This must be the place (to commit a crime). Testing the law of crime concentration in Milan, Italy

Introduction

In 1989, Sherman, Gartin, and Buerger introduced the term criminology of place to describe a new area of scientific inquiry developed as a reaction to the limitations of the offender-based criminology of the 1970s. From the early 1980s to nowadays, a theoretical interest on the micro-dynamics of crime has emerged and a large number of studies demonstrated how crime significantly clusters at places irrespective of the unit of analysis defined (i.e., addresses, street segments, blocks or clusters of these units) (Johnson, 2010; Weisburd et al., 2009). This finding had great implications for crime forecasting and police resource allocation models (Johnson, 2010) supporting the development of successful crime prevention programs at places (Braga et al., 1999; Braga and Weisburd, 2010; Sherman and Weisburd, 1995). During the years, scholars have conducted research on the relationship between crime and micro places which is now a well-developed topic especially in the United States (Braga et al., 2010; Braga and Clarke, 2014; Felson et al., 2013; Goodwill and Alison, 2005; E. Groff, 2013; Groff, 2011; E. R. Groff, 2013; LaFree et al., 2012; McCord and Ratcliffe, 2007; Ratcliffe and Rengert, 2008; Sherman and Weisburd, 1995; Tita and Radil, 2011; Weisburd et al., 1992, 2012), Canada (Andresen, 2006, 2007; Andresen et al., 2016b; Curman et al., 2015; Kennedy and Forde, 1990) and in some European countries (Bernasco, 2010a, 2010b; Bernasco and Steenbeek, 2016; Bruinsma et al., 2013; Ceccato, 2009; Ceccato and Oberwittler, 2008; Dugato, 2013, 2014; Johnson et al., 2007; Johnson and Bowers, 2004; Steenbeek et al., 2012; van Nes and López, 2010; van Wilsem, 2009).

Most recently, a specific interest has grown on the use of street segments as privileged unit of analysis. First, the street segment has been conceptualized as the portion of space able to capture the essence of social environments in which people interact. Human actions are driven by the behavioural-settings in which individuals are involved and the exposure to different social environments can determine the involvement in criminal actions (Appleyard, 1981; Taylor, 1997; Wikström, 2004). Behaviour-settings are defined as “small-scale social systems whose components include people and inanimate object” (Wicker, 1987) and later the “parts of the environment which an individual, at a particular moment in time, can access with his or her senses” (Wikström, 2006). Different behavioural-settings can influence individuals’ moral actions as well as impact the development of characteristics related to their crime propensity. Many scholars identified street blocks or street segments as the unit of geography that better approximate the behavioural-settings and advocated for their relevance as unit of analysis (Inderbitzin et al., 2016; Jonathan-Zamir et al., 2015; Oberwittler and Wikström, 2009; Taylor, 1997; Weisburd et al., 2012). Second, an analysis at street segment level permits to better investigate patterns of crime variability that could have been lost analysing larger aggregations of geography (i.e., census tracks; neighbourhoods). Studies highlighted a great street by street variability in the distribution of crime which means that street segments registering a high number of offences can be adjacent to street segments reporting no crime at all (Weisburd et al., 2004a, 2012; Weisburd, 2015). The identification of
this variability is important from theoretical and practical reasons in order to improve the knowledge on crime distribution and better orient preventive measures. The fact that these patterns can only be identified through a street segment or an address analysis pushed scholars to develop further studies on this topic. Third, there is a strong evidence that crime at street segment level concentrates similarly across cities. Pioneering research conducted in Boston and Minneapolis found that 50% of emergency calls to the police concentrated, respectively, in 3.6% and 3.5% of the street segments (Pierce et al., 1988; Sherman et al., 1989). Similar figures emerged from the analysis of reported crimes in several US cities (Weisburd, 2015).

Concentration occurs also outside the specific urban environment of American cities, as shown for Rotterdam (the Netherlands) (van Wilsem, 2009), Tel Aviv-Yafo (Israel) (Weisburd and Amram, 2014), Vancouver (Canada) (Curman et al., 2015), the Hague (the Netherlands) (Steenbeek and Weisburd, 2016) and Jaipur (India) (Mazeika and Kumar, 2016). Weisburd (2012; 2015) suggests that these findings reflect the presence of a law of crime concentration at places which may be claimed the first law of the criminology of place.

Studies testing the law of crime concentration

In one of his latest pieces, Weisburd (2015) systematises the knowledge on crime concentration preparing the ground for future investigations. As a consequence, in the last few years scholars have positively embraced Weisburd’s call to “examine a wide array of cities [...] to develop further the generalizability of the law of crime concentration [and] identify whether there are specific contexts in which the law does not apply” (Weisburd, 2015, p. 148). New studies tested the presence and, more interestingly, the stability and the variability of crime concentration in many different cities (Andresen et al., 2016a, 2016b; Curman et al., 2015; Gill et al., 2016; Hibdon et al., 2016; Hipp and Kim, 2016; Levin et al., 2016; Steenbeek and Weisburd, 2016). The presence of the same amount of crime in the same percentage of street segments has been the primary focus of the studies on this topic, whereas traditionally very few scholars empirically tested the stability of these concentrations over time (Braga et al., 2010; Weisburd et al., 2004b, 2012). For a long period this was the first and only longitudinal analysis proving the stability of crime concentration and the predictability of crime at street segment level. This gap has been largely covered by this new wave of studies giving great support to the stability and predictability of crime events at street segment level in Vancouver, Brooklyn Park, Seattle and the Hague (Andresen et al., 2016b; Gill et al., 2016; Hibdon et al., 2016; Steenbeek and Weisburd, 2016).

The proliferation of new studies is the direct demonstration of the growing interest in the law of crime concentration and, more in general, in the criminology of place. Nevertheless, there are still open questions to be addressed and several elements to be discussed.

