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ARTICLE

The beer garden state: Neolocalism and clustering of craft breweries in New Jersey

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Abstract

This paper investigates the growth and clustering of craft breweries in New Jersey. We compiled a historical dataset from 1995 to 2020 that allows us to measure the degree of geographic clustering among craft breweries in New Jersey. The number of craft breweries in New Jersey grew 491% from 2012 to 2020 (from 22 to 130 craft breweries). An impetus for this growth was that New Jersey enacted legislation in 2012 that made opening and operating a craft brewery in the state more economically viable. Our analysis finds that craft breweries in New Jersey are clustering in specific parts of the state and that this is likely due to co-location benefits such as building a culture of craft beer that drives innovation, knowledge sharing, customer sharing, and a thicker labor market. While distinct craft beer clusters have formed in New Jersey, we find there is still significant opportunity for growth. Our analysis confirms this using data on planned craft brewery openings to measure changes in the size and density of clusters and where, in New Jersey, new clusters are likely to form.

Keywords: agglomeration; clustering; craft beer; neolocalism; New Jersey

JEL classifications: L66; R12; R30

I. Introduction

This paper investigates the spatial clustering of craft breweries in New Jersey[1] from 1995 to 2020. We identify geographic areas in New Jersey where craft breweries are clustering and how the size and density of these clusters have changed over time. New Jersey experienced a 491% growth in craft breweries from 2012 to 2020 (from 22 to 130 craft breweries). This growth coincided with a change in state law passed in 2012 (P.L.2012,

[1]New Jersey is often lampooned for many things—including its seemingly specious nickname, "The Garden State." However, New Jersey has 9,900 farms with an average size of 76 acres (United States Department of Agriculture, 2023).

Chapter 47) that increased the amount of beer small breweries could produce and where they could sell it (New Jersey Legislature, 2012). This legislation made it more economically feasible for a small independent craft brewery to operate in New Jersey. For example, on-premise beer consumption is now allowed after a required brewery tour, and customers can buy beer in breweries to take home. Consequently, we assert that 2012 marks the beginning of New Jersey's craft beer boom (or "revolution," as it is often referred to). Our paper finds that craft breweries in New Jersey are choosing to cluster together geographically, thus gaining advantages from co-locating, which includes knowledge sharing, customer sharing, increased innovation from competition, and a thick labor pool. We test this hypothesis and further explore the implications of craft brewery clustering in New Jersey in the near future.

New Jersey has a comparatively low craft beer-per-capita output of one gallon per drinking-age adult, but its total craft beer annual output is one of the fastest-growing in the United States in recent years (Brewers Association, 2023d). As a result, New Jersey is an interesting case study in startup craft brewery location strategies. Nascent craft brewery owners in New Jersey have many choices to consider when opening their breweries. Perhaps their most important decision is location (Shaffer, 2015). Most craft breweries benefit from and promote neolocalism, which is about establishing a connection with the local community (see Hart, 2018; Holtkamp et al., 2016; Murray, 2012; Schnell and Reese, 2003). Many craft breweries tap into consumers' preference for localness by naming their breweries and beers after their cities, local landmarks, streets, and folklore. Many craft breweries incorporate ingredients and tasting room décor from locally-sourced materials and artists, thus, further reinforcing neolocalism (see Staples et al., 2021). It is not surprising, therefore, that the Brewers Association's 2019 Craft Beer Consumer Insights poll found that 57% of craft beer drinkers only buy beer brewed locally (i.e., in their town or city) (Keith, 2019). Since this poll only includes craft beer drinkers, there is some selectivity bias toward people who exclusively buy craft beer. Local craft beer is often more expensive compared to non-locally brewed beer. In 2019, locally produced craft beer was found to cost 55% more compared to non-locally produced craft beer (Kendall, 2019). Thus, many craft beer drinkers are willing to pay a premium to drink local brews. The latest Brewers Association Craft Beer Consumer Insights poll found that 61% of craft beer drinkers noted that "locally made" beer was an important or very important factor in their purchase decision (Brewers Association, 2023b).

While craft breweries benefit from and play to their local communities' characteristics, there are advantages to having a strong culture of craft beer where breweries benefit from clustering near one another, which are known as agglomeration effects. Some benefits from agglomeration include a thicker labor pool, growing customer awareness, competition that incentivizes innovation, and resource/knowledge sharing, as is more widely known in the economic theory of agglomeration (Glaeser, 2010, p. 1). We use spatial statistics to identify and locate craft brewery clusters in New Jersey over time. We also use planned craft brewery openings in New Jersey to assess changes in the size and density of existing clusters and where new clusters are likely to form.

The following sections include a history of beer in New Jersey and the growth of the state's craft breweries since 2012. We also study some reasons why craft breweries cluster. Then we present our spatial analysis of craft breweries in New Jersey from 1995

to 2020. Next, we discuss what our analysis portends for New Jersey's craft beer industry in the future. Lastly, our conclusion summarizes our findings and implications.

II. Short history of beer in New Jersey

> "New Jersey is like a beer barrel, tapped at both ends, with all the live beer running into Philadelphia and New York."
>
> —Benjamin Franklin

New Jersey has a long beer-making history with an inauspicious start. The first commercial brewhouse in New Jersey was opened in Hoboken in 1641 by a Dutch settler, Aert Tewnissen van Patten, but was soon after burned down by Lenni Lenape natives (Pellegrino, 2009). By 1879, there were 58 commercial breweries in New Jersey selling over 500,000 barrels of beer. The largest was Ballantine Brewery, which opened in 1840. They later became the first television sponsor of the New York Yankees. Hunter S. Thompson wrote about drinking Ballantine Ale twice in *Fear and Loathing in Las Vegas* (1971), "Into the Ballantine Ale now, zombie drunk and nervous" (p. 89). Ernest Hemingway endorsed Ballantine, and Jasper Johns created a famous sculpture of two Ballantine beer cans titled Painted Bronze (Ale Cans, hand painted in 1960). In fact, New Jersey is the birthplace of the beer can, originating when Kreuger first sold beer in a can in 1935.

In 1910, beer represented the seventh-largest industry in New Jersey's economy (Pellegrino, 2009). The prohibition years (1920–1933) were, consequently, hard on New Jersey. New Jersey was one of only three states not to ratify the Eighteenth Amendment, which enacted prohibition. The years after prohibition ended belonged to the large industrial breweries, both in New Jersey and across the United States. In 1873, there were 3,171 breweries in the United States. The number collapsed to less than 100 after prohibition and up until the 1980s. Then President Jimmy Carter made homebrewing legal again in 1978, which is credited with renewing interest in small-scale brewing (Elzinga, Tremblay, and Tremblay, 2015). Craft brewing started slowly through the 1980s and 1990s. The exponential growth of craft breweries in the United States started around 2009, with 1,653 breweries growing to 9,709 at the end of 2022 (Brewers Association, 2023c). While the COVID-19 pandemic in 2020 caused some closures of craft breweries across the United States, there has since been a rebound leading to market growth (Arthur, 2022).

