

population density) had higher levels of crime concentration. These studies might lend additional support to the assumption that crime concentrations increase as geographic areas become more rural.

Moreover, few micro-place studies (referring to studies on a street segment level or below) have explicitly focused on drug crimes. Studies that have addressed this issue found that drug crimes show especially high degrees of concentration (Weisburd & Green, 1995; Weisburd & Mazerolle, 2000; Taniguchi et al., 2011; Haberman, 2017; Hibdon & Groff, 2014; Hibdon et al., 2016). For example, while Weisburd and Green (1995) found that about 46% of drug sales were concentrated in 4.4% of places in New Jersey, Haberman (2017) found even higher concentrations of narcotic distributions in Philadelphia, 50% at 1.69 percent of intersections. And Hibdon et al. (2016) found that 50% of calls for service for drug activity (as well as EMS calls) were concentrated in less than 1% of street segments in Seattle, Washington. These high levels of spatial concentration are predicted by the "general model" of drug markets, which argues that ideal drug-selling locations should allow for easy access to customers while offering high levels of security to sellers and buyers (Eck, 1995; St. Jean, 2007). In this model, only few places offer ideal opportunities for drug buyers and sellers to converge in the absence of guardianship, and high drug crime concentration would be expected (Olaghere et al., 2018). However, the limited information we have about drug crime concentrations in micro-places stem, once more, only from major U.S. metropolitan areas.

Empirical approaches to assessing crime concentrations

There are several methodological problems with studying crime in micro-places in general and non-urban areas specifically. For example, Hipp and Kim (2017) argue that the law of crime concentration is difficult to test since the bandwidth into which crime concentrations should fall is not clearly defined (Hipp & Kim, 2017; Hipp & Williams, 2020). Connected to this is the problem of the appropriate macro unit or area to study crime concentrations in micro-places. Most studies use "the city" to study crime. Still, definitions of area boundaries impact crime concentrations, and researchers do not use one coherent definition of city boundaries across the U.S. or, even less so, the world (Hipp & Williams, 2020). This problem is exacerbated if we take into account that, as outlined previously, studies beyond traditional-urban areas seem to find differing bandwidths of crime concentration (Gill et al., 2017; Hibdon, 2013; Hipp & Kim, 2017; Macbeth & Ariel, 2019; Park, 2019). One solution to this problem might be to use one consistent classification of urban-rural areas across the U.S.

The current assumptions about the law of crime concentration are also primarily based on approaches that include all places in their analysis, including micro-places that have a very low probability of encountering crime to start with (Andresen et al., 2017; Hipp & Kim, 2017; Steenbeek & Weisburd, 2016). Studies that include, for example, only places that saw at least

one crime event (termed the frequency approach (Lee et al., 2017)) indicate that crime is less concentrated and within a wider bandwidth than expected by the law of crime concentration (Boivin & de Melo, 2019; Lee et al., 2017; Steenbeek & Weisburd, 2016). However, since establishing what places have the opportunity to encounter a crime event is arbitrary from the outset (e.g., including only places that have at least one crime event) or at least requires intense research and justification why specific places should be excluded from the outset, it seems reasonable to continue to use all places in the denominator—the "prevalence" approach (Lee et al., 2017). Moreover, some studies have found that the frequency approach might still overestimate the degree of crime concentration (Chalfin et al., 2021).

Finally, and most importantly, research has pointed out that many approaches to establishing crime concentrations have used unadjusted approaches that might deliver biased results (Bernasco & Steenbeek, 2017; Curiel, 2019; Hipp & Williams, 2020). Since crime is an overall rare phenomenon and, in many studies, there are more micro-places than crimes, there will be crime concentration that is occurring "naturally" (Bernasco & Steenbeek, 2017; Curiel et al., 2018). Accounting for these issues is critical if we study crime disaggregated or across geographic areas with lower crime counts. And only unbiased estimations of crime concentrations allow comparisons across settings (Mohler et al., 2019). Several methods based on the Gini approach and adjustments to the Lorenz curve have been proposed to account for this problem (Bernasco & Steenbeek, 2017; Mohler et al., 2019; Curiel et al., 2018).