First, the generalizability of the law of crime concentration is missing important information regarding non-US cities, especially Europe. Except for the newly published study on the Hague (Steenbeek and Weisburd, 2016), previous research directly testing the law of crime concentration mainly involved the US and the research conducted in other countries present different lacks in the analysis of stability patterns and crime determinants. For what is concerning Europe, a large amount of research has been produced on the relationship between crime, especially property crime, and micro places. These include temporal and
spatial analysis of hotspots and patterns of victimization in European cities (Bernasco, 2008; Ceccato et al., 2002; Ceccato, 2009; Ceccato and Oberwittler, 2008; Dugato, 2014; Johnson et al., 2007; Johnson and Bowers, 2004; Uittenbogaard and Ceccato, 2012), analysis of crime generators and attractors (Newton, 2008, 2008; Sidebottom and Bowers, 2010; Steenbeek et al., 2012) and the application of the risk terrain modelling (Dugato, 2013). Among the abundant literature, few studies focused on street segments mainly analysing how the conformation of the street network influences crime occurrence (Hillier, 2004; Hillier and Shu, 2000; Johnson and Bowers, 2010; van Nes and López, 2010). In 2009, Van Wilsem conducted a qualitative analysis of violence in 200 streets on three selected neighbourhoods supporting the presence of concentrations in the city. Afterwards, Johnson (2010) reviewed all the available evidence that crime concentrates at different spatial scales including street segments. Nevertheless, with the exception of Steenbeek and Weisburd (2016), none of these studies directly and strictly tested the law of crime concentration.

Second, very few studies testing the law of crime concentration both in the US and in Europe considered the concentration patterns of different crime types. The importance of targeting and shaping crime prevention measures on different crimes is well discussed in the literature (Clarke, 1992, 2008; Copes, 1999; Weisburd et al., 1992). Nevertheless, few authors, more or less openly, stressed the importance of a crime-specific approach at street segment level despite the fact that different offences present different levels of concentration (Bernasco and Steenbeek, 2016; Braga et al., 2010, 2011; Hibdon et al., 2016).

Third, the determinants of crime concentration have not been extensively explored in the literature. Very few studies examine why crime concentrates at small number of places (Clarke and Eck, 2007; Smith et al., 2000; Weisburd et al., 2012; Wikström et al., 2012), and even less consider street segment as unit of analysis (Johnson and Bowers, 2010; Weisburd et al., 2012). Thus, the existence of concentrations of crimes within the street network is largely supported, but the worldwide scientific community has not largely investigated the determinants of their presence. This is mainly due to difficulties in collecting longitudinal contextual data at such a small unit of geography. Systematic research on the causal factors are still scarce and usually relays on the theoretical framework of the opportunity theories of crime. Recently, environmental studies have combined opportunity and social disorganization theories as possible explanations of crime at micro level (Ceccato and Oberwittler, 2008; Dugato, 2014; Johnson and Bowers, 2010; Rice and Smith, 2002; Smith et al., 2000; Uittenbogaard and Ceccato, 2012; Weisburd et al., 2012, 2014). This approach of theoretical integration originated an intense debate among scholars who claim that social disorganization theory may be ineffective at street segment level (Braga and Clarke, 2014) and researchers who support the idea that conjugating the theoretical frameworks will help in better understanding micro dynamics of crime because both opportunity and social disorganization factors play an important role as crime determinants (Braga and Clarke, 2014; Weisburd et al., 2012, 2014). In light of this, crimes can be influenced by factors that are physically part of the street segment network (e.g., number of targets, guardians, accesses), as well as by streets’ contextual factors (e.g., socio-economic composition, land use, level of urbanization, level of collective efficacy) (Johnson and Bowers, 2010; Weisburd et al., 2012). Indeed, if street segments are conceived as behaviour-settings it is possible to conceptualize them as small communities with specific social, economic and environmental conditions.
The present study aims to address these limitations testing the presence, stability and determinants of crime concentration in Milan (Italy) over a 7-year period (2007-2013). This study represents an unique opportunity to explore crime concentration in Italy and to extend the literature on the criminology of place investigating clusters of different crime types.

**The present study**

This study not only aims at testing for the first time the presence and the stability of crime concentration at street segment level in Italy (Milan)\(^5\), but seeks to identify the determinants of this concentration from an opportunity and social disorganization perspective taking into account specific crime types (burglary and robbery). The elaboration of targeted preventive measures, capable of combining place-oriented strategies with comprehensive social interventions, starts also from here. Two specific objectives guide this analysis:

- **Objective 1: Testing the presence and stability of crime concentration in Italy**

This study hypothesizes that crime concentrates at street segments in Milan, since many other studies confirm the presence, and in few cases also the stability, of clusters of crime in Europe (Bernasco, 2008; Ceccato and Oberwittler, 2008; Johnson and Bowers, 2010; Steenbeek and Weisburd, 2016; Uittenbogaard and Ceccato, 2012) and in Italy (Dugato, 2013, 2014).

- **Objective 2: Testing the effect of opportunity and social disorganization theories in explaining crime concentration**

This study hypothesizes that both opportunity and social disorganization factors play a role in explaining crime concentration in Milan. To the author’s knowledge, there are no other studies testing the factors influencing crime concentration in Italy, but previous research on crime distribution in other European cities have supported a theoretical integration of these frameworks (Ceccato and Oberwittler, 2008; Dugato, 2013; Johnson and Bowers, 2010; Uittenbogaard and Ceccato, 2012).

**Data and methods**

This paragraph presents the data and the methodologies used to achieve the objectives.

