large enough to avoid the impractical focus of singular addresses but not so large to lead to erroneous conclusions about crime at the micro level (Groff et al. 2010). The street block has recently been recognized as an optimal compromise within crime and place research (Weisburd et al. 2004, 2012; Groff et al. 2010; Braga et al. 2011; Bernasco and Block 2011). Weisburd et al. (2012) stressed the accuracy of the street block in assessing crime volumes as well as the benefit that the street block is a ‘‘social unit that has been recognized as important in the rhythms of everyday living in cities’’ (p. 27). The street block is also large enough to avoid coding errors inherent in geocoding processes, but not so large to lead to ecological fallacy conclusions. Research observing criminal activity at the block level is consistent within the theories of environmental criminology1 in that crime clusters are stable over time, and holds particular use for crime prevention initiatives and police enforcement strategy (Curman et al., 2015).

On the other, that street segments represent micro level units of analysis means that they are well-aligned with the need to retain spatial granularity in crime analysis (Brantingham et al. 2009). Perhaps more importantly, the street segment is of theoretical significance. It has, for example, previously been shown that clustering at the street segment level is a significant driver of more general spatial patterns (Weisburd et al. 2004; Andresen and Malleson 2011). Furthermore, it is at the level of the street segment that numerous social processes (including criminal activity) take place. Street segments can be reconciled with relevant social concepts: they corre- spond to notions of community, for example, and can be classified in terms of the nature of activity taking place upon them. Indeed, segments of different types, in this sense, have been shown to display distinctive criminological character (Weisburd et al. 2012) (Davies & Johnson, 2015).

In their seminal effort to investigate the stability of crime concentrations in Seattle over time, Weisburd et al. (2004) concluded that half of all crime1 was concentrated in 4–5% of Seattle street segments and that the 24% citywide crime reduction which occurred during the 14-year study period was a spatially concentrated process. Just 14% of street segments generated the citywide trend and had a strong declining crime trend over time. Conversely, 84% of street segments exhibited stability and saw no meaningful changes in their crime trajectories (see also, e.g., Groff et al. 2010; Weisburd et al. 2009). Recently, the Seattle study (Weisburd et al. 2004) was replicated in Vancouver (Curman et al. 2015) and Albany (Wheeler et al. 2016), where crime decreased in recent years (- 40% in Vancouver2 and - 35% in Albany3). Similar to Seattle, half of all crime in Vancouver was stably clustered in about 8% of street segments (Curman et al. 2015) and 241 street segments (5%) in Albany remained consistent high-crime clusters (Wheeler et al. 2016). In contrast to Weisburd et al. (2004), both Curman et al. (2015) and Wheeler et al. (2016) found that crime was decreasing across most street segments. In fact, a large number of micro places in Vancouver (30%) and Albany (40%) followed the citywide declining trend and contributed to the observed crime reduction throughout the study period. Further contrasting with Seattle, where 2% of street segments saw a relatively large increase in crime during the study period, no increasing crime trajectories were identified at all in both cities prompting the researchers to note for Vancouver that ‘‘this decline in criminal activity was more widespread […] and almost all street blocks would have played a role in this change over time’’ (Curman et al. 2015, p. 142). (Vandeviver & Steenbeek, 2019).

My remark, so far street segment was the most studied micro place and evidence shows that few streets segment are responsible for overall crime drop. Examine the crime in smaller spatial units will provide understand about which spatial unit should be preferred in future crime location choice studies.

Burglary is strongly clustered at the street segment level with 50% of all burglaries occurring in approximately 2% of all street segments.17 Despite the citywide burglary reduction, the percentage of street segments that account for 50% of burglaries remains stable throughout the entire study period and no particular trend can be discerned (Vandeviver & Steenbeek, 2019).

Results at the micro-spatial level showcase in the first place that the city-level decline scaled rather proportionally across street segments. Half of all street segments with bur- glary experienced substantially larger declines in burglary percentages but these were infrequently observed across the entire study period. Burglary spatial point patterns were stable in most street segments and decreased just once or twice at significantly higher rates. Interestingly, relative burglary volume was found to increase in just a handful of street segments but the majority of those street segments were at some point in time also affected by the burglary drop in Antwerp. Finally, we do not see strong evidence that street segments that experienced (stronger) burglary declines also cluster spatially (Vandeviver & Steenbeek, 2019).

Undeniably, burglary is strongly concentrated in Antwerp street segments. Under 10%of Antwerp street segments experienced burglary at least once during the study period and fewer than 3% of all street segments produced the majority of burglaries (Vandeviver & Steenbeek, 2019).

At first glance, our results do not confirm the importance of micro-level or place-specific processes in our understanding of the observed macro burglary trends (Vandeviver & Steenbeek, 2019).