However, besides some issues in the actual estimation procedures (Mohler et al., 2019), all advancements in crime concentration assessment based on the Gini approach have the disadvantage that they do not allow consistent comparison to previous studies and the established % of all crimes in % of micro-places measure used in the law of crime concentration and the vast majority of studies (Chalfin et al., 2021). Similarly, communicating the Gini results and their implications for hot spots interventions to practitioners and policymakers might be challenging (Connealy & Hart, 2023). Chalfin et al. (2021) propose expanding on the conventional way of expressing crime concentration by comparing the empirical to the expected random distribution given the empirical number of criminal incidents and micro-places in the data. In other words, the approach assesses to what degree the empirical crime distribution exceeds the concentration simulated by randomization. This approach then presents the classic or empirical crime concentration measure, for example, for 50% of all crimes X% of micro-places, alongside the marginal crime concentration measure, expressed as the ratio of the expected to the empirical crime concentration. Addressing two major methodological issues of crime in micro-place research, this approach allows a reliable assessment of how concentrated crime is beyond expectation, accounting for naturally occurring concentration due to low crime counts (Curiel et al., 2019) while also allowing easy comparisons to past research (Chalfin et al., 2021). Yet, this approach has not empirically been used to assess crime concentration in non-urban areas.

Current Study

As outlined, research on crime concentration in micro-places has predominantly focused on major U.S. cities (Telep & Weisburd, 2014). Studies conducted in smaller cities and outside the U.S. suggest that less urbanized areas might have even higher levels of crime concentration (Gill et al., 2017; Hibdon, 2013; Hipp & Kim, 2017; Macbeth & Ariel, 2019; Park, 2019; Weisburd, 2015). However, published studies have, so far, been limited to small cities and overlooked diverse non-urban regions such as towns and rural areas. Accordingly, this study addresses a key research question for crime in micro-place research: *To what extent do drug crime concentrations in micro-places differ across the rural-urban continuum?* This study addresses this research question by developing an integrated dataset combining criminal incidence data for the entire state of Delaware (2010-2017) with a local area classification adapted from the "Locale" classification of the National Center for Education Statistics (NCES). Analytically, crime concentrations are assessed using conventional measures of crime concentration (i.e., X percent of crime in X of places and group-based trajectory models). I also apply approaches specifically developed to capture crime concentrations in cases of rare events which have not yet been used to assess crime concentrations in non-urban areas. This study so contributes to the understanding of the universality of the law of crime concentration and the potential usefulness of place-based drug crime policing approaches in less urbanized areas.

