Where Size Matters:
Agglomeration Economies of Illegal Drug Markets in Philadelphia

Travis A. Taniguchi, George F. Rengert and Eric S. McCord

There is a debate over whether police attention focused on an illegal drug market causes dealers to spatially displace their activities "around the corner" therefore having no positive impact on the aggregate level of illegal drug sales in the city. The alternative perspective is that focused police attention lowers the rate of illegal drug sales in the city. Recent research in Jersey City, New Jersey has demonstrated that focused police attention does not simply move illegal drug dealing around the corner. The present analysis explains why this finding is likely to be common in other cities using the economic theory of "agglomeration economies." Agglomeration economies illustrate that taking the largest and most profitable site from illegal drug dealers will make dealing in the surrounding neighborhoods less rather than more profitable and lead to a smaller marketplace overall. The empirical analysis focuses on Philadelphia, Pennsylvania.

Keywords illegal drug markets; agglomeration economies; hot-spot policing; crime displacement; diffusion of benefits

Illegal drug markets remain a serious problem for American society. It is not only the sale and use of illegal drugs that is a problem, but also the associated...
crime and disorder that accompanies its distribution. There is a general consensus that illegal drug markets destabilize communities with their noxious activities that include associated violence (Braga et al., 1999; Eck & Wartell, 1996; Fagan, 1993; Rengert, 1989a; Rengert, Chakravorty & Henderson, 2000), property crime (Gandossy, Williams, Cohen & Harwood, 1980; Rengert, 1996), and general incivilities (Skogan, 1990; Weisburd & Green, 1994, 1995). There is less consensus as to the proper public response to this noxious activity. For example, it is common for police officials to argue that it does no good to focus attention on a specific illegal drug market; the illegal drug dealers will simply "move around the corner" and reopen business on a neighboring block. This is referred to as crime displacement.

Crime displacement refers to the shift of crime either in terms of space, time, or type of offending from the original targets of crime prevention interventions (Weisburd et al., 2006). One of the first scholars to explicitly examine crime displacement was Reppetto who reasoned:

The police, however, cannot be everywhere; ...A different level of protection between various potential targets...will always exist. Given the differential and no reduction in the offender population, will not the foreclosure of one type of criminal opportunity simply shift the incidence of crime to different forms, times and locales? (1976: 167)

If displacement is an inevitable result of focused police prevention efforts, then the utility of their place-based crime prevention approaches would be limited.

Recent research in Jersey City, New Jersey discovered that this is not the case (Weisburd et al., 2006). When police focused their resources on a particularly active illegal drug market and prostitution stroll, they discovered that the drug dealers and prostitutes did not simply move a few blocks away to reopen business. Rather, the surrounding areas enjoyed a “diffusion of benefits” (Clarke & Weisburd, 1994) as these illegal activities decreased in the surrounding areas as well. Although empirical research suggests that a diffusion of benefits is quite common in response to focused crime interventions, the reason(s) for this phenomenon are unclear. Clarke and Weisburd (1994) provide two social-psychological explanations: deterrence and discouragement. Deterrence is when offenders overestimate the crime prevention efforts of the police and assume that they are at higher risk of apprehension in the areas surrounding the focused police activity than they actually are. Discouragement occurs when police reduce the rewards associated with a criminal act such as discouraging “Johns” from traveling into an area of prostitution so that the surrounding areas also experience fewer customers. These are social and psychological explanations for why one might expect a diffusion of benefits from place-based focused police activity. Economic explanations for this phenomenon also exist and are explored in the following discussion.

An economic reason to expect a "diffusion of benefits" from focused police attention is due to “agglomeration economies.” This is an economic concept that explains why spatially clustered competitors may actually be more profitable
than spatially dispersed competitors. If focused police activities are capable of
dispersing these clusters, the theory of agglomeration economies can explain
why the surrounding areas become less, rather than more, profitable.

In the following sections, we outline the theory of agglomeration economies
as they apply to retail and criminal activities. This section is followed by one
that details the plan of analysis and operationalizes the concept of agglomera-
tion economies for analysis of the spatial pattern of crime. The formal analysis
is followed by a discussion section and the conclusions. To begin, one must
understand the relationship between spatial clustering of activities and agglom-
eration economies.

