# Introduction

The research in crime location choice has seen a notable shift from examining larger spatial units such as states, cities, and neighborhoods (Baumer et al., 1998; Loftin & Hill, 1974) to a micro-unit like street segments and face blocks (Eck & Weisburd, 1995; Sampson & Groves, 1989). This transition to micro-level analysis is important to improve our understanding of the location choice of offenders. The focus on the micro units enables us to understand crime trends with greater precision (Weisburd et al., 2004). The granularity of micro-level analysis enhances our theoretical comprehension of crime location choice and plays a major role in shaping crime prevention strategies and policymaking. However, despite its growing popularity, there is a lack of consensus in the location choice literature regarding the impact of multiple spatial scales. This raises a question about the universal applicability and reliability of conclusions drawn from micro-level spatial analyses. This gap highlights the necessity for systematically exploring the influence of various spatial scales on crime location choice studies. This effort is needed for theoretical evolution and practical application.

Recent research in crime location choice (e.g., shows growing interest in using micro-level spatial units. However, these studies highlight a key issue: there's still uncertainty about how different spatial scales impact the ability to compare and understand crime data from various studies. This lack of clarity and comparability presents a significant challenge, as it undermines the ability to better understand crime patterns and hinders the development of universally applicable theoretical frameworks. Therefore, addressing this issue is important for enhancing the efficacy of practical applications derived from crime location choice research findings.

In this study, we aim to examine the effects of multiple spatial scales on crime location choice of robbery using data sets from Chennai and Chicago. This examination aims to bridge the gap in understanding how different spatial units impact the analysis and interpretation of crime data.First, we review existing literature to map the evolution of spatial scale usage in crime location choice research and to understand the current state of knowledge. Then, we empirically analyze crime data sets at multiple spatial scales using the discrete choice method. This analysis demonstrates how varying spatial units could lead to different interpretations and conclusions about crime location choice. By achieving these objectives, this paper seeks to improve the understanding of spatial scales' role in crime location choice research and contribute to the crime location choice literature.

This paper is structured as follows: First, we present a literature review providing an overview and historical perspective on the use of spatial scales in location choice studies. A data and methods section follows this. Next, we present an empirical analysis examining the influence of multiple spatial scales on crime location choice. The paper concludes with a discussion of the findings and their implications.

# ****Literature Review****

The crime location choice research has significantly transformed from its initial focus on larger geographic units to micro-level analysis. Prior studies mostly analyzed larger geographic units such as states, cities, and neighborhoods, laying a foundational understanding of crime patterns across broader areas (Baumer et al., 1998; Loftin & Hill, 1974). These studies were important in proving foundational knowledge about crime distribution and its correlation with characteristics of larger spatial units. However, the introduction of micro place analysis marked a major shift in crime location choice research, focusing on more specific places like street segments, census blocks or grid cells (e.g., Bernasco, 2019; Bernasco et al., 2013; Bernasco & Jacques, 2015). This shift was not merely a change in the unit of analysis but provided an understanding of crime trends at the micro-level.

This shift to micro-level analysis was influenced by emerging theoretical perspectives that the crime and the opportunities are presented at micro-places (Curman et al., 2015; Weisburd et al., 2004). Hence, it is important to study crime patterns at a micro-level where the details of offending behavior are distinct from macro-level analysis. Micro-level analysis has provided insights into crime trends and patterns and enabled researchers to identify and examine the specific characteristics of places that influence crime, such as the presence of crime generators and attractors, and how these influence crime location choice (Bernasco & Block, 2011; Kuralarasan & Bernasco, 2022).

Further, crime concentration at micro places makes it an important unit of analysis to understand crime patterns (Groff et al., 2010). Additionally, crime is not uniformly distributed but is concentrated in micro places (Brantingham & Brantingham, 2017), often with high stability over time (Curman et al., 2015). This concentration and stability challenge the idea of crime as a uniformly distributed phenomenon and highlight the importance of micro-level analysis in understanding the spatial distribution of crime. However, though smaller spatial units can offer detailed insights, one challenge with smaller units is the potential for spillover effects. This means that the characteristics of one small area, such as a street segment, might influence or be influenced by adjacent areas (Bernasco et al., 2013) and making it difficult to ignore the factors contributing to crime in micro-places.

Furthermore, crime data is often aggregated at larger scales, such as neighborhoods or census tracts. While smaller units provide detailed insights, the availability and common use of larger-scale data is one reason for including larger units in spatial analysis. It is evident from the crime location choice literature that both macro and micro units are preferred. However, there are noticeable gaps, particularly when comparing results across different spatial units. The lack of a standard approach for choosing the appropriate spatial unit for analysis makes comparing and consolidating findings from different studies difficult. Our research aims to address these gaps by reviewing how prior crime location choice used spatial scales and quantitative analysis of how different spatial scales impact the crime location choice of robbery in Chennai and Chicago, thereby contributing to understanding the location choice of crime.