III. Post-2012 growth of craft beer in New Jersey

In 2012, there were fewer than two dozen craft breweries in New Jersey. Then in 2012, New Jersey passed P.L.2012, Chapter 47, in bipartisan support to encourage craft beer growth throughout the state. Different definitions exist for craft breweries. In this paper, we define craft breweries as independent brewers with one of the following New Jersey brewery licenses: (1) limited brewery license, which is a typical craft brewery that allows on-site consumption, samples, sales of up to one keg (i.e., 15.5 fluid gallons) for home consumption, no food sold on premise, and malt beverage production up to 300,000 barrels (31-gallon barrels) a year; and (2) restricted brewery license, which

is a "brew pub" with malt beverage production up to 10,000 barrels a year with a plenary retail consumption license (permitting beer consumption on premise) and dining facility. Of New Jersey's 143 craft breweries at the start of 2023, there are 122 traditional craft breweries with limited brewery licenses and 21 brew pubs with restricted brewery licenses, according to the New Jersey Division of Alcoholic Beverage Control (2023). Again, our study conflates these two groups of small independent brewers into one category called craft breweries.[2]

Since 2012, the number of craft breweries in New Jersey has grown 550% (from 22 to 143). According to the Brewers Association (2023d), New Jersey's craft beer industry had an economic impact of $1.8 billion in 2022. In 2022, there were 2.2 breweries for every 100,000 New Jersey citizens. New Jersey craft brewers made 222,062 barrels of beer, which is one gallon per legal drinking-age New Jerseyan. As of 2022, New Jersey ranked 26th out of all states for craft beer produced, but it ranks 44th in breweries per capita. New Jersey was, however, tied with Kentucky for the most craft brewery production growth in the country, at 47% from 2015 to 2018 (Zajechowski, 2019). These statistics suggest that New Jersey's craft beer industry is growing at a high rate.

The COVID-19 pandemic that disrupted the global economy in early 2020 affected the craft brewery industry in New Jersey, which was heavily influenced by the pandemic. As a result, most of our analysis focuses on pre-pandemic data through 2020, as this is a study of brewery agglomeration (clustering) over time and not one on the effects of the pandemic (we will save that for future work). We do, however, include discussion and projections using planned breweries for the future to extend our current analysis. New Jersey's craft beer industry has proven quite resilient. Only a few breweries have closed since the pandemic, and one has moved out of state. One of the breweries that closed, "Dark City" in Asbury Park, was sold to another brewery, "Wild Air," to operate in the same location with the same equipment.

IV. Craft brewery clustering

Business clustering is a topic that dates to Alfred Marshall's 1890 book *Principles of Economics* (2013), where he discusses the advantages. "[A] localized industry gains a great advantage from the fact that it offers a constant market for skill" (p. 225). Marshall also discusses the benefits of localized industries for customer convenience and resource sharing among businesses. Michael Porter (1990, 1998) provides a modern examination of business location strategies. He agrees with Marshall that business clusters can create larger localized labor pools and lead to resource sharing, but he extends the analysis further. Porter (1990) states there are four interrelated influences of business location on competition, which is known as his diamond model (the graphic is in the shape of a diamond): "factor conditions (the cost and quality of inputs); demand

[2]The Brewers Association defines craft breweries a little more broadly, but is similar to our definition. To be a craft brewery, according to the Brewers Association (2023a), it has to be (a) small—produce less than six million barrels of beer a year; (b) independent—less than 25% of the brewery is owned or controlled by a beverage alcohol industry member that is itself not a craft brewery; and (c) has a Tax and Trade Bureau Brewer's Notice and produces beer.

conditions (the sophistication of local customers); the context for firm strategy and rivalry (the nature and intensity of local competition); and related and supporting industries (the local extent and sophistication of suppliers and related industries)" (Porter, 1998, p. 90).

Factor conditions are not as critical for craft brewery clustering because brewers often obtain their inputs from a variety of non-local sources. There is an exception, however, if the brewery is close to farms (farm-to-glass brewers) or other sources of local ingredients (e.g., honey, cannabis, bull testicles) that can enhance the neolocalism of the beer—the quirkier the better sometimes (again, bull testicles[3]). Porter's second factor speaks to the knowledgeable customer base that is willing to spend a premium on craft beer specific to a given community (Brewers Association, 2023b) and that a more affluent customer base often demands a greater variety of specialized craft offerings (Anderson, 2023). The larger the craft beer customer base, the more likely craft breweries will cluster and offer a wide variety of products because there is sufficient demand, which leads to the next factor of Porter's diamond model. Porter's third factor of local competition is a driver of innovation among local craft brewers that often generates a strong craft beer culture. Craft brewers compete, but they are also colleagues who want the craft beer industry to grow, as illustrated by the communal spirit of events such as the Great American Beer Festival. Also, craft breweries in the same area will likely share many of the same customers, so there is a combination of competition and cooperation to grow the local beer culture (Watson, 2016, pp. 84–89). The fourth factor of supporting industries was, in the early days of craft brewing, a possible consideration in locating nearby industries for the purpose of sharing technology in the practice of brewing and packaging beer on a small scale, but with the advent of the internet, technology sharing and purchasing of equipment can now occur online, untethered from the physical location of the brewing business (see *The New Brewer* trade magazine for an example of online technology sharing). In the present day and with the methods applied here, it cannot be concluded that nearby brewing businesses actively share information. However, what we can conclude from craft brewery clusters is that breweries benefit from sharing customer bases, agglomeration economies facilitated by events such as beer festivals, and the innovation required to compete for the same customers. Most of their physical capital is a one-time purchase, facilitated by the internet, of not highly specialized equipment (i.e., it is widely available or can be purchased online), and their inputs (water, barley, malt, hops, and yeast) are either given (water) or purchased from a variety of sources in modest quantities. Again, the only exception to this are local industries that can supply unusual ingredients that enhance the neolocalism of the beer. No research shows that breweries choose to cluster in a specific area for access to local ingredients, but it is possible. In fact, the opposite has been shown to be true in craft brewery agglomerations, leading to the formation of a market for local ingredients, specifically hops (see Dobis et al., 2019).

Porter's diamond model is applicable to craft breweries, but craft brewery clustering also has unique characteristics. Craft breweries benefit from neolocalism, but they

[3]The beer is Rocky Mountain Oyster Stout by Wynkoop Brewing in Denver, Colorado. It started as an April Fools' Day joke, but people liked the idea so much that the brewery started making it. We imagine the bulls were less enthusiastic (Jasso, 2022).

also often cluster within reasonably close proximity to each other for strategic reasons (see Carr, Fontanella, and Tribby, 2019; Nilsson, Reid, and Lehnert, 2018). First, they can build a stronger culture of craft beer, what is known as social terroir (see Sjolander-Lindqvist and Skoglund, 2019). Second, having several craft breweries in close proximity can result in more craft beer tourists. Additionally, "spatial concentration of demand might also favor clustering [….] The variety of styles offered by craft brewers reflects favorably with the segment's primary customers" (Nilsson, Reid, and Lehnert, 2018, p. 116). Third, an area may have more demand for craft beer than one brewery is able to provide. As such, a craft brewery cluster can benefit from external economies of scale.

V. Craft brewery clustering in New Jersey

New Jersey has added over 100 craft breweries since 2012 (totaling 130 in 2020). New Jersey is the most densely populated state in the United States, with high average incomes (United States Census Bureau, 2020a, 2020d). It has distinct regions (Jersey Shore, New York City border, Philadelphia border, Atlantic City, etc.) where we expect clusters to exist. We want to test whether craft breweries in New Jersey are clustering within specific distances from one another, where they are clustering, and whether the density of these clusters is increasing over time. As clusters gain density, this provides further evidence that breweries are benefiting from co-locating. Using this information, we can see where craft brewery presence is strongest in the state and where it is growing and is likely to grow in future years.