**Objective 1: Testing the presence and stability of crime concentration in Italy**

A street segment analysis was conducted in the city of Milan. Lorenz’s curve and Gini coefficient were presented to test the presence of the concentration of burglaries and robberies.\(^x\) The stability patterns were tested through a group-based trajectory analysis (Zero Inflated Poisson [ZIP]).\(^{xi}\)

**Street segments network**

This study defined a street segment as both sides of the street between two intersections (Weisburd et al., 2012; Weisburd, 2015; Weisburd and Amram, 2014). The preparation of the street segments network started from a shape-file of the streets obtained through the SIT - Sistema Informativo Territoriale of the Municipality of Milan. Segments were specifically
created 1) when a street crossed beyond Milan city limits and 2) at a “T” intersection. The final number of segments in Milan is 18,973 with an average length of 106 meters.

Crime data

Crime incident data were provided by the Italian Ministry of the Interior. They included reported burglaries and robberies registered between 2007 and 2013. Information of police records permitted to geocode 50.4% of robberies and 70.8% of burglaries occurred in Milan between 2007 and 2013. These are quite high geocoded percentages for Italy. The precision of law enforcement records is still very low, especially if compared to the US. This is a limit that is important to consider when presenting the results. The total number of crime events included in the study is 43,615 of which 25.5% are robberies (11,138) and 74.5% are burglaries (32,477). Percentages of completed events are higher (79.9% for burglary and 88.8% for robbery) than the attempted ones (20.1% and 11.1%). The trend of geocoded burglaries follows the distribution of the registered burglaries between 2007 and 2013, whereas the trend of geocoded robberies in 2012 and 2013 does not match the distribution of registered robberies. The results coming from the analysis of data on robberies have to be interpreted with particular caution. The total number of geocoded robberies and burglaries were joined based on their spatial location with their corresponding street segments using ArcGIS 10.1. The final sample included 11,138 robberies and 32,477 burglaries joined with 18,973 street segments.

Objective 2: Testing the effect of opportunity and social disorganization theories in explaining crime concentration in Italy

To understand the effects that influence burglary and robbery concentration negative binomial regressions models were conducted using STATA 12.0. This model is a generalization of Poisson regression, since it has the same mean structure, but it has an extra parameter to model the over-dispersion. This method was preferred to a Poisson regression model because the dependent variables included in the analysis are over-dispersed, meaning that their conditional variance exceeded their conditional mean (Hilbe, 2011; Long, 1997). Negative binomial regression models are largely used in social-sciences where the dependent variable is countable with a skewed distribution.

Dependent variables

The dependent variables are the average number of burglaries and robberies reported in each street segment from 2007 to 2013. Since it was not possible to collect longitudinal data for the explanatory variables, the analysis focuses on a fixed point in time. Two different models were computed depending on which crime type was analysed. Two additional models were included in the Annex I to test the effects of the same explanatory variables on a standardized version of the dependent variables. As first attempt, the average number of burglaries was standardized on the length of the street segments, whereas the average number of robberies on the resident population.

TABLE 1. HERE
On average between 2007 and 2013, a street segment experienced 0.24 burglaries and 0.08 robberies (Table 1). The majority of the segments registered 0 burglaries (57.7%) and robberies (75.8%). On average, they experienced a maximum of 8.4 burglaries and 21.0 robberies.

Explanatory and control variables

The explanatory variables come from the opportunity and social disorganization theories. Difficulties in collecting geocoded data at such a small unit of geography only permit to gather information in a fixed point in time for explanatory and control factors. Thus, it was not possible to conduct a longitudinal analysis on the entire period 2007-2013.\textsuperscript{xiv}

Burglary and robbery differ in\textit{ modus operandi}, in property stolen, in the interaction with the victim, and in other dynamics. As a consequence, this study creates different models to understand which are the factors influencing these crimes. Clarke (Clarke, 1980, 1992) has already stressed the importance of targeting specific preventive measures to specific crimes.

In the models the choice of the opportunity variables was driven by the crime type, whereas the same social disorganization conditions are supposed to influence both crimes. While opportunities are situational, based on the here and now, social disorganization factors are settled in the street segments’ social environment.

Table 2 and Table 3 summarise all the information regarding the opportunity factors included in the models. The tables present a brief definition of each variable and its operationalization, the source, the year of availability, the type of proxy represented by the variable (target, guardian, accessibility) and the type of variable (explanatory or control). The social disorganization factors are summarised in a single table and they are the same for both models (Table 4). Variables measuring social disorganization represent structural features of the places and specific characteristics of the communities, so they can affect any crime type. The variables were selected following existing literature and being consistent with Weisburd, Groff and Yang (Weisburd et al., 2012) which represents the starting point of this analysis. However, the study choses a set of factors that were reshaped on the peculiarities of Milan and readapted according to data availability.

The model for burglary includes as opportunity factors: resident population, schools, police stations, bus stops and streets with limited access. Retail shops, licensed premises and personal care shops are used as controls (Table 2).\textsuperscript{xv} Residents represent potential victims and if the number of residents is high in a street segment, so it should be the number of houses/apartments that are targets for motivated offenders. Schools are perceived as crime attractors because they are usually concentrated in residential areas. A buffer of 100 meters was created around each school because crime attractors are supposed to have an impact also in their proximity (Groff and McCord, 2011; Weisburd et al., 2012). The variable is expressed as a dummy, so 78.7% of the segments do not have any school, whereas 21.3% present at least a school. The presence of a police station in a street segment or in its proximity is expected to be correlated with less crime events compared to streets without any station (Dugato, 2013, p. 20; Weisburd et al., 2012). Milanese police stations and their 100 meters buffer were used as a proxy of guardianship. Several studies have investigated the effects of bus stops on criminal behaviour (Levine et al., 1986; Loukaitou-Sideris, 1999; Yu, 2011). They are often used as a measure of public transport accessibility and their presence is
associated with an increase of crime occurrence (Gerell and Kronkvist, 2016; Groff and McCord, 2011; Weisburd et al., 2012). The presence of a bus/tram stop on a segment should increase the possibility to reach a target in that street and consequently increase crime. Conversely, streets with limited access are supposed to be negatively correlated with crime occurrence (Weisburd et al., 2012). In Milan, the Limited Traffic Zones (ZTL) limit the traffic in specific congested areas of the city at specific hours. ZTL segments are more controlled and supposedly less prone to crime occurrence.