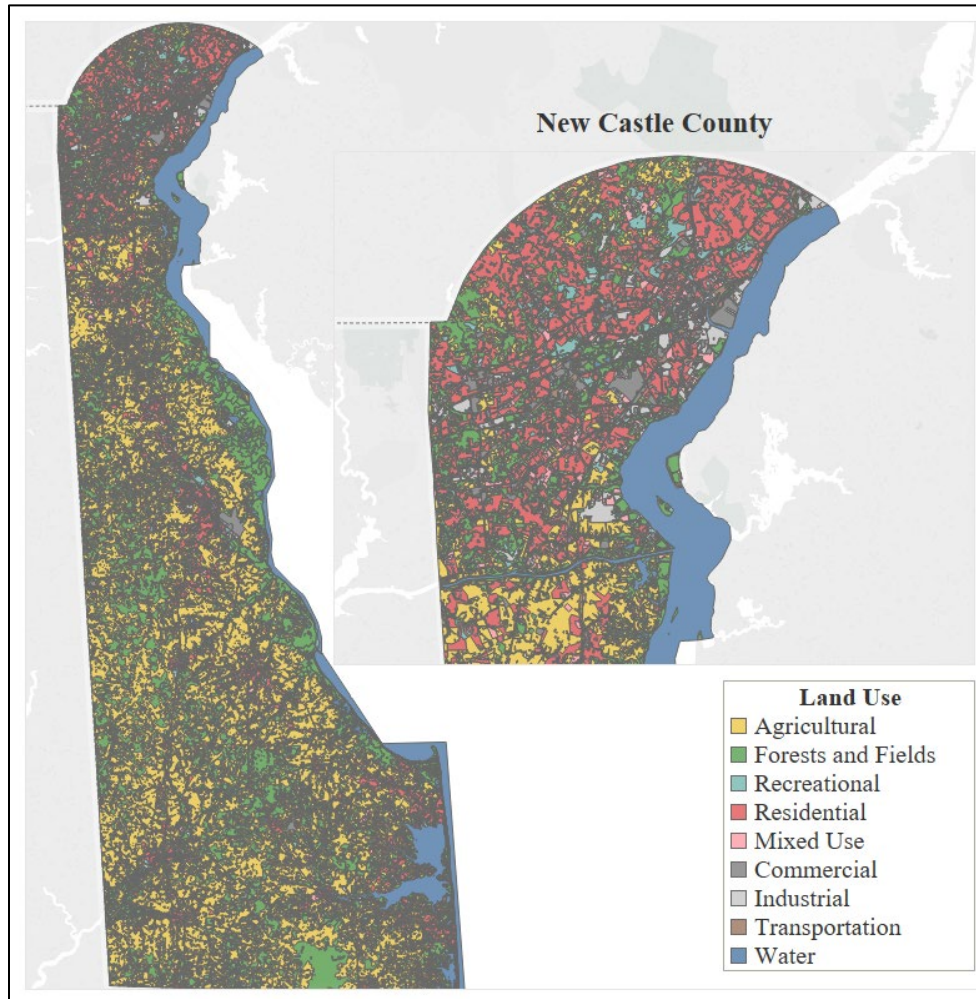
Data and Methods

Study Location

This study examines crimes across the whole state of Delaware. Delaware (see Figure 1) is located on the U.S. Atlantic Coast, neighboring Pennsylvania, Maryland, and New Jersey. Delaware consists of three counties. In the North, bordering all three neighboring states, is New Castle County. New Castle County is the most urbanized part of Delaware, with the highest population density (see Figure 1). New Castle County also includes the city of Wilmington, which is part of the Philadelphia-Camden-Wilmington metro area. Outside of Wilmington are residential areas, including the small city of Newark that harbors the main campus of the University of Delaware. Below New Castle County is Kent County, with the capital of Delaware, Dover. Dover is a small city with several attractions, such as a racetrack and a casino, and it hosts the annual Firefly Music Festival. Besides the city of Dover and several smaller towns, Kent County is mainly agricultural (see Figure 1). The same holds for the southern part of Delaware, Sussex County. Sussex County is most famous for the beach regions around Rehoboth and Lewes, with millions of tourists frequenting the area over the summer months. Otherwise, Sussex County is also predominantly agricultural (see Figure 1).

Figure 1

Overview Map of the State of Delaware Shaded by Land Use Classification (2012)



Notes: (Land Use Layer obtained from firstmap.gis.delaware.gov; reclassified by author)

To date, no study in the U.S. has analyzed crime data in micro-places across a whole state. The differing levels of urbanization and diverse land use patterns across Delaware make it an especially interesting case to compare crime concentrations in micro-places. Delaware also offers the opportunity to compare two types of small cities and surrounding suburban areas. While Wilmington is typical of small cities on the outskirts of major metro areas, Dover is more isolated with many agricultural areas and fewer residential areas surrounding it. Since prior studies have found variation across small cities but offered no explanation or typology of small cities, this analysis also allows for comparing two types of small cities. Moreover, Delaware has been substantially impacted by the opioid epidemic (Abraham et al., 2021); drug problems are,

overall, prevalent across the state (Wagner et al., 2019), and neighborhood-level analyses of drug crimes have shown comparable patterns to other areas in the U.S., for instance regarding environmental correlates of drug crimes (Donnelly et al., 2022). All these factors make Delaware a highly relevant study site to explore questions about drug crimes in micro-places and how they vary along the rural-urban continuum.

Geographic Area Classification

As outlined, one of the major problems for studying crime in micro-places is varying definitions of what constitutes a city or, even more problematic, a suburban or rural area. Over the years, several definitions of urban and rural areas have been proposed (Cromartie & Bucholtz, 2008; Pizzoli & Gong, 2007). However, many definitions allow only distinctions between urban and rural, ignoring the immense variation within these major groupings (Atav & Darling, 2012; Koziol et al., 2015). One widely used classification, which offers an intuitive but detailed classification, is the "Locale" classification by the NCES. The "Locale" classification consists of four main area types (City, Suburban, Town, and Rural), each containing three subtypes. These subtypes are differentiated by size and proximity (for urban and suburban areas: large, midsize, small; and, for towns and rural areas: fringe, distant, remote). The classification refines standard urban and rural definitions established by the U.S. Census Bureau. Figure 2 shows the "Locale" classification applied to Delaware with minor adjustments. For example, the areas identified as Town-Distant in the NCES classification identify a specific touristic-rural area in Delaware (see Figure 2). These areas are characterized by high levels of vacant housing units for vocational purposes and high concentrations of residential areas, comparable to the small cities (see Figure 1). The label 'Touristic' was assigned to reflect this specific type of rural area (see Figure 2).