We obtained data on New Jersey craft breweries by submitting an Open Public Records Act (OPRA) request with New Jersey's Department of Law & Public Safety's Division of Alcoholic Beverage Control. They provided us with historical data that included the names of the breweries, license type, location of owners and the brewery's address (if known), issue date, etc. Brewery closures are indicated by the nonrenewal of a license, which is reflected in our records. The address of the licensed brewery operation was used to "geocode" (locate) the brewery using the ArcGIS World Geocoding Service in ArcMap 10.8.1, and this was later verified. We also used data collected by New Jersey Craft Beer (2023), which is a website that provides information on the craft beer industry in New Jersey. The website was helpful here in cross-referencing our findings from the licenses to those of an industry observer. We then researched the breweries to ensure that they were, and are still, in operation. To ensure our data was accurate, we verified the location, operational status, and opening year of every brewery.[4]

We start here with a plot of the number of craft breweries opened by year in New Jersey (Figure 1), illustrating the growth of the industry and the need to study where the industry is growing. The plot illuminates a critical timeframe of analysis for studying

[4]In our commitment to rigorous research, we selflessly visited many, many craft breweries throughout New Jersey to ensure that they do, in fact, produce and serve craft beer. It required significant selfless determination and academic integrity, but our personal sacrifices were necessary to guarantee the accuracy of our data. If a site visit was not possible, we acquired information on the establishment, including its opening year, by way of their website or a phone call to speak with management.

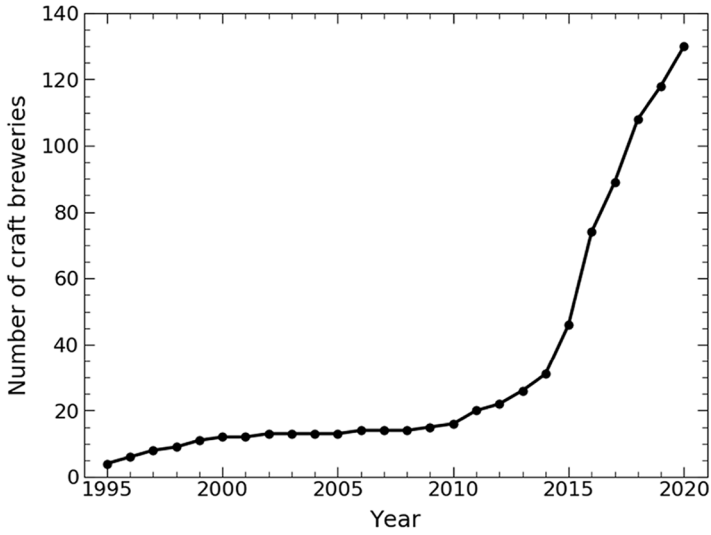

Figure 1. Number of craft breweries in New Jersey, 1995 to 2020.
Source: Created by the authors using data from the New Jersey Division of Alcoholic Beverage Control (2023).

where craft brewers choose to locate in the time period following an industry-changing law (P.L.2012, Chapter 47), which went into effect immediately upon its passage in the year 2012. In the time before that law, the industry as measured by the number of craft breweries remained largely stagnant, accruing only an average of 0.9 craft breweries per year (16 new breweries total) in the 17 years between 1995 and 2011, before the law was enacted. Following the 2012 law relaxing limits on beer production, that rate changes to 12 new craft breweries per year (108 new breweries total) in the nine years ending in 2020. The growth rate of the number of craft breweries makes us focus on a time period after P.L.2012, Chapter 47, in our study of where craft breweries are located and how they cluster over time. We stop short of saying the 2012 law caused the growth illustrated in Figure 1 because, as we previously noted, there has been exponential growth in the number of craft breweries nationwide over the past decade (Brewers Association, 2023c). However, it is worth noting that a previous nationwide study (Carr, Fontanella, and Tribby, 2019) found craft brewery clusters in neighboring states but none in New Jersey in the year 2014, implying that growth in the industry occurred sooner in neighboring states, and the 2012 New Jersey law may have helped industry growth depicted in Figure 1. The idea that New Jersey's 2012 law led to industry growth is one that should be examined in a follow-on study to this in which New Jersey's craft brewery growth is compared to that of other similar states where no such laws apply. This may lead to policy recommendations for the enactment of similar laws to spur the craft brewing industry in other states. However, for now, the focus of the present study is on the spatial clustering of craft breweries and the neolocalism of such craft brewery clusters.

Following the growth of craft breweries in New Jersey, we show the location of craft breweries every two years, starting in 2010 and ending in 2020. Our focus moving

forward is even years, as there is little change year over year, and a focus every two years simplifies results and has a "flip book"-like effect of showing small, incremental changes over time. A presupposition of our analysis is that craft brewers prefer to locate where people live in population centers. This is evident in the breweries located in the urban sprawl of New York City (see the Jersey City area) and Philadelphia (see the Camden area), the first and sixth most populous cities in the United States, respectively (United States Census Bureau, 2020a). Craft breweries extend from these metropolitan areas and are found up and down the New Jersey shore, from Asbury Park to Wildwood. On the other hand, few craft breweries are located in the less populated parts of the state, such as the mountains in northern New Jersey and the coastal plains found in southwestern and southern New Jersey inland of shore towns, such as Atlantic City. It is important to note the correspondence between craft brewery locations and population, as our analysis accounts for variations in population that range widely in New Jersey, from rural mountain enclaves to the New York City metropolitan area. The reader may also note a pattern of craft breweries opened in later years (circles) clustered around each other (see, for instance, the cluster at Asbury Park or outside of Camden). Our analysis assesses the statistical significance of that pattern using a variety of techniques for multiple lines of evidence regarding the historic pattern of craft brewery clustering.

Business clustering is not a perfectly defined concept, where a specific distance between businesses and the specific number of similar businesses defines a cluster. In our study, we use Ripley's K-function to measure craft brewery clustering, where $K(r)$ is the expected count of breweries within distance r of breweries randomly distributed relative to population. The general approach applied here amounts to a "simulation" following that of Carr, Fontanella, and Tribby (2019) in comparing observed brewery locations to those of the same number of brewery locations randomly distributed by population a total of 99 times (this is the simulation part). The simulated brewery locations are distributed based on the United States Census Bureau American Community Survey five-year[5] tract estimate of population, in which the probability of a tract receiving a brewery is proportional to its share of the population following a multinomial distribution. Greater shares of the population translate into a greater probability of the tract having a brewery, which is then randomly located within the tract, a survey area of the United States Census Bureau (2019) that normally has between 1,200 and 8,000 people (or about the area of a city neighborhood). The fundamental null hypothesis of our simulation is therefore that the geographic distribution of breweries follows that of population, a reasonable assumption given the observations of Figure 2 and previous findings of the distribution of craft breweries throughout the United States (see Carr, Fontanella, and Tribby, 2019). That same study also finds that population relates to other demographic factors that might be related to the location of breweries, such as population between 20 and 34 years old and income. Population therefore approximates other factors that may relate to brewery location (hence the focus on population here).

[5]The term "five-year" in this case does not refer to the time period of the estimate, but rather the sample used in the estimate of population in a tract in a given year (i.e., a sample of five years is used to estimate tract population in a given year).