The model for robbery includes as opportunity factors: retail shops, licensed premises, personal care shops, bank branches, police stations and bus stops. Residents which are an opportunity factor of the burglary’s model, are used as controls (Table 3). Retail shops are any kind of business who sells products in the city. They represent a proxy of suitable targets because they contribute to attract people in specific places during the day. Potential victims are both employees of these retail shops and possible clients who may have money to spend that can be stolen. Licenced premises such as bars, restaurants, night clubs and other premises who have the licence to sell alcohol to their clients are also crime attractors for suitable targets, especially during the night. Moreover, these places are often connected with crime events, usually violent crimes (Abbey, 2011; Ayres and Treadwell, 2012; Brady and Li, 2013; Gerell and Kronkvist, 2016; Murray and Roncek, 2008), especially robberies (Ceccato and Oberwittler, 2008; Gaziarifoglu, 2011). From one hand, the use and abuse of alcohol makes people more aggressive and prone to be engaged in fights, assaults and other forms of violence. From the other hand, drunk people can be the target of motivated offenders for street robberies. Dugato (2013) stressed the importance of including these venues as crime generators/attractors in Milan. Personal care shops can also attract suitable targets, especially female and quite wealthy victims. Including this variable permitted to consider different targets in the analysis of robberies’ patterns. The presence of bank branches has been proved to be correlated with robberies in Milan (Dugato, 2013, 2014). Indeed, the closeness to a bank branch increases the risk of being victim of a robbery. Police stations and bus stops were included as measures of guardianship and accessibility also in the case of robbery.

Social disorganization factors included in the analysis are: real estate values, public housing, land use (residential/mixed), disorder (physical/social), presence of associations, urbanization. The controls for social disorganization are the length of the street and the spatial lag (Table 4). The values of the real estate are a proxy of the wealth of each segment. It was assumed that the street segments that present real estate values higher than the average can be considered in a more valuable area from an economic point of view. The values are expressed as a dummy to diversify the segments presenting real estate values under the average of the distribution and the segments presenting values above the average. This variable represents an indicator of the socio-economic advantages assuming that segments presenting values above the average would be more prone to experience crime (Dugato, 2013). The presence of public housing is an indicator of the socio-economic disadvantages which may also be related with high level of crime (Kubrin and Weitzer, 2003). Indeed, crime is often associated with poor and deteriorated neighbourhoods (Sampson and Groves, 1989; Smith et al., 2000). Poor areas usually present poorly designed environment that can increase crime opportunities. The number of public housing is a proxy of both socio-economic disadvantages and poorly designed environments (Dugato, 2013). Another aspect related to social disorganization is the
type of land use (Sampson and Groves, 1989). This study includes both residential and mixed land use in its analysis. The first hypothesis is that residential land use is positively correlated with both burglary and robbery. Indeed, residential land presents many target opportunities for both crimes. Controversial is the relationship between mixed land use and crime. Several studies have proved how mixed lands are more likely to experience higher crime rates because of the weaker ties present among their residents (Groff and McCord, 2011; Roncek, 2000; Weisburd et al., 2012) and the lack of social control (Taylor, 1997; Wilcox et al., 2004). On the other hand, the presence of bars, theatres and cinemas can enhance the vitality of an area which is usually empty during the evening/night and increase the perceived security. In the latter case, mixed land use could play a positive effect in reducing crime (Jacobs, 1961). This study hypothesises both a positive and negative relationship between mixed lands and crime. Residential and mixed land use were operationalized as dummy variables, so a street segment can be non-residential/residential or non-mixed/mixed. The idea that physical and social disorder could affect crime occurrence goes back to the Broken Windows Theory (Kelling and Wilson, 1982; Zimbardo, 1969). Disorder can deteriorate informal social control creating fear of crime (Skogan, 1986, 1990). In this study, the variable measuring physical and social disorder is countable and includes a number of single events of disorder reported by the Milanese Local Police. These events are supposed to be positively correlated with crime at street segment level. Conversely, the number of associations are supposed to be negatively correlated with crime. Sampson, Raudenbush, and Earls (Sampson et al., 1997) extended the concept of social disorganization including also collective efficacy which is the capacity of a community to realize common values and regulate behaviour through mechanisms of mutual trust. The presence of associations should measure civic engagement and community trust. Finally, starting from the first theorization of Burgess’s concentric zone model (Burgess, 1925) several authors have identified the importance of measures of urbanization. Different areas of the city can experience different crime patterns depending on their distance from the city-centre. Two circular rings cut the radial network of Milan in three concentric zones, namely Centre, Circle1 and Circle2. The more peripheral areas are supposed to present higher level of crime compared to the Centre. Despite the Centre is a residential area for most of its part, it is also a very important commercial and business area of the city. In addition, the access to the historical centre is limited by the Congestion Charge area (Area C) and this can influence the accessibility in the area and discourage motivated offenders.

Table 2; Table 3 and Table 4 HERE

Results

For the sake of clarity, the results are presented according to the study’s objectives.

Objective 1: Testing the presence and stability of crime concentration in Italy

Both burglary and robbery concentrations are present in Milan. On average, 4.0% and 1.6% of the street segments in the city accounts for 50% of burglaries and robberies, respectively (Figure 1 and Figure 2). Generally speaking, robbery experiences a higher crime concentration compared to burglary over the years. This is also confirmed by the Lorenz
curve and the Gini coefficient equal to 0.772 for burglary and 0.868 for robbery (Figure 3). This difference might be due to the smaller number of robberies’ targets (e.g., bank branches) and facilitators (e.g., crowded places) compared to burglaries’ targets (e.g., houses and apartments) which are more present in the territory. This result supports the idea of tailoring the analysis on specific crime types to better target prevention policies.