Spatial Clustering and Agglomeration Economies

Illegal drug dealers, similar to legal retail outlets, are in economic competition
for market share. Economic competition should dictate that new entrepreneurs
will locate as far as possible from competing dealers in order to capture a larger
market share and to avoid violent confrontations. Research has demonstrated
that this is not the case for illegal drug dealers (Eck, 1994; Olligschlaeger, 1997;
Rengert et al., 2000; Weisburd & Green, 1995). Just as is the case with prostitu-
tion, illegal drug dealers tend to cluster in space. There are several theoretical
explanations for why illegal drug dealers cluster in space. The concept of
"agglomeration economies" is central to several of these explanations.

Agglomeration Economies

In any given economic activity, the forces of repulsion and attraction among
units are usually both present to some degree. A common source of repulsion in
retail sales is economic competition. Economic competition is expected to drive
businesses as far away as possible from other competitors in order to attract the
largest possible market share. This idea led to the theory of "Central Place
Geography" to explain the spatial arrangement of settlements (Abler, Adams &
Gould, 1971; Berry, 1967). The attraction of large cities to retail activities is
termed "urbanization economies." Rengert (1996) illustrated how this attrac-
tion influenced illegal drug dealers to be more active in large cities than smaller
places. However the clustering of illegal drug markets within a city can result in
"localized aggregate increasing returns" or more commonly termed, "agglomera-
tion economies" (Duranton & Puga, 2004).

Agglomeration economies refer to the benefits of locating near similar facili-
ties; benefits derived from factors that are external to the unit. This idea is
commonly associated with the spatial clustering of manufacturing firms and is
credited to the work of Marshall (1890) although Smith (1887) may have
conducted the first analysis of the benefits from agglomeration due to the divi-
sion of labor. More recently, scholars have recognized the benefits of retail
stores clustering in space (Getis & Getis, 1968). These attraction forces may include sharing of knowledge and expenses, transportation infrastructure, and other external factors.

In the case of illegal drug dealers, the question turns on whether forces of competition or agglomeration economies dominate. The common association of illegal drug sales with economic competition and violence (Braga et al., 1999; Eck & Wartell, 1996; Fagan, 1993; Rengert, 1989a) would lead one to expect that the forces of repulsion would dominate and illegal drug dealers would not be clustered in space. Yet, empirical research has demonstrated that they do. Weisburd and Green (1995) mapped “intersection areas” that were hot spots of illegal drug sales, and discovered that these drug hot spots made up only 4.4% of the street intersections of Jersey City, New Jersey. However, these “hot spots” accounted for approximately 46% of narcotics sales arrests in this city.

Research has also established that competing dealers can operate from a given location. Albini quotes Massing (1989) who describes competing drug dealers operating from one location in Washington Heights (New York City) as follows:

On every block there are four or five different crews or gangs touting its own brand of the drug....Some blocks were hotter than others, depending on the availability of the crack. On the hottest blocks (crack) is available “24/7”; 24 hours a day, seven days a week. (1992: 104)

Steve Volk describes a similar illegal drug market in Philadelphia:

This spot marks the entrance to a narcotics strip mall....How bad is it? One day last month, as the temperature hovered in the high 40s, more than two dozen dealers worked these corners, the buzz of commerce equal to that of a farmers’ market or a street bazaar. The prospect of getting caught seemed so remote to the dealers and buyers that they didn’t even bother to palm the plastic baggies in their hands. (2007: 11–12)

While research in the field has established that drug dealers cluster in space, what has received much less attention is why violence clusters around drug dealers. The fact that high levels of violence surround drug dealing areas seems to be counter-theoretical to the agglomeration economies framework. It is necessary, however, to consider the exact mechanisms that lead to the relationship between drug distribution and violence. This relationship would be most counter-theoretical to agglomeration economies if the violence stems from competition between dealers. Rengert (1996), however, illustrates that the violence surrounding illegal drug markets can result from six factors of which competition between dealers is only one. In fact, violence between dealers may be overestimated by many scholars who do not discriminate between the above six factors, but ascribe all violence to the competition between dealers. We have yet to establish how much of the violence surrounding illegal drug markets is due to competition between dealers. If the findings of this analysis
are correct, it may be to dealer’s advantage not to engage in violence between competing dealers.