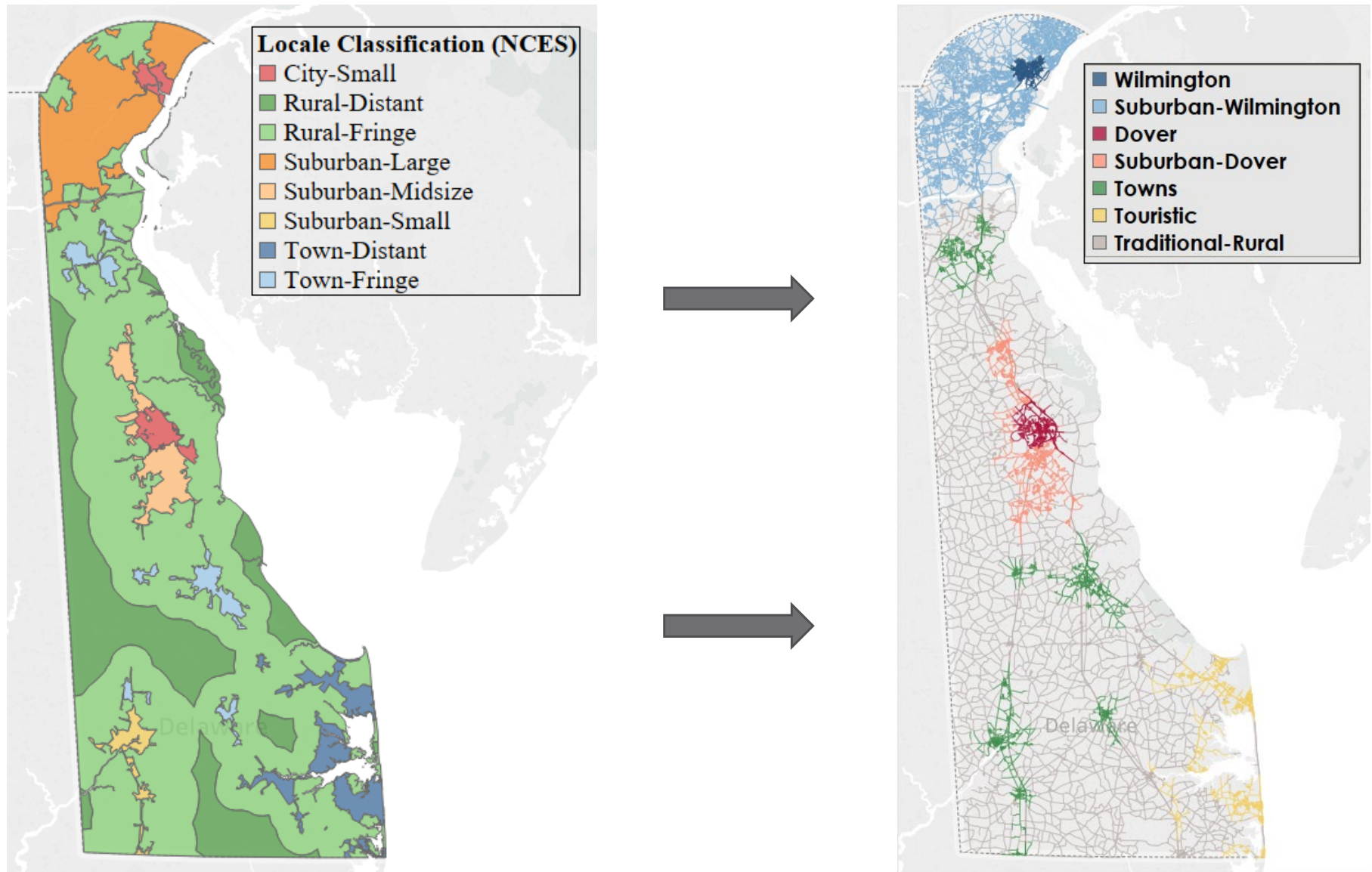
Dependent Variable

Delaware has local and state police agencies, 36 police departments, and eight state police troops (Delaware State Police Annual Report, 2018). Most police presence is concentrated in the northern part of the state, mainly due to higher population density and crime activity. All agencies' criminal incident and arrest records are shared in a central database, the Delaware Criminal Justice Information System (DELJIS). The shared database offers the unique opportunity of easy access to crime data across jurisdictions and counties. It makes the state of Delaware a convenient case to study crimes across geographic areas. This study relies on offense data from DELJIS collected over eight years: 2010-2017.²

² Policing practices and associated biases might impact spatial studies that use official crime data (Beckett et al., 2005; Moffatt et al., 2012; Rosenfeld & Decker, 1999). Additionally, rural and urban police departments differ in resources and strategies for policing drug crimes, further advising caution in interpreting findings drawn from official crime data.

Figure 2

Overview of Geographic Areas in Delaware adapted from the Locale Classification of the National Center for Education Statistics



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