Figure 1; Figure 2; Figure 3 HERE

Aggregating all the incidents occurred between 2007 and 2013, 8.2% of the street segments account for 50% of burglaries and 4.0% for 50% of robberies supporting previous results at European level (Bernasco and Steenbeek, 2016; Steenbeek and Weisburd, 2016). However, these represent higher percentages if compared with the concentration levels experienced each single year. This means that not always the same street segments are experiencing burglaries and robberies over the years. Thus, the concentrations do not seem to present a great stability over the 7-year period assuming a possible variability in the level of concentration of specific crime types as recently theorised by Hipp and Kim (2016). Group-based trajectory analysis for burglary (Figure 3) identifies a chronic-crime trajectory pattern (number 7) involving a residual 0.2% of the street segments where, on average, 3.1% of burglaries occurred between 2007 and 2013. There is also a high-rate increasing pattern involving 1.7% of the street segments that could generate possible chronicity in the future. In the case of robbery, the analysis highlights low-stable trajectory patterns (number 1, 2), a moderate-stable trajectory pattern (number 3) and a high-rate decreasing trajectory pattern (number 4). No chronic-crime trajectory pattern was identified (Figure 4).\textsuperscript{xix} For the streets belonging to the burglary chronic-crime trajectory and the robbery moderate-stable trajectory it is possible to articulate targeted preventive measures considering the specific crime type happened in those small areas over the years. For the other trajectories it is difficult to identify a crime problem or to predict crime events.

Figure 4; Figure 5 HERE

Objective 2: Testing the effect of opportunity and social disorganization theories in explaining crime concentration in Italy

The results of the models highlight that social disorganization factors play an important role in explaining crime concentration at street segment level in Milan (Table 5). Both opportunity and social disorganization determinants present interesting results, but the ones coming from the social structure are always significant. The models indicate that all the variables are significantly correlated with the presence of burglaries, except for schools and bus/tram stops, and with the presence of robbery, except for streets with limited access.\textsuperscript{xx}

Streets with limited access and police stations, as hypothesized, have a negative correlation with burglaries. The Incidence Rate Ration (IRR) suggests that the average number of burglaries in a street segment decreases, by approximately, 36.0% (IRR=0.640) if a segment is at limited access and 13.5% (IRR=0.865) with every one unit increase of police stations. Interestingly, streets with limited access are not significantly correlated with robberies. Robberies, especially street robberies, are usually carried out without the use of vehicles, so segments with limited access to vehicles are not influential in explaining robbery
occurrence. Contrarily, the presence of bank branches in a segment is positively and significantly correlated with robberies in Milan. The average number of robberies at each street segment increases by approximately 60.8\% (IRR=1.608) with every one unit increase of bank branches. Bank branches are perfect targets for bank and street robbers who hit people withdrawing money from ATM machines. Robberies increase also by approximately 6.0\% (IRR=1.060), 5.7\% (IRR=1.057) and 2.3\% (IRR=1.023) every one unit increase of, respectively, retail shops, licenced premises, personal care shops. The risk of victimization increases also with the presence of bus and tram stops. Every one unit increase of them lead to a 17.0\% of increase in the average number of robberies, which often happen in crowded places such as transports’ stops. Conversely, bus and tram stops are not significantly correlated with burglaries. This crime is often committed with a private or stolen vehicle rather than using public transports. Residents are positively and significantly correlated with burglaries (IRR=1.204), whereas schools do not seem to be a fitting variable to measure suitable targets in the city. The lack of direct information on the presence of houses/apartments should be better addressed finding more appropriate measurements.

Social disorganization factors are always highly significant for both models. Burglary is positively correlated with residential land use and negatively correlated with mixed land use. Being a segment located in a residential area may increase the average number of burglaries by 124\% (IRR=2.237), whereas being located in a mixed area may decrease the average number of burglaries by 30.9\% (IRR=0.691). Both residential and mixed lands work as mitigating factors for robbery. They decrease the average number of robberies by respectively 11.6\% and 35.4\%. The characteristics of residential areas are not suitable for robbers and mixed areas work as informal control intimidating possible offenders. The coexistence of residential and commercial premises in a street segment can discourage possible robbers and burglars. Being inside the Circle1 increases the average number of both burglaries and robberies by approximately 62.2\% (IRR=1.622) and 78.1\% (IRR=1.781) compared to segments that are outside Circle1. The increase is about 37.7\% (IRR=1.826) for burglary and 63.0\% (IRR=1.630) for robbery if the segment is inside the Circle2 compared to segments that are outside Circle2. Segments in Circle1 and Circle2 seems to be more criminogenic than the ones of the city centre. Both public housing and disorder have a positive and significant effect on burglary and robbery, as well as real estate values. These variables do not present high coefficients, but all of them confirm previous hypotheses. Contrarily, the presence of associations, which should be a measure of collective efficacy and should be negatively correlated with crime, has also a positive effect on crime. The variable represents a proxy of civic engagement. However, this has turned into a measure positively associated with crime. As Braga and Clarke (2014) stressed in their piece, which was largely supported by Weisburd et al. (2014), it is difficult to measure collective efficacy at street segment level. These authors focused on the necessity to better improve data collection at small units of geography to better shape the analysis and to produce better results. This is valid also for this study that had sometimes to reshape its measurements according to data availability. In the next chapter this issue will be discussed together with the main findings and further research application.