It is now accepted that illegal drug dealers cluster in space. What we are interested in examining is the reason for this clustering in space. Only two explanations of why illegal drug dealers are expected to cluster in space have been offered. Both are external economies to the sales unit and can be considered agglomeration economies. The first perspective argues from a biological framework couched in studies of “swarming”. This reasoning is defined in the following quote (Kleiman):

Drug transactions are highly concentrated geographically, almost certainly more concentrated than consumption, with a strong bias toward poor and socially disadvantaged neighborhoods ... Sellers cluster for the same reasons fish school and birds flock: protection from natural enemies, in this case the police. Since police routines tend to create a distribution of officers which is more uniform than the distribution of illicit activity, being the sole dealer on a corner is far riskier than being one of twenty. Buyers, too, insofar as they face enforcement risk, face much less of it in a crowd than they would alone. (1991: 8-10)

A second source of agglomeration economy was formulated by Rengert (1996) who argues that illegal drug dealers cluster in space due to search behavior of customers with imperfect knowledge. Auto dealerships (legal) and prostitution (illegal) cluster in space around auto malls and red light districts because once an area becomes known as a source region, customers will travel to this location to obtain an automobile, or the services of a prostitute rather than patronize a single source that is less certain to satisfy their needs. The same scenario may hold for the sale of illegal drugs. Rengert, Ratcliffe, and Chakravorty (2005: 35) argue: “The more dealers there are at a specific location, the more likely it will be that drugs of choice are available, and the more buyers will patronize this location.” In other words, the larger the cluster the more profitable it becomes as it is better known and will draw customers from a wider area (Hough & Edmunds, 1997).

This idea is illustrated in Figure 1. Consider a single drug user who leaves home in search of illegal drugs. This person has two choices. The shortest path is to a single drug dealer who has a small market and may or may not be open for business when the drug user arrives. If the drug dealer is not open for business when the drug user arrives on the scene, the drug user must then travel on to the larger market place that is almost guaranteed to be open twenty-four hours a day, seven days a week. This requires the buyer to travel a longer distance than if they had gone directly to the larger market in the first place. Over time, the drug user learns that it is more certain and convenient to travel directly to the large market place and the smaller dealer loses a customer. In fact, it would be profitable for this small dealer to move the sales unit to the larger market area that is attracting customers from a wider area and possibly regain the customer lost in the above scenario. Customers choose certainty over a potentially shorter path in their retail behavior if uncertainty leads to a longer journey in some cases.
Figure 1  Paths to drugs: Uncertain knowledge. $D_1$ is distance to a single (uncertain) drug dealer. $D_2$ is the distance to a guaranteed drug market if uncertain drug market is not open for business. $D_3$ is the direct distance to the guaranteed drug market. Note: $D_3$ is shorter than the distance $D_1 + D_2$.

Closely related to this imperfect information scenario is one where the occasional drug user only knows of one location to purchase drugs. This is due to the fact that illegal drug dealers do not have access to the mass media to advertise their location and wares. However, the print media often provides this advertisement free of charge when they list exact addresses in their stories of drug infested neighborhoods. In an article in the Philadelphia Inquirer Magazine, Zucchino lists an address and quotes a drug dealer:

We provide a professional service….These fellows know they are not going to get ripped off here. They know they can do business here away from their families and bosses…. You cannot name another place in North Philly with our combination of services. We’re like Howard Johnson’s. We got a flavor for everyone. (1992: 38)

This news article seems designed to “advertise” this location as an ideal spot to obtain illegal drugs. Again, this free advertisement focuses on large illegal drug markets not small individual drug sellers.

Word of mouth and social network advertisement also tend to focus on large retail sales areas. Just as red light districts become known as the place to go if one wants the services of a prostitute, large illegal drug sales locations become known as the place to go to purchase illegal drugs. Therefore, large retail illegal drug sales locations attract customers from a wider area and become more profitable and desirable as a place to sell drugs.

This idea is well recognized in legal retail activities such as the clustering of auto sales units into auto malls, retail food venders into food courts of shopping
malls, as well as advertising agencies on Madison Avenue in New York City. Again, to a limit, the larger the location (in terms of the number of dealers), the more profitable it becomes. In fact, McCann and Vroom (2007) discovered that the entry of a new hotel at a given location allowed the existing hotels to raise rather than lower their room rates. Stuart (1979, p. 17) also noted this potential in his work on the benefits of agglomeration noting that: "...the addition of a new seller to a marketplace might increase the drawing power of the marketplace sufficiently to increase the demand faced by sellers already there." In other words, rather than a new entry increasing competition and lowering prices, in some cases the new entry provides agglomeration economies that allow the existing units to raise prices.