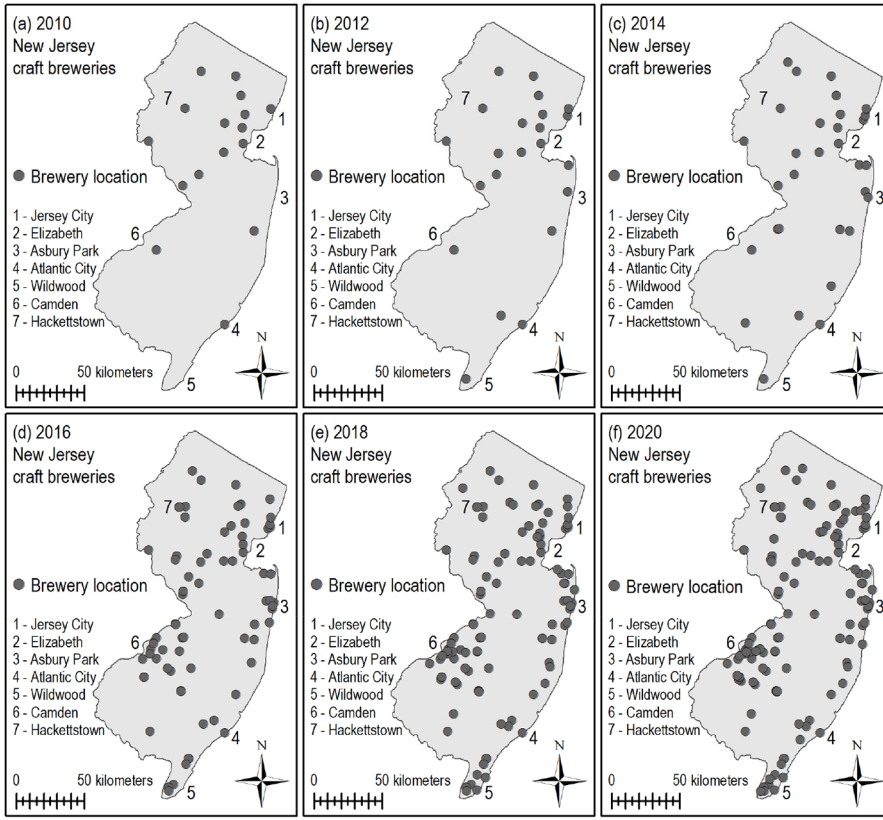

Figure 2. Maps of craft breweries in New Jersey open as of the years indicated in the maps.
Source: Created by the authors using data from the New Jersey Division of Alcoholic Beverage Control (2023).

We use radial distances of 5 kilometers and 20 kilometers to test for clusters, as the shorter distance accounts for local patronage of a craft brewery inspired by neolocalism in the confines of a city or neighborhood (Sjolander-Lindqvist and Skoglund, 2019), whereas the longer distance accommodates travel distances of beer tourism in a larger metropolitan area or county in which individuals travel to a brewery at a location they would not normally visit (Nilsson, Reid, and Lehnert, 2018). At these distances, the circles generated by radial distances inevitably extend beyond the borders of New Jersey into areas, such as the Atlantic Ocean, that are not part of the study area. These so-called "edge effects" mean that the circles drawn from a brewery (observed or simulated) extend beyond the study area and should be weighted by the fraction of the circle's area in the study area. In this case, a circle is drawn at a given radial distance from a subject brewery, neighboring breweries within that distance are identified, and then further circles are drawn at the radial distances between the subject brewery and its neighbors. Those circles are then used to weight neighboring breweries according to the fraction of the circle in the study area, where a circle completely within New Jersey assigns a weight of one and those that extend beyond New Jersey assign a weight of less than one. We focus this highly computationally intensive analysis on the radial distances of 5 and 20 kilometers for reasons previously explained and those illuminated in

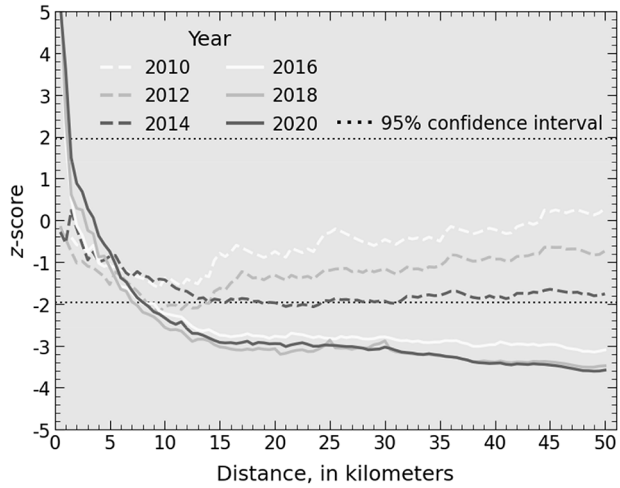

Figure 3. Global *K*-function analysis of craft breweries in New Jersey indicating brewery clustering (above horizontal dashed lines), a distribution of breweries following that of population (between horizontal dashed lines), and an even dispersion of breweries (below horizontal dashed lines) using a 95% confidence interval at distances ranging from 500 meters to 50 kilometers at increments of 500 meters in the years listed in the plot legend.
Source: Created by the authors using data from the New Jersey Division of Alcoholic Beverage Control (2023).

an analysis that follows global (overall) pattern of brewery clustering at incrementally longer distances.

The first analysis of brewery locations is that of global (overall) brewery clustering at distances ranging from 500 meters to 50 kilometers in increments of 500 meters, applying what is known as the "global *K*-function" in Figure 3, where the reader should focus on results above the pair of dashed lines (significant clustering). The function is expressed as a *z*-score (y-axis in Figure 3) in which the number of standard deviations from the mean (z) is calculated using the average number of breweries within a given distance (x-axis in Figure 3), weighted by area as explained in the last paragraph, where the observed average ($\overline{x}$) is subtracted by the average of the complete sample including the observed breweries and 99 simulations ($\overline{y}$), then divided by the standard deviation of the complete sample (σ) as shown:

$$z = \frac{(\overline{x} - \overline{y})}{\sigma}. \tag{1}$$

An observed average larger than that of the complete sample is a sign of clustering, and a *z*-score greater than 1.96 (>95% confidence that the observed average is greater than the complete sample average) is taken as statistically significant clustering. The analysis finds that significant clustering occurs at shorter distances (less than a kilometer), meaning there are more breweries within a kilometer of each other than one might expect given the distribution of population. This occurs in later years (solid lines in Figure 3) following the passage of P.L.2012, Chapter 47 (the law relaxing beer production limits), whereas years closer to the law's passage (dashed lines)

exhibit clustering patterns that mimic what one might expect given the distribution of population (i.e., the null hypothesis). The strength of clustering in the later years (solid lines) as measured by the z-scores gets stronger with each successive year, with the strongest clustering occurring in 2020, the only year to exceed the 99% confidence threshold of clustering (z-score > 2.58) at the one-kilometer distance. This pattern speaks to the agglomeration of craft breweries in that breweries seemingly attract other breweries at a distance of a kilometer or less beyond what one would expect given the population of the area. Local communities are attracting craft breweries and forming statistically significant clusters over time (see the years 2016, 2018, and 2020), a result that could only be found by this study's use of annual data, a feature that distinguishes this study from prior ones of craft brewery clustering, such as Carr, Fontanella, and Tribby (2019). Because Carr, Fontanella, and Tribby (2019) is a study of the entire United States, they focus on one time period (i.e., craft breweries opened in 2014) in which craft brewery clusters are similarly found at shorter distances as in this study, albeit the size of the clusters is larger given the scale of Carr, Fontanella, and Tribby (2019). This study builds on the foundation of Carr, Fontanella, and Tribby (2019) to show that craft brewery clustering gets stronger over time, and that is accompanied by a converse pattern of even dispersion (significantly negative z-scores) at longer distances, which is also shown in Carr, Fontanella, and Tribby (2019). The significantly negative z-scores (< -1.96) of this study in later years at distances of about ten kilometers or greater mean that craft breweries are more evenly dispersed than one might expect given the distribution of population. This can be further unpacked to mean that there are populated parts of New Jersey that are craft brewery "deserts" in that they have fewer craft breweries than one might expect given their population. This is indicated in the sparse distribution of breweries in some of the most populated parts of the state (see the "brewery desert" that is Newark between Jersey City and Elizabeth in Figure 2). We go on to evaluate the geographic distribution of brewery clusters in our subsequent analyses.