Table 5 HERE
References


FIGURES

Figure 1. Percentage of street segments that accounts for 50% and 100% of burglaries

Source: author’s elaboration of Ministry of Interior’s data

Figure 2. Percentage of street segments that accounts for 50% and 100% of robberies

Source: author’s elaboration of Ministry of Interior’s data

Figure 3. Lorenz curve for burglary and robbery (2007-2013)

Source: author’s elaboration of Ministry of Interior’s data
Figure 4. Trajectories of reported burglaries. Year 2007-2013

Source: author’s elaboration of Ministry of Interior’s data

Figure 5. Trajectories of reported robberies. Year 2007-2013

Source: author’s elaboration of Ministry of Interior’s data
**TABLES**

Table 1. Descriptive statistics of the dependent variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Observations</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burglary</td>
<td>18973</td>
<td>.24</td>
<td>.47</td>
<td>0</td>
<td>8.4</td>
</tr>
<tr>
<td>Robbery</td>
<td>18973</td>
<td>.08</td>
<td>.32</td>
<td>0</td>
<td>21.0</td>
</tr>
</tbody>
</table>

*Source: author’s elaboration of Ministry of the Interior’s data*
<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
<th>Year</th>
<th>Proxy</th>
<th>Type of variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents</td>
<td>Resident population on each street segment expressed as a fraction of 100</td>
<td>ISTAT</td>
<td>2010</td>
<td>Target</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Schools</td>
<td>Total number of schools with a 100mt buffer that are on or intersect street segments</td>
<td>Municipality of Milan</td>
<td>2013</td>
<td>Target</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Police Stations</td>
<td>Total number of police stations with a 100mt buffer that are on or intersect street segments</td>
<td>Polizia di Stato</td>
<td>2012</td>
<td>Guardian</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Bus stops</td>
<td>Total number of bus stops on each street segment</td>
<td>Municipality of Milan</td>
<td>2013</td>
<td>Accessibility</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Streets with limited access</td>
<td>Dummy variable (1= presence of a segment with limited access)</td>
<td>Municipality of Milan</td>
<td>2013</td>
<td>Accessibility</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Retail shops</td>
<td>Total number of retail shops on each street segment</td>
<td>Municipality of Milan</td>
<td>2013</td>
<td>Guardian</td>
<td>Control</td>
</tr>
<tr>
<td>Licensed premises</td>
<td>Total number of licensed premises on each street segment</td>
<td>Municipality of Milan</td>
<td>2013</td>
<td>Guardian</td>
<td>Control</td>
</tr>
<tr>
<td>Personal care shops</td>
<td>Total number of personal care shops on each street segment</td>
<td>Municipality of Milan</td>
<td>2013</td>
<td>Guardian</td>
<td>Control</td>
</tr>
</tbody>
</table>

Source: author’s elaboration
Table 3. Summary of the opportunity factors used in the model for robbery

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
<th>Year</th>
<th>Proxy</th>
<th>Type of variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail shops</td>
<td>Total number of retail shops on each street segment</td>
<td>Municipality of Milan</td>
<td>2013</td>
<td>Target</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Licensed premises</td>
<td>Total number of licensed premises on each street segment</td>
<td>Municipality of Milan</td>
<td>2013</td>
<td>Target</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Personal care shops</td>
<td>Total number of personal care shops on each street segment</td>
<td>Municipality of Milan</td>
<td>2013</td>
<td>Target</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Bank branches</td>
<td>Total number of bank branches on each street segment</td>
<td>ABI</td>
<td>2011</td>
<td>Target</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Police Stations</td>
<td>Total number of police stations with a 100mt buffer that are on or intersect street segments</td>
<td>Polizia di Stato</td>
<td>2012</td>
<td>Guardian</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Bus stops</td>
<td>Total number of bus stops on each street segment</td>
<td>Municipality of Milan</td>
<td>2013</td>
<td>Accessibility</td>
<td>Explanatory</td>
</tr>
<tr>
<td>Residents</td>
<td>Resident population per street segment expressed as a fraction of 100</td>
<td>ISTAT</td>
<td>2010</td>
<td>Target/Guardian</td>
<td>Control</td>
</tr>
<tr>
<td>Schools</td>
<td>Total number of schools with a 100mt buffer that are on or intersect street segments</td>
<td>Municipality of Milan</td>
<td>2013</td>
<td>Target/Guardian</td>
<td>Control</td>
</tr>
</tbody>
</table>

Source: author’s elaboration
Table 4. Summary of the social disorganization factors used in the models for burglary and robbery

<table>
<thead>
<tr>
<th>Social disorganization factors- BURGLARY and ROBBERY</th>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
<th>Year</th>
<th>Proxy</th>
<th>Type of variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Real estate value</td>
<td>Dummy variable (under/above the average) created on the average values of real estate expressed euro/m²</td>
<td>Real Estate and Land Registry Agency</td>
<td>2011</td>
<td>Socio-economic factor</td>
<td>Explanatory</td>
</tr>
<tr>
<td></td>
<td>Public housing</td>
<td>Total number of public housing on each street segment</td>
<td>Public housing’s Company (ALER)</td>
<td>2011</td>
<td>Socio-economic factor</td>
<td>Explanatory</td>
</tr>
<tr>
<td></td>
<td>Residential use</td>
<td>Dummy variable (1= segment presenting a “dense residential urban fabric”)</td>
<td>DUSAF</td>
<td>2009</td>
<td>Land use</td>
<td>Explanatory</td>
</tr>
<tr>
<td></td>
<td>Mixed use</td>
<td>Dummy variable (1= segment presenting an “irregular, sparse, discontinuous residential urban fabric”)</td>
<td>DUSAF</td>
<td>2009</td>
<td>Land use</td>
<td>Explanatory</td>
</tr>
<tr>
<td></td>
<td>Physical and social disorder</td>
<td>Total number of physical and social events happened at each street segment</td>
<td>Local Police</td>
<td>2000-2010</td>
<td>Disorder</td>
<td>Explanatory</td>
</tr>
<tr>
<td></td>
<td>Associations</td>
<td>Total number of associations at each segment</td>
<td>Municipality of Milan</td>
<td>2013</td>
<td>Collective efficacy</td>
<td>Explanatory</td>
</tr>
<tr>
<td></td>
<td>Circle 1</td>
<td>Dummy variable (1= segments belonging to the first circle)</td>
<td>Municipality of Milan</td>
<td>2013</td>
<td>Urbanization</td>
<td>Explanatory</td>
</tr>
<tr>
<td></td>
<td>Circle 2</td>
<td>Dummy variable (1= segments belonging to the second circle)</td>
<td>Municipality of Milan</td>
<td>2013</td>
<td>Urbanization</td>
<td>Explanatory</td>
</tr>
<tr>
<td></td>
<td>Length</td>
<td>Length of each street segment in meters</td>
<td>Authors’ elaboration</td>
<td>2014</td>
<td>Type of street</td>
<td>Control</td>
</tr>
<tr>
<td></td>
<td>Spatial lag</td>
<td>Measures of spatial autocorrelation</td>
<td>Authors’elaboration</td>
<td>2014</td>
<td>Type of street</td>
<td>Control</td>
</tr>
</tbody>
</table>