# Crime Generators

Crime generators and crime attractors are concepts in crime pattern theory that poten- tially play an important role in crime location choices. They are facilities that have elevated levels of crime because they bring together crowds either continuously or at certain moments during the day or the week (Brantingham and Brantingham 1995; Kinney et al. 2008). Crime generators are places and facilities where all kinds of people go to perform legal daily activities. Crime attractors have been defined as places and facilities that have a reputation of providing opportunities for crime, which makes them particularly attractive to motivated offenders (and unattractive to some potential victims) (Brantingham and Brantingham 1995). Because crime attractors share many features with crime generators, and because the reputational element in their definition may be difficult to evaluate objectively, especially in the context of a non-western culture, in this paper we will subsume crime attractors under the more general label of crime generators. Although it may be impossible to enumerate all types of facilities that can operate as crime generators, some stand out as being particularly attractive for some types of crime, and they will be discussed in the present section. We describe elements common to certain classes of facility, although even amongst the same class (e.g. bars) there exists consider- able heterogeneity making some of them risky places but others not (Eck et al. 2007). (Song et al., 2019)

A concentration of adolescents around high schools would possibly generate a concentration of crime before and after school hours (Roncek and Faggiani 1985; Roncek and LoBosco 1983). Near elementary schools, oppor- tunities for TFP are abundant when it is crowded because parents, grandparents and other caretakers drop off the children in the morning, and also when they pick them up later in the afternoon. Research on street robbery has demonstrated that proximity to small scale businesses, including grocery stores, corner stores, gas stations, barber shops and fast-food restau- rants, increases the risk of street robbery (Bernasco and Block 2011; Bernasco et al. 2017a; Haberman and Ratcliffe 2015). To the extent that these are the types of businesses where cash payments are more common than non-cash payment modes, customers may be likely to carry cash. Because street robbery and TFP are similar offenses in terms of location (public space) and preferred items to steal (concealable, removable, available, valuable, enjoyable and disposable, see Clarke 1999; Wellsmith and Burrell 2005), these businesses might also function as crime generators for TFP. For similar reasons, banks and ATMs have been shown to have the same effect (Haberman and Ratcliffe 2015). (Song et al., 2019)

The criminogenic effects of bars and other types of alcohol outlets have been demonstrated repeatedly to generate not only violent crimes but also property crime, in particular robbery, and mostly likely because of intoxicated patrons might be easy targets for robbers and thieves (Bernasco and Block 2011; Conrow et al. 2015; Groff 2011; Roncek and Maier 1991). Especially during rush hours, transit stations (bus stations, subway stations) are crowded

places that offer opportunities for theft, in part because travelers may be distracted and not vigilant in their attempts to find the way to their destinations. Many studies have con- firmed that crime rates are elevated in and around transit stations (Bernasco and Block 2011; Block and Block 1999; Block and Davis 1996; Clarke et al. 1996; Haberman and Ratcliffe 2015; Qin and Liu 2016). In sum, the extant literature provides empirical evidence for the fact that locations where people congregate, often in large crowds, are more likely to be selected as crime sites by motivated robbers and thieves. This is particularly true for locations with functions that potentially indicate larger benefits or the presence of vulnerable and non-vigilant victims (Song et al., 2019).

Crime generators, according to Brantingham and Brantingham (1995), are specific areas that draw in large numbers of people for non-criminal reasons, but they generate crime events because they temporally and spatially concentrate people and other rewarding poten- tial crime targets. Some of those people will be criminally motivated and take advantage of the criminal opportunities presented at and around these locations. Consistent with the conceptualization of crime generators, several studies demonstrate the criminogenic effects of various place types on crime at micro-places such as blocks (e.g., Groff and Lock- wood 2014; Groff and McCord 2012; Grubesic and Pridemore 2011; Kurland et al. 2014; LaGrange 1999). In a particularly comprehensive example of such research, Bernasco and Block (2011) examined the effects of various place types on robbery counts per block in Chicago. They found that many place types acted as crime generators, with significantly higher counts of robberies on blocks with bars and clubs, fast food restaurants, barbers and beauty salons, liquor stores, groceries, general merchandise stores, gas stations, laundro- mats, pawn shops, and check cashing services. Moreover, Bernasco and Block’s (2011) analysis revealed that the effects of crime generators are not limited to the block itself, with several place types having a similar, albeit smaller, criminogenic effect on adjacent blocks. As reviewed above, PIN cross-level propositions suggest that micro-places that spatially

and temporally concentrate people and other rewarding targets can differentially generate crime depending on neighborhood-level context, because characteristics of broader con- texts can intensify or attenuate the perceived opportunity associated with such places. Specifically, the extent to which “crime generators” actually generate crime may depend on neighborhood-level criminal opportunity in the form of aggregate supplies of offend- ers, the availability of valuable targets, and/or weak collective guardianship. To this end, we consider how three indicators of neighborhood-level crime opportunity—concentrated disadvantage, vehicular traffic, and civic engagement—may moderate the effects of crime generators. (Skubak et al., 2020).