As the results of our global K-function analysis indicate clustering in the year 2016 and later (Figure 3), we focus our spatially distributed analysis of brewery clusters in those years. Results not pictured in years prior indicate no statistically significant brewery clusters, and thus are not of interest to show. What we do show are craft breweries surrounded by more breweries than one might expect given the distribution of population (our null hypothesis) using the "local K-function" as calculated in Carr, Fontanella, and Tribby (2019) at distances of 5 and 20 kilometers in the years 2016, 2018, and 2020 (Figure 4). The calculation uses the number of breweries within a given distance of a brewery (x), as previously calculated for the average number of breweries in the global K-function analysis. That number is then used at a given brewery to count the instances in which the number of simulated breweries (y) equals or exceeds the number of observed breweries ($s = \sum_{i=1}^{n} [y_i \geqslant x_i]$). The number of simulations at or greater than the observed number of breweries (s) is then used to calculate a p-value (p), where that number plus one is divided by 100 (i.e., the complete sample size including the observed breweries and the 99 simulations), as shown:

$$p = \frac{(s+1)}{100}. \tag{2}$$

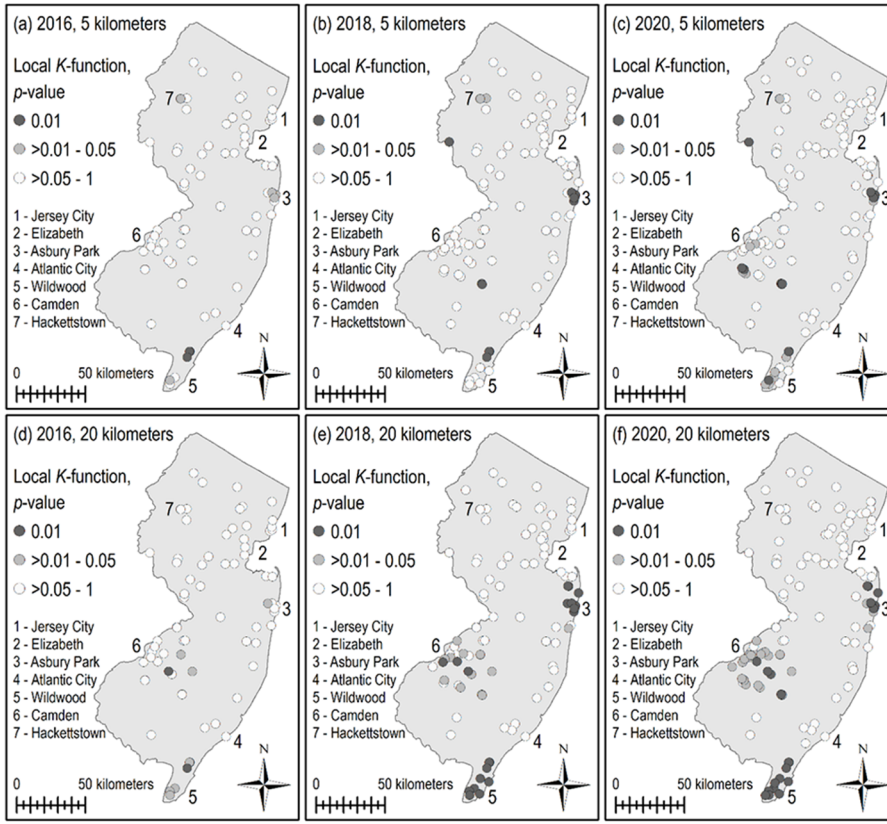

Figure 4. Maps of craft breweries surrounded by a statistically significant number of other craft breweries (p-value ≤ 0.05) at distances of (a)–(c) 5 kilometers and (d)–(f) 20 kilometers starting in the year 2016.
Source: Created by the authors using data from the New Jersey Division of Alcoholic Beverage Control (2023).

This calculation equals a p-value, where smaller numbers indicate less probability of the null hypothesis that the brewery is surrounded by a number of breweries than one would expect due to population (i.e., the brewery is surrounded by more breweries than one would expect due to population). We indicate that the null hypothesis is rejected and a brewery is surrounded by a statistically significant number of breweries using two thresholds of 0.05 and 0.01 (see the gray-colored points in Figure 4). What is obvious once again is that more breweries are surrounded by a statistically significant number of other breweries as the years progress (i.e., breweries or their communities are attracting other breweries over time). Craft breweries are not deterred by the competition of neighbors, but rather establish themselves in communities that welcome them and have a ready supply of patrons who appreciate businesses that reflect the local community, as has been shown in craft brewing agglomerations in several states in the western United States (Holtkamp et al., 2016). This can be illustrated here in the many breweries in New Jersey that take on local names, such as Cape May Brewing Company and its many "shore" (a colloquialism for the beach) inspired beers. This pattern of communities attracting breweries is readily apparent in the five-kilometer

local *K*-function results at Asbury Park, the area around Wildwood, and select pockets in the suburbs of Camden and the exurban sprawl of Philadelphia, where presumably long-distance commuters to Philadelphia have excess income to spend at craft breweries (see, for instance, Schuetz et al. (2018) for an analysis of income increases at greater distances from the central business district in the metropolitan statistical area of Philadelphia). Broadening the scope to beer tourism in locations one does not normally visit (at the 20-kilometer scale), the number of breweries surrounded by a statistically significant number of other breweries expands in number and area around those initial kernels of statistically significant breweries at the five-kilometer scale (see the expansion around Asbury Park, Wildwood, and Camden). This same pattern of expansion of statistically significant breweries at longer distances has been previously observed in the application of this method (see Carr, Fontanella, and Tribby, 2019). We find here that as you expand the distance, you expand the number of breweries surrounded by a statistically significant number of breweries, and their statistical significance increases as well (see how the points get darker in the 20-kilometer maps). Conspicuously missing from this discussion thus far are the breweries of the New York City metropolitan area in northern New Jersey (see the white points in the Jersey City and Elizabeth areas). These breweries are not surrounded by an excess number of breweries, given the population of the area. In fact, their *p*-values are regularly at or near one, meaning the number of surrounding breweries in the simulations usually exceeds that of the observed breweries. In the context of servicing the large population of the New York City metropolitan area in New Jersey, you could therefore characterize this area as "underserved" by the craft brewing industry. Where there are underserved communities, there is growth potential, as we will examine in later analyses.