Table 1 presents the prior studies on crime location choice, spatial units, number of incidents, number of units and name of the incidents. These studies are based on three sources. First set of studies are based on the review of location choice research by Ruiter, (2017). Second, we updated this list based on a CSV file of all location choice studies from Sophie Curtis-Ham and third, we added further studies using the Boolean keywords search in Web of Science “("offender" OR "burglar" OR "robber") AND ("location" OR "target" OR "spatial") AND ("discrete" OR "choose" OR "choice" OR "select)”. Our selection criteria are studies that employed the discrete choice model, a method common in analyzing crime location choice (e.g. Bernasco & Block, 2009; Vandeviver et al., 2015). Ultimately, we included 42 distinct studies that utilize 44 various spatial scales. The studies are arranged chronologically to show how the usage of spatial scale evolved, and they indicate how studies used smaller and larger spatial units over the years.

The table indicates that studies in the early 2000s mostly used neighborhood scales. Post 2010, there was a shift towards smaller units such as postal code areas and census blocks. The emphasis on micro-spatial analysis is evident in the 16 studies that utilize street segments and individual property units. These studies account for a significant portion of the latter half of the table, indicating that contemporary studies focus on smaller spatial units that influence crime occurrence. For example, Bernasco & Jacques, (2015) used a smaller scale of 103 meters. The diversity in spatial scale also challenges the comparability and generalizability of findings across different spatial scales (Steenbeek & Weisburd, 2016; Weisburd et al., 2012). Table 1 shows that there is no standardized approach to selecting spatial units.

Despite data availability at smaller scales, some studies, even after 2020, continue to utilize larger spatial units, such as neighborhoods. For example, (A. Chamberlain et al., 2022; Long & Liu, 2022; S. van Sleeuwen et al., 2021) have employed larger units in their analysis. This enduring use of broader units may often be attributed to data availability, as larger-scale data tend to be more readily accessible than finer, more granular datasets. However, technological advancements and methodological innovations, such as interoperability - a method that allows data to be disaggregated on various scales - have made it possible to conduct detailed analyses even when they are smaller units. The current study uses such methods to examine the effects of multiple spatial scales on crime location choices. By critically analyzing and comparing findings across different spatial units, the research aims to explain how spatial scale influences the interpretation of crime patterns, addressing a critical gap identified in the existing literature.