Source: author’s elaboration
Table 5. Results of the negative binomial regression models for burglary and robbery

<table>
<thead>
<tr>
<th></th>
<th>Burglary</th>
<th></th>
<th>Robbery</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>IRR</td>
<td>β</td>
<td>IRR</td>
</tr>
<tr>
<td><strong>Opportunity theory</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residents</td>
<td>0.186***</td>
<td>1.204</td>
<td>0.0584***</td>
<td>1.060</td>
</tr>
<tr>
<td>Schools</td>
<td>0.0208</td>
<td>1.021</td>
<td>0.0554***</td>
<td>1.057</td>
</tr>
<tr>
<td>Police stations</td>
<td>-0.145**</td>
<td>0.865</td>
<td>0.0227***</td>
<td>1.023</td>
</tr>
<tr>
<td>Bus and tram stops</td>
<td>-0.0192</td>
<td>1.019</td>
<td>0.475***</td>
<td>1.608</td>
</tr>
<tr>
<td>Streets limited access</td>
<td>-0.447***</td>
<td>0.640</td>
<td>0.168*</td>
<td>1.183</td>
</tr>
<tr>
<td><strong>Social disorganization</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real estate values</td>
<td>-0.107**</td>
<td>1.113</td>
<td>0.219***</td>
<td>1.244</td>
</tr>
<tr>
<td>Public housing</td>
<td>0.0482***</td>
<td>1.049</td>
<td>0.0506***</td>
<td>1.052</td>
</tr>
<tr>
<td>Disorder</td>
<td>0.00977***</td>
<td>1.010</td>
<td>0.0310***</td>
<td>1.031</td>
</tr>
<tr>
<td>Residential land use</td>
<td>0.805***</td>
<td>2.237</td>
<td>-0.124**</td>
<td>0.884</td>
</tr>
<tr>
<td>Mixed land use</td>
<td>-0.370***</td>
<td>0.691</td>
<td>-0.436***</td>
<td>0.646</td>
</tr>
<tr>
<td>Associations</td>
<td>0.253***</td>
<td>1.288</td>
<td>0.160**</td>
<td>1.173</td>
</tr>
<tr>
<td>Circle 1</td>
<td>0.484***</td>
<td>1.622</td>
<td>0.577***</td>
<td>1.781</td>
</tr>
<tr>
<td>Circle 2</td>
<td>0.320***</td>
<td>1.377</td>
<td>0.489***</td>
<td>1.630</td>
</tr>
<tr>
<td><strong>Controls</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail shops</td>
<td>0.0305***</td>
<td>1.031</td>
<td>0.00118***</td>
<td>1.000</td>
</tr>
<tr>
<td>Licensed premises</td>
<td>0.0988***</td>
<td>1.104</td>
<td>-2.3e-06</td>
<td>1.000</td>
</tr>
<tr>
<td>Personal care shops</td>
<td>0.0249***</td>
<td>1.025</td>
<td>-3.459***</td>
<td>0.031</td>
</tr>
<tr>
<td>Length</td>
<td>0.00274***</td>
<td>1.003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spatial lag</td>
<td>-1.28e-05***</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-2.812***</td>
<td>0.060</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pseudo R² (McFadden's R²)</strong></td>
<td>0.1643</td>
<td></td>
<td>0.1126</td>
<td></td>
</tr>
</tbody>
</table>

*** p<0.01, ** p<0.05, * p<0.1
Table 6. Results of the standardized negative binomial regression models for burglary (ANNEX I)