We further define craft brewery clusters operationally as in Carr, Fontanella, and Tribby (2019) (and previously applied in the context of clustering research and development facilities in Buzard et al. (2017)) using a filter of at least four other craft breweries surrounding a statistically significant craft brewery (from Figure 4) at 5- and 20-kilometer distances. Statistically significant craft breweries are assigned at the 0.01 *p*-value threshold (see the darker gray points in Figure 4), a buffer of the given distance is drawn as a circle around that brewery, and those buffers having four or more neighboring craft breweries are coalesced to form a geographically defined craft brewery cluster as shown in Figure 5. The results of this procedure are condensed into three maps showing both analytical distances (5 and 20 kilometers) over the years 2016, 2018, and 2020. Readily visible again is the growth of craft brewery clusters over time, both in terms of the number of clusters and their geographic extent. The smaller clusters of five kilometers show a coalescing of craft breweries in highly localized communities as time progresses, very much following our argument about the neolocalism of the craft brewery industry. We see these highly localized craft brewery clusters in small communities compared to those of more densely populated parts of New Jersey, which includes the top four most densely populated cities in the country (United States Census Bureau, 2020a). Craft breweries are not located there, but instead, are situated in the far less densely populated communities of Asbury Park and the Pitman/Glassboro communities outside of Camden. It is in these smaller communities where the roots of craft brewery neolocalism take place. This pattern converges with consumer preference for locally produced beer (Hart, 2018) and craft breweries that reflect the identity of their

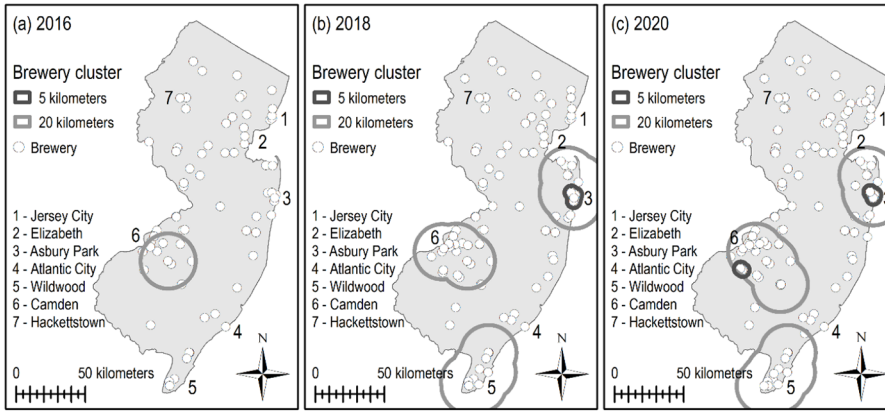

Figure 5. Geographic clusters of craft breweries defined by statistically significant craft breweries from Figure 4 (p-value = 0.01) are surrounded by at least four other craft breweries at buffer distances of 5 and 20 kilometers in the years (a) 2016, (b) 2018, and (c) 2020.
Source: Created by the authors using data from the New Jersey Division of Alcoholic Beverage Control (2023).

community, evoking a sense of place (Taylor and DiPietro, 2020). For instance, "Dark City Brewing" uses a local historical name for Asbury Park, and nearby "Asbury Park Brewery" uses a seahorse logo, which is part of the official seal of the City of Asbury Park.[6] This is a similar pattern of attracting local customers, as illustrated in a study of what might be argued as more well-established craft brewery markets in the western United States (see Holtkamp et al., 2016). In reflecting local communities, craft breweries form small clusters at the five-kilometer scale. This finding very much follows that of Carr, Fontanella, and Tribby (2019), who found craft brewery clusters at the scale of eight kilometers in communities known to have a strong sense of place, such as Asheville, North Carolina (Merced, 2023, p. 40), Boulder, Colorado (home of the Brewers Association for small and independent craft brewers and a history of craft brewing as written in Casey (2021)), and Portland, Maine (Keller and Ghatak, 2023). These places share a history of craft industries, as illustrated in the artisan markets of Asheville (Merced, 2023, p. 40), and craft brewing can be seen as an offshoot of that.

Unlike the study of Carr, Fontanella, and Tribby (2019), our study finds statistically significant clusters of craft breweries in New Jersey (see Figure 5), and this is attributed to our use of locally sourced data from more recent years (Carr, Fontanella, and Tribby (2019) used "ReferenceUSA" nationwide business files in the year 2014). Therefore, our analysis shows how local policy, here in the form of state law P.L.2012, Chapter 47, may help stimulate a statewide "craft brewery revolution" (as the growth in craft breweries is commonly known). Given that the craft brewery industry of New Jersey has now reached critical mass in the form of brewery clusters and that, contrary to popular opinion, New Jersey is an agriculturally rich state (see our first footnote), it will be of interest to investigate the ensuing growth of a local hops market, as has been shown to be the case in the west of the United States (see Dobis et al., 2019). The growth

[6]See https://www.cityofasburypark.com.

of New Jersey's craft brewery market manifests itself in the two highly local (five-kilometer) clusters at Asbury Park and Pitman/Glassboro. The former is now known for its recent redevelopment and subsequent gentrification, in particular on the shore side of Asbury Park (see Ammon, 2015, among others), which now counts three craft breweries[7] in a small two-kilometer area (or over one brewery per square kilometer). This cluster follows the broad model of craft brewers flocking to newly gentrified areas where greater rents are expected to translate into greater disposable income (Nilsson and Reid, 2019). Although it is historically known as a "city of consumption" (Ammon, 2015), the newfound population of Asbury Park envisions it as a place for "makers,"[8] including celebrating those who make beer.[9] The present work is not the only one to note the pairing of gentrification and craft markets in Asbury Park (see Makris and Gatta, 2020). This can be more broadly viewed as an effort to distinguish a place from the homogeneity of the urban landscape in the United States, and craft brewing has been shown to be an important part of that process (Holtkamp et al., 2016).

In terms of the five-kilometer cluster at the Pitman/Glassboro area outside Camden (see Figure 5c), nearby Rowan University might be of influence, as it has been noted that universities can prompt the neolocal culture (and income) that attracts craft brewing (Casey, 2021). Rowan may also be contributing to the craft brewery labor pool of the area by offering curriculum on the geography of beer and its local production.[10] The community celebrates its craft brewing culture with the now ten-year tradition of the Glassboro Craft Beer Festival,[11] at which Rowan alumni receive a discounted rate, illustrating the tie to the local university. This is impressive at a time when many craft beer festivals, such as Breckenridge Big Beers and WeldWerks Invitational, are scaling back their operations, according to news media reports.[12] Events like the Glassboro Craft Beer Festival, occurring at a far smaller scale than national events, are emblematic of local brewery clusters and a sign of co-location benefits for local brewers (Porter, 1998). Innovation among local brewers is evident in the variety of beer available in the Pitman/Glassboro cluster, where one brewery specializes in Vienna and Helles lagers ("Bonesaw Brewing Company"), another in saisons and other ales ("Kelly Green Brewing Company"), and a third in India Pale Ales ("Axe & Arrow Brewery"), all within about three kilometers of each other. The variety illustrated here is a notable feature of a strong craft beer customer base (Anderson, 2023) and speaks to Porter's (1998) co-location benefit of local competition leading to innovation, here in the form of using different brewing ingredients and techniques for a greater variety of products.

As for the larger-scale clusters at 20 kilometers, these show a craft brewery cluster near Camden starting in 2016 (Figure 5a), followed by an expansion of that cluster to include the greater Camden area in 2018 and 2020 (Figure 5b and c). It is not until

[7] If you are thirsty in Asbury Park, please find the three breweries referenced here at https://newjerseycraftbeer.com.

[8] Signs of craft production in Asbury Park can be found at https://www.asburyparkbazaar.com.

[9] AsburyFest highlights its local beer culture at https://asburyparkchamber.com/asburyfest.

[10] A class we all might have enjoyed in college is at https://earth.rowan.edu/departments/geography/newsletter/fall-2021/geo-beer.html.

[11] Ten years of Glassboro Craft Beer Festival history can be found at https://glassborobeerfest.com.

[12] The downturn in national beer festivals is outlined at https://www.axios.com/2023/07/11/decline-craft-beer-festival-gabf-2023.

2018 that we see other 20-kilometer clusters in the area around Wildwood and the aforementioned five-kilometer cluster of Asbury Park, which serves as the center of the north Jersey Shore cluster. These clusters are signs of a beer tourism market because, at areas averaging around 2,500 square kilometers, these are not areas encompassing one's normal radius of travel and would require a special trip to a location where one might choose from a variety of craft breweries (Nilsson, Reid, and Lehnert, 2018), as we found in our previous analysis of breweries in the Pitman/Glassboro area. A beer tourist might envision themselves traveling to the Pitman/Glassboro area for the day to choose from their selection of local craft beer (with responsible driving accommodations for the drive home).