Crime generators and crime attractors are two similar concepts that are used to explain spatial concentrations ofcriminal activity (Brantingham and Brantingham 1995; Kinney et al. 2008). Crime generators are places that are easily accessible to the public. They may become hot spots of crime because the presence of large groups of people creates occasions for crime. Typical examples are shopping precincts, high schools, and public transport stations. Some places provide very specific opportunities and become crime attractors. They are places that do not necessarily bring together large groups ofpeople at the same time, but their function makes them well suited for motivated offenders to find attractive and weakly guarded victims or tar- gets. For robbery, crime attractors are likely to be places that have cash economies, that is, places where many transactions are being made, and where the majority of these transactions involve cash, as opposed to pay- ments by credit card or electronic payment systems (Wright and Decker 1997). Most property offenders prefer items that are concealable, remova- ble, available, valuable, enjoyable, and disposable (Clarke 1999; Wellsmith and Burrell 2005), and cash fulfills these requirements best. Payments tend to be cash in small-scale businesses that sell items of limited value. Exam- ples of such businesses are bars, barber and beauty salons, grocery stores, fast-food restaurants, gas stations, and pawn shops. Some crime attractors are places where the main activities are illegal. Illegal markets for gambling, fencing, prostitution, and drug dealing are themselves already hot spots of consensual crimes. They also attract moti- vated offenders who find the illegal market an ideal hunting ground for theft or armed robbery, because they involve mostly cash transactions and because many of the participants are vulnerable and will not report victimization to the police. In addition to crime generators and crime attractors, offender anchor points are likely to be relevant for where crime occurs. According to the principle of least effort (Zipf 1949) offenders will—all other things being equal—prefer shorter trips over longer trips. Therefore, a place is more likely to experience crime if it is located nearby offenders’ homes. The ‘‘set space’’ (Tita, Cohen, and Engberg 2005) where gangs hang out can be seen as a special ‘‘home-like’’ anchor point. They are small places such as street corners, empty buildings, or vacant lots where gang members spend a considerable amount of time. Although gangs are not defined in terms of criminal activity, their members are disproportionally involved in crime. Therefore, a place is more likely to experience crime if it is situ- ated in the vicinity of the activity node of a gang (Bernasco & Block, 2011).

# Methodological advantages

Instead of using trajectory analysis to investigate crime trajectories of micro places (see,e.g., Curman et al. 2015; Weisburd et al. 2004; Wheeler et al. 2016), some authors have relied on a non-parametric area based spatial point pattern test (Andresen 2009, 2016)to explicitly study changes in the actual spatial patterns of crime (see Andresen et al. 2017; Andresen and Malleson 2011; Hodgkinson et al. 2016). This approach has the advantage over trajectory analysis that it allows to formally test the assumption of spatial stability of spatial crime patterns and that it may detect small but meaningful changes in spatial crime patterns over longer periods that could otherwise go undetected in a trajectory analysis (Andresen et al. 2017, pp. 4, 6) (Vandeviver & Steenbeek, 2019).

With respect to the statistical modeling of spatial effects, this study has demonstrated the relevance of modeling effects of the spatial environment in situations where the spatial units ofanalysis are as small as census blocks. Theoretical arguments were put forward to use (negative binomial) regres- sion models with lagged independent variables rather than spatial error or spatial lag regression models. Other research modeling spatial crime distributions has typically tackled the issue of spatial autocorrelation by using spatial lag or spatial error mod- els (Anselin 1988) and by referring to the associated parameter as indicating spatial ‘‘diffusion’’ or ‘‘spillover.’’ Although this spatial diffusion para- meter effectively captures remaining residual spatial autocorrelation, in general this procedure as not a constructive modeling approach unless it is very explicitly specified what the ‘‘diffusion’’ or ‘‘spillover’’ process entails. Diffusion, for example, implies a fixed temporal order, and ‘‘spil- lover’’ assumes a fixed amount that is redistributed, but these characteristics are not implied in the estimation of a spatial autocorrelation parameter. Spatial lag models assume that the number of robberies in a block has a causal effect on the number ofrobberies in adjacent blocks, but it is difficult to think of a plausible mechanism that could underlie such an effect. Rob- bers do not select a place because it is near to the location ofother robberies, but because it is near to the target that also attracted other robbers. The effects of spatially lagged independent variables in our model are much more direct and explicit. They indicate, for example, that the number of robberies in a block is affected by the proximity ofa gas station or a gro- cery store. The nontrivial level of residual spatial autocorrelation that is present in our models is in part a consequence of specifying explicit spatial effects in the form of specified lagged independent variables. The diagnos- tic value ofthe result is that it demonstrates that apparently there exist other spatially correlated factors that drive the distribution of robbery incidents at block level but that have not been included in our analyses. Other poten- tially relevant but unmeasured crime attractors and crime generators include, for example, bus stops, parking places, supermarkets, warehouses, bookstores, clothing stores, and pharmacies. Other potentially relevant block characteristics may include, for example, the signs of physical dete- rioration and the lack ofcollective efficacy that St. Jean (2007) investigated (Bernasco & Block, 2011).

# Future research suggestions

Interestingly, our finding of high volatility at certain street segments, especially in the city center, may suggest that burglary there could have been affected by smaller scale, place-specific processes. In summary, explanations of the observed stability of burglary patterns should be made with a healthy dose of caution because the counterfactual outcome is unknown. Nevertheless, we encourage future researchers to pursue such explanations of micro-spatial burglary changes, for which the current study provides a toolbox to identify such changes. A

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