<table>
<thead>
<tr>
<th></th>
<th>Burglary standardized on the street segments’ length</th>
<th>( \beta )</th>
<th>IRR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Opportunity theory</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residents</td>
<td></td>
<td>0.126***</td>
<td>1.134</td>
</tr>
<tr>
<td>Schools</td>
<td></td>
<td>0.00777</td>
<td>1.008</td>
</tr>
<tr>
<td>Police stations</td>
<td></td>
<td>-0.226***</td>
<td>0.798</td>
</tr>
<tr>
<td>Bus and tram stops</td>
<td></td>
<td>-0.0343</td>
<td>0.966</td>
</tr>
<tr>
<td>Streets limited access</td>
<td></td>
<td>-0.445***</td>
<td>0.641</td>
</tr>
<tr>
<td><strong>Social disorganization</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real estate values</td>
<td></td>
<td>0.101**</td>
<td>1.106</td>
</tr>
<tr>
<td>Public housing</td>
<td></td>
<td>0.0521***</td>
<td>1.053</td>
</tr>
<tr>
<td>Disorder</td>
<td></td>
<td>0.0133***</td>
<td>1.013</td>
</tr>
<tr>
<td>Residential land use</td>
<td></td>
<td>0.776***</td>
<td>2.173</td>
</tr>
<tr>
<td>Mixed land use</td>
<td></td>
<td>-0.350***</td>
<td>0.704</td>
</tr>
<tr>
<td>Associations</td>
<td></td>
<td>0.219***</td>
<td>1.244</td>
</tr>
<tr>
<td>Circle 1</td>
<td></td>
<td>0.447***</td>
<td>1.564</td>
</tr>
<tr>
<td>Circle 2</td>
<td></td>
<td>0.277***</td>
<td>1.320</td>
</tr>
<tr>
<td><strong>Controls</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail shops</td>
<td></td>
<td>0.0296***</td>
<td>1.030</td>
</tr>
<tr>
<td>Licensed premises</td>
<td></td>
<td>0.115***</td>
<td>1.122</td>
</tr>
<tr>
<td>Personal care shops</td>
<td></td>
<td>0.0215***</td>
<td>1.022</td>
</tr>
<tr>
<td>Spatial lag</td>
<td></td>
<td>-1.02e-05***</td>
<td>0.999</td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td>-2.410***</td>
<td>0.090</td>
</tr>
<tr>
<td>Pseudo R(^2) (McFadden’s R(^2))</td>
<td></td>
<td></td>
<td>0.0917</td>
</tr>
</tbody>
</table>

*** p<0.01, ** p<0.05, * p<0.1
Notes

1 More information on the units of analysis in geographic criminology can be gathered from Weisburd et al., 2009.
2 Residents living in the same street segment become familiar, share the same rituals (i.e., the mail carrier who delivers at the same time of the day, the same cleaning service of the roads and the same days for the collection of the recycle bins), and develop roles they play in the streets’ daily life (Taylor, 1997).
4 The law states that “for a defined measure of crime at a specific micro geographic unit, the concentration of crime will fall within a narrow bandwidth of percentages for a defined cumulative proportion of crime” (Weisburd, 2015, p. 138).
5 The studies conducted in Tel Tel Aviv-Yafo (Israel) and Jaipur (India) did not present a longitudinal analysis investigating the stability patterns and the determinants of crime concentration at street segments (Mazeika and Kumar, 2016; Weisburd and Amram, 2014). An analysis of the causes of crime is missing also in the studies conducted in Vancouver (Canada) (Andresen et al., 2016a, 2016b; Curman et al., 2015).
6 Opportunity theories mainly concern crime situational prevention (Clarke, 1980, 1992), routine activity theory (Cohen and Felson, 1979, p. 197) and crime pattern theory (Brantingham and Brantingham, 2008, 1993). All of them place a great emphasis on the role of the context in providing crime opportunities (Weisburd, 2015).
7 Social disorganization theory emerged from the Chicago School’s ecological theories. Crime is linked with the ecological characteristics of the neighbourhoods. Both physical (e.g., urban deterioration, proximity with industrial lands) and social characteristics (e.g., poverty, racial heterogeneity, unemployment) can influence crime occurrence. The weakening of social bonds intensifies the crime problem (Shaw and McKay, 1942).
8 For more insights on the theoretical integration see Bernard and Snipes (1996).
9 According to the most updated census data, the city counted 1,350,680 citizens in 2014 (Comune di Milano, 2014). With a surface of 181.76 km², the city present a very high population density (7,431.12 inhabitants/km²) compared to most American cities. The urban centre presents a mono-centric radial structure characterized by a dense and irregular street network.
10 The Lorenz curve is a graph that was originally designed to visualize income inequality, but it has also been used in various other disciplines. In the case of crime concentration, “the Lorenz curve is a function that links the cumulative distribution of a variable (e.g. crime) to the cumulative distribution of observational units (e.g. places). [...] The Gini coefficient [...] summarizes the level of concentration in a single number between 0 and 1, the former representing a completely equal distribution of crimes across places, and the latter representing maximal concentration of all crimes in a single place” (Barnasco and Steenbeek, 2016).
11 Daniel Nagin developed the group-based trajectory analysis to understand if micro-places have generally stable concentrations of crime over time (Nagin and Land, 1993). Longitudinal data are the basis of this analysis and the “developmental trajectory is used to describe the progression of any phenomenon, whether behavioural, biological, or physical” (Nagin, 2010, p. 53).
12 The number of street segments in Seattle and Tel Aviv-Yafo was, respectively, 24,023 and 17,160 with an average length of 118 meters and 62 metres.
13 The over dispersion of the dependent variables was tested through a likelihood test of the dispersion parameter (α). The likelihood ratio test compares Negative binomial to a Poisson model. The results of this test suggests that alpha is non-zero in all the models, so Negative binomial model is more appropriate.
14 Data collected on these determinants covered the years from 2009 to 2013, assuming these factors have remained quite stable over this timespan. This cannot be assumed if going back to 2008 when the economic crisis hit the world, but especially the South European countries, changing economic, social and political assets. From a theoretical point of view, it is risky to assume stability before and after 2008. For this reason, explanatory variables were collected for the last available year, but not going back to the years before 2009. The only exception is represented by the variable disorder which includes a number of events reported by the Milanese Local Police between 2000 and 2010 (the entire dataset was included to create a larger sample).
15 These are the opportunity factors of the robbery’s model.
16 This category includes supermarkets, clothing/shoe stores, newspapers kiosks, pharmacies, butcher shops, bakeries, perfume shops and others.
17 Disorder is described as a violation of the social rules in the use of public spaces that can lead to a condition of decay of the public areas helping the proliferation of crime caused by the lack of formal/informal control.
18 The concept of collective efficacy is broad and includes many other measurements (e.g., active voters).
19 It is worth mentioning that the geocoding rate could have affected these results.
20 Levels of significance are different (p<0.01, p<0.05, p<0.1).