VI. Future of craft beer in New Jersey

The craft brewery industry is growing throughout New Jersey—even during the COVID-19 pandemic and its economic consequences. Compared to neighboring states such as Pennsylvania, New York, and Connecticut, New Jersey has far fewer craft breweries per capita and produces fewer barrels (Brewers Association, 2023c). New Jersey's neighboring states had a head start, and New Jersey's 2012 legislation may have finally unshackled entrepreneurial spirits. We have seen more potential for growth in previous results where the New York metropolitan area of northern New Jersey has no breweries surrounded by a statistically significant number of breweries (see Figure 4), and further that analysis of growth potential here using United States Census tracts that have fewer craft breweries than one might expect given their population (i.e., tracts of craft brewery growth potential). In this calculation (one that we could not find in the literature), we draw a circle from the geographic center (as applied in the ArcObjects centroid property) of a tract at the two distances of 5 and 20 kilometers, in which the number of craft breweries (observed and simulated) is counted for the purpose of calculating a z-score at each tract. The z-score is calculated as the number of observed breweries within the given distance minus the mean number of breweries for the complete sample (observed and simulated), which is then divided by the standard deviation of the complete sample (see Equation (1) for the form of this calculation). Edge effects are not taken into account in this calculation, as a tract is only compared to itself, and thus has the same edge effect as a distance extending outside of the state's boundary. A z-score less than -1.96 is a tract of craft brewery growth potential at 95% confidence where the number of craft breweries in the vicinity of the tract is less than one would expect given its population. The opposite of that (z-score > 1.96) is a tract that has significantly more craft breweries than one would expect given its population at 95% confidence, or what might be characterized as a "saturated market" that has a supply of craft breweries in excess of the tract's population, largely deviating from what might be characterized as an "average" craft brewery market. In the neolocalism framework proposed here, a "saturated market" is a community that patronizes craft breweries more than expected given its population. These areas occur at an analytical distance of five kilometers in pockets of the state previously named as craft brewery clusters (i.e., tracts around Asbury Park, Wildwood, and Camden), plus in more rural parts of New Jersey in the area around Atlantic City and Hackettstown (Figure 6). They expand to enclose larger swaths around each of the aforementioned

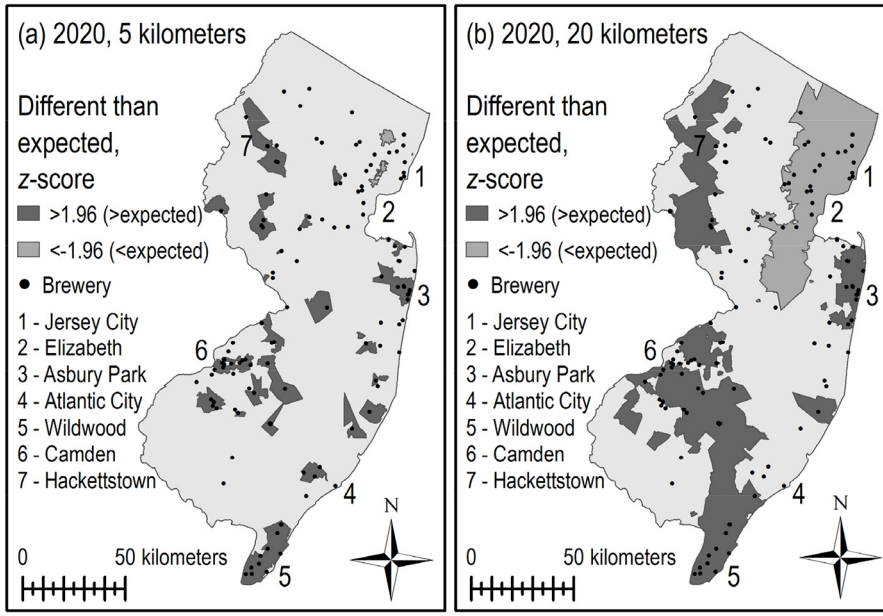

Figure 6. Tracts that have access to significantly greater (*z*-score $>$ 1.96) or significantly less (*z*-score $<$ −1.96) than expected craft breweries in the year 2020 relative to population and distances of (a) 5 kilometers and (b) 20 kilometers.
Source: Created by the authors using data from the New Jersey Division of Alcoholic Beverage Control (2023) and tract data from the United States Census Bureau (2020b).

cities at the 20-kilometer scale. Conversely, tracts not served by craft breweries relative to population are in northern New Jersey, in the New York City metropolitan area. At the five-kilometer scale (Figure 6a), these tracts number four and total 62 square kilometers. That area expands to include about a quarter (2,672 square kilometers) of the expansive New York City metropolitan statistical area in New Jersey (10,499 square kilometers). This means a large area, in particular the area immediately adjacent to the city (see Figure 6b), has growth potential in the craft brewery market. The area is known for its high incomes, with two counties (Bergen and Middlesex) in the top hundred median household incomes in the United States (United States Census Bureau, 2020d) occupying about half (45%) of the growth potential area (light gray) in Figure 6b. It is possible that this area has not formed clusters yet because real estate values are high compared to the rest of the state (United States Census Bureau, 2020c). In addition to greater operating costs, this may also translate into greater labor costs and less labor availability. This combination of factors may make opening a craft brewery in this part of the state more challenging. It is also worth noting that this is one of the more ethnically and racially diverse parts of the state, largely reflecting the diversity of nearby New York City (United States Census Bureau, 2020b). The fact that craft breweries struggle to engage diverse consumers (Matthews and Patton, 2016) and are largely perceived as catering to white people (Chapman and Brunsma, 2020) is problematic for growth in this area of northern New Jersey. Nonetheless, the growing movement of neolocalism

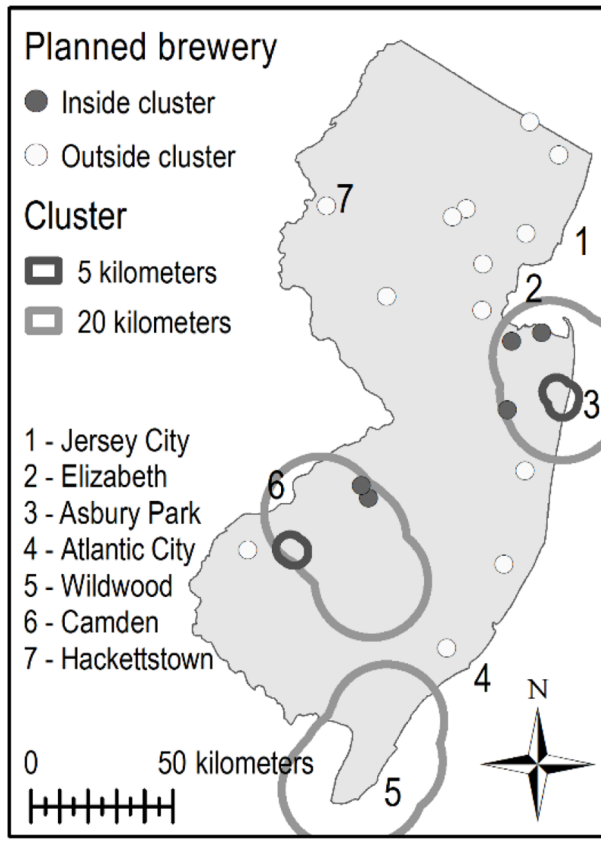

Figure 7. Map of planned craft breweries relative to clusters of existing craft breweries.
Source: Created by the authors using data from the organization New Jersey Craft Beer (2023) and confirmed via evaluation of breweries progress toward an opening date (i.e., evaluation of physical space, website, and social media presence/communication).

and its embrace of local culture may be a means of growing a craft beer market among more diverse consumers, such as those in northern New Jersey (Matthews and Patton, 2016).