Table 1:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S. No** | **Citation** | **Size of the unit (km2)** | **No of units** | **No of incidents** | **Unit of analysis** |
| 1 | (Bernasco & Luykx, 2003) | 0.65 | 89 | 26 | Neighborhood |
| 2 | (Bernasco & Nieuwbeerta, 2005) | 0.65 | 89 | 548 | Neighborhood |
| 3 | (Bernasco, 2006) | 0.65 | 89 | 1.174 | Neighborhood |
| 4 | (Clare et al., 2009) | 6.7 | 291 | 1.761 | Residential suburb |
| 5 | (Bernasco & Block, 2009) |  | 844 | 12.872 | Census tract |
| 6 | (Bernasco, 2010a) | < 0.805 (urban)< 3.219 (rural) | 4 | 7.179 | Postal code area |
| 7 | (Bernasco & Kooistra, 2010) |  | 4.006 | 1.539 | Postal code area |
| 8 | (Bernasco, 2010b) | 0.017 | 23.984 | 1.311 | Postal code area |
| 9 | (Bernasco et al., 2013) | 19.68 | 24.594 | 12.938 | Census block |
| 10 | (Baudains et al., 2013) |  | 4.765 | 2.299 | LSOA |
| 11 | (Townsley et al., 2015) | 8.48 | 158 | 889 | Other administrative unit |
| 12 | (Lammers et al., 2015) | 2.96 | 142 | 12.639 | Postal code area |
| 13 | (Townsley et al., 2015) | 2.04 | 131 | 398 | Other administrative unit |
| 14 | (Townsley et al., 2015) | 0.65 | 89 | 1.835 | Neighborhood |
| 15 | (Bernasco et al., 2015) | 0.51 | 1.687 | 3.337 | LSOA |
| 16 | (Bernasco & Jacques, 2015) | 0.103 | 262 | 50 | Street segment |
| 17 | (Johnson & Summers, 2015) |  | 198 | 721 | LSOA |
| 18 | (Vandeviver et al., 2015) |  | 503.589 | 4.308 | Residential property |
| 19 | (Townsley et al., 2016) | 8.48 | 158 | 2.844 | statistical local areas |
| 20 | (Menting et al., 2016) | 2.96 | 142 | 19.42 | Postal code area |
| 21 | (A. W. Chamberlain & Boggess, 2016) |  | 334 | 5.182 | Neighborhood |
| 22 | (Bernasco et al., 2017) | 19.68 | 24.594 | 12.938 | Census block |
| 23 | (Lammers, 2017) | 2.96 | 142 | 3.037 | Postal code area |
| 24 | (Frith et al., 2017) |  | 5.286 | 459 | Street segment |
| 25 | (Langton & Steenbeek, 2017) |  | 51.378 | 2.911 | Residential property |
| 26 | (S. E. M. van Sleeuwen et al., 2018) | 2.96 | 142 | 12.639 | Postal code area |
| 27 | (Menting, 2018) | 1.68 | 76 | 13.088 | Postal code area |
| 28 | (Long et al., 2018) | 1.62 | 1.973 | 527 | Community |
| 29 | (Hanayama et al., 2018) | 0.5 | 1.134 | 369 | Grid cell |
| 30 | (Song et al., 2019) | 1.62 | 1.616 | 3.436 | Census unit |
| 31 | (Frith, 2019) | 0.44 | 616 | 1.105 | Other administrative unit |
| 32 | (Bernasco, 2019) | 0.2 | 4.558 | 5.092 | Grid cell |
| 33 | (Marchment & Gill, 2019) |  | 890 | 150 | Small areas |
| 34 | (Vandeviver & Bernasco, 2020) | 0.79 | 193 | 679 | Neighborhood |
| 35 | (Menting et al., 2020) | 0.68 | 12.821 | 140 | Neighborhood |
| 36 | (Xiao et al., 2021) | 2.74 | 2.643 | 3.86 | Community |
| 37 | (Long et al., 2021) | 1.62 | 1.971 | 4.358 | Community |
| 38 | (Long & Liu, 2021) | 1.62 | 1.971 | 4.358 | Neighborhood |
| 39 | (S. van Sleeuwen et al., 2021) | 0.66 | 71 | 13.305 | Neighborhood |
| 40 | (Kuralarasan & Bernasco, 2022) | 2.18 | 201 | 1.573 | Other administrative unit |
| 41 | (Long & Liu, 2022) | 1.62 | 1.971 | 4.358 | Neighborhood |
| 42 | (A. Chamberlain et al., 2022) |  | 304 | 4.92 | Neighborhood |
| 43 | (Curtis-Ham et al., 2022b) |  | 2153 | 4.5 million | Census Statistical Area |
| 44 | (Curtis-Ham et al., 2022a) | 1.2 | 2.153 | 38.57 | Census unit statistical area |
| 45 | (Yue et al., 2023) | 1.558 | 2643 | 1540 | Community |

# Data

## Crime Data

Chennai data comprises 1573 cleared street robberies (snatching) committed by 1152 offenders from August 2010 to July 2017. The data were obtained from the State Crime Records Bureau (SCRB), Tamil Nadu, India, and included the date, time, location, age, gender, number of offenders, crime and offender addresses. The addresses are geo-coded using Google Earth. Offense locations are approximated to nearby addresses, with potential deviations up to 200 meters. The analysis includes the number of prior offenses by the same offender in each ward and the distance from the offender’s home to the crime location.

Chicago data includes 12,938 cleared street robberies committed by 18,114 offenders, recorded by the Chicago Police Department from 1996 to 1998. The data includes the date, time, number of offenders, and geo-coded location of each incident.

**Unit of Analysis**

Chennai's unit of analysis is the ward; it comprises 201 wards, and the average surface area of each ward is 2.18 km2. For the multi-scale analysis, we used three levels of square grid cells: 1500 m2, 1000 m2, and 500 m2.

Chicago's unit of analysis is census blocks, focusing on 24,594 census blocks, excluding non-land blocks and blocks without residential functions. Each block has an 844-person population, and a block with a population size of less than 100 is excluded from the analysis.

**Crime Generators and Attractors**

We used crime generators and attractors as predictors for crime location choice. For Chennai, facilities like transport hubs, educational institutions, government offices, retail facilities, and places of worship were identified using Google Earth (see Kuralarasan & Bernasco, 2022 for more details). In the case of Chicago, variables such as the presence of cash economy businesses and illegal activities. Additional variables such as accessibility of blocks, presence of schools, population, racial and ethnic composition, annual drug arrests, annual prostitution arrests, collective efficacy, and high were included (see Bernasco & Block, 2009 for more details). The surface area of the spatial units and population were considered as spatial units.

# Methods

## Discrete choice model

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