Planned breweries totaling 18 as of the year 2021 (the year following our analysis) are retrieved from New Jersey Craft Beer (2023) and verified by means of evaluating their progress toward an opening date (i.e., evaluation of physical space, website, and social media presence/communication). We use planned breweries as a means of evaluating if clusters as of the year 2020 are attracting new breweries and in the assessment of new clusters emerging as a result of the planned breweries. We admit that the sample is small and the results are therefore limited, but we include this analysis to show the reader how agglomeration effects might be evaluated using proposed businesses, a form of analysis we did not encounter in the literature. We first overlay the 18 planned breweries on a map of our 2020 brewery clusters (Figure 7) and find that 28% (five) of the planned breweries are located in existing craft brewery clusters, showing a tendency

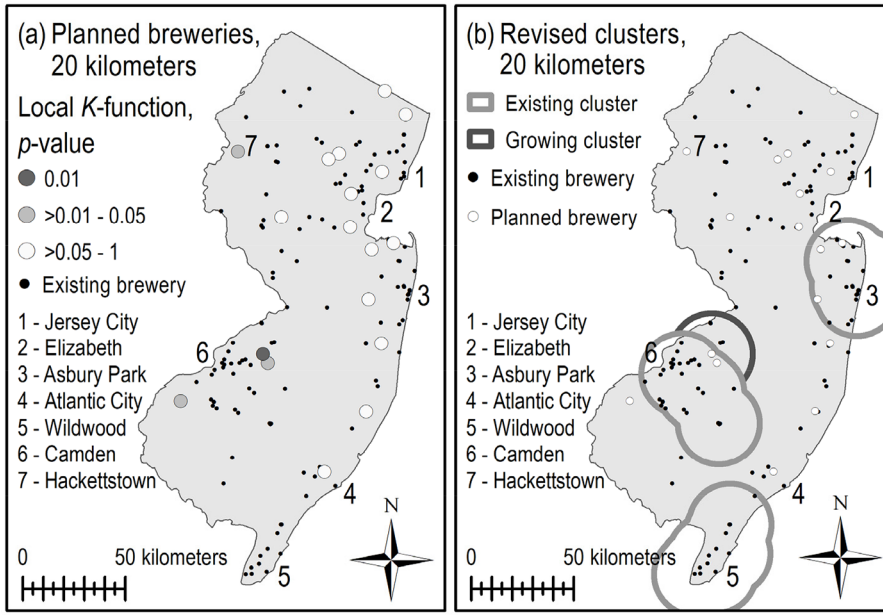

Figure 8. Maps of results at a distance of 20 kilometers showing (a) planned craft breweries surrounded by a statistically significant number of existing craft breweries (p-value ≤ 0.05) and (b) geographic clusters of craft breweries revised to include planned craft breweries.
Source: Created by the authors using data from the New Jersey Division of Alcoholic Beverage Control (2023) for existing breweries and data for planned breweries from New Jersey Craft Beer (2023), confirmed via evaluation of breweries progress toward an opening date (i.e., evaluation of physical space, website, and social media presence/communication).

for locating in close proximity to other breweries. We compared this percentage to percentages derived from 99 simulations of new brewery locations relative to population and found there is a 36% chance of exceeding the observed percentage (p-value of 0.36). We do not find that a statistically significant number of new breweries are locating in existing craft brewery clusters, and thus go on to investigate if the planned breweries are forming new clusters around existing breweries.

Our final analysis is of planned breweries forming new brewery clusters using our previously established methods of the local K-function and our operational definition of a brewery cluster having a significant number of neighboring breweries (p-value $= 0.01$), including at least four neighbors, both evaluated at a distance of 20 kilometers (Figure 8). Of the 18 new craft breweries, four (22%) are surrounded by a statistically significant number of breweries (Figure 8a). The Camden craft brewery cluster has two of these breweries. Because these breweries are at the periphery of the existing cluster, the new breweries extend the Camden cluster to the northeast (see Figure 8b). This is the only cluster that changes due to the addition of the planned breweries. Clearly, there is a tendency for planned breweries to be located near other craft breweries, but those additions in the northern New Jersey area around Jersey City and Elizabeth are still not dense enough to overcome the population density of that

area. We also find two planned craft breweries surrounded by a statistically significant number of breweries in more rural areas near Hackettstown and removed from the Camden craft brewery cluster to the southwest (see Figure 8a). In the years to come, given the low population density of these areas and their high incomes (United States Census Bureau, 2020a, 2020d), it will be interesting to see if other craft breweries will locate in the area and contribute to new brewery clusters. As it stands now, we find little change in the brewery clusters of New Jersey with the addition of one year of planned breweries, but we do find a tendency (although not entirely statistically significant) for new breweries to locate in proximity to other breweries. At the very least, we find breweries locating near each other and continuing to prefer areas where there are larger populations (see the many planned breweries near New York City). As this is the first analysis of its kind that we could find in the literature, we cannot draw any connections between what we find here and other studies of where breweries plan to locate in the future.

VII. Conclusions

In 2012, New Jersey revised its legislation concerning craft breweries, which made it more economically viable to operate a craft brewery in the state. Following the law, the number of craft breweries in New Jersey increased by 491% from 2012 to 2020 (from 22 to 130 craft breweries). In this paper, we study if craft breweries in New Jersey are forming clusters, where they exist, and whether they are changing based on planned brewery openings. Craft breweries that cluster benefit from external economies of scale and can create a more vibrant beer culture in their area than one brewery could likely produce alone. Craft breweries are both collaborators and competitors where there is resource sharing, thicker labor pools, customer sharing, and culture building (or social terroir) often occurring in the form of neolocalism, in which breweries reflect and champion the local community.

Using spatial statistics, we find that craft breweries are clustering in three distinct areas of New Jersey: Asbury Park (north Jersey Shore), Camden (on the border with Philadelphia, Pennsylvania), and Wildwood (south Jersey Shore). The closest and tightest clusters of craft breweries (within a five-kilometer radius) are in the vicinities of Asbury Park and another such cluster in the Pitman/Glassboro area outside of Camden near Rowan University, both exhibiting possible signs of neolocalism by way of celebrating the local community. The methods presented here for locating craft brewery clusters are entirely transferable and could be applied to other emerging craft brewery markets for the analysis of agglomeration effects. We also assessed 18 planned breweries that are opening soon to see if they are locating within existing clusters. We find that 28% of planned breweries (not a statistically significant number) are planning to open within existing clusters. Adding these new breweries to our data, we find no evidence of new clusters; the Asbury Park and Wildwood clusters remain unchanged, but the Camden cluster did grow slightly toward the north. Although no new clusters emerged, we do find that planned breweries are located in close proximity to existing ones, and in some cases (4 of 18 planned breweries), this results in a new brewery surrounded by a statistically significant number of existing breweries.

We also find that there exists potential for a new cluster to develop in the northeastern part of the state (near Jersey City and Elizabeth) that borders New York City. There are likely cost factors limiting the development of a craft brewery cluster in this area, and breweries in this part of the state need to engage more diverse consumers (which could be achieved by way of neolocalism), but it remains a highly populated, high-income part of the state with cluster potential and room for growth in the craft brewery market.

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Competing interests. The authors declare none.

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