The literature lists several other sources of agglomeration economies that may apply to illegal drug sales. These include Hotelling’s minimum differentiation principle which suggests that agglomeration of sales units of the same type allows customers to reduce uncertainty, to compare prices, and to socialize with other customers with just one trip (Brown, 1989: Hotelling, 1929). Also, sales units may share some fixed costs such as “lookouts” that may serve several dealers in an illegal drug market place. In short, there may be many economic advantages for retail sales units to agglomerate in space. The present analysis is not designed to sort out which of these advantages exist. In fact, Arnott, Anas, and Small (1998, p. 145) note: "Agglomeration economies have resisted attempts to fully understand their microfoundations.... We do not know which external economies will be internalized through private initiative...we do not know the specific forces that produce these relationships....” What we can determine is whether or not agglomeration economies exist in illegal drug sales. This is the goal of the present analysis.

The Analysis Plan

The analysis focuses on drug arrests in Philadelphia, Pennsylvania. First, we must determine whether illegal drug sales are indeed clustered in space in Philadelphia. Figure 2 illustrates a local indicators of spatial association (LISA) analysis that isolates local clustering of events in space. While a simple choropleth map would portray areas of high and low illegal drug sales, it contains no analysis of what defines a cluster. Furthermore, choropleth maps are highly sensitive to the absolute count values in an area. One particularly high area, for example, may wash out a smaller but still important cluster somewhere else on the map. A LISA analysis provides a more sophisticated and sensitive method of visualizing the distribution of the dependent variable.

This analysis, similar to Weisburd and Green (1995), uses drug sales arrests as a proxy for illegal drug sales. Justification for this proxy measure is discussed more fully below. Figure 2 illustrates that there is only one major cluster of drug sales arrests in the city of Philadelphia located in North Philadelphia. A much smaller cluster exists in West Philadelphia. Philadelphia is a large city.
The reader may wonder why there are not major clusters of illegal drug sales in South and/or West Philadelphia as well. This spatial pattern is what the present analysis is designed to explain.

There are several reasons why illegal drug dealers may cluster in space in addition to agglomeration economies. Each of these possible explanations is examined in turn and their explanatory power statistically controlled so that in the end, we can determine whether or not agglomeration economies can explain a statistically significant amount of the remaining variance. Keep in mind that the present analysis is not designed to isolate what micro elements create the agglomeration economy. Rather, we are concerned with whether or not agglomeration economies exist in illegal drug sales in Philadelphia. In other words, will a specific neighborhood tend to have a high level of illegal drug sales
if surrounding neighborhoods also are high, and conversely, will specific neighborhoods tend to have a low level of illegal drug sales if they are surrounded by other neighborhoods that have low levels of illegal drug sales (agglomeration economies or diseconomies), or will specific neighborhoods have low levels if surrounding neighborhoods have high levels of drug sales (economic competition) once other theoretical reasons for the spatial arrangement of illegal drug sales have been statistically controlled for.

Clearly, we need to ascertain whether size matters with respect to illegal drug markets. A first step toward this objective is to determine whether the drug sales are larger in contiguous areas or larger in a specific area. Again, the converse of this is that the smaller the drug market place, the smaller (or nonexistence) will be the drug sales in neighboring communities.

In the present analysis, an agglomeration economy is operationalized by using a "spatial lag term." A spatial lag term predicts the value of a variable within an area by the value of that variable in the spatially contiguous surrounding areas. In other words, if there are a large number of illegal drug dealers in neighborhoods surrounding an area, this area will tend to have a large number of illegal drug sales as well. And, vice versa, if there are few illegal drug sales in neighborhoods surrounding an area, that area will also have few illegal drug sales. This is because agglomeration economies predict that an illegal drug dealer has incentives to sell in areas that already have many dealers, and disincentives to establish in an area with few drug dealers. Statistically, we are predicting the size of illegal drug sales in any unit area by the size of the illegal drug sales in contiguous surrounding areas.

First, we must remove any variance associated with competing explanations for why illegal drug dealers may cluster in space not associated with agglomeration economies. Four theoretical explanations are expected to explain why some illegal drug markets cluster in space and become larger than others. These theoretical explanations form the basis of our first two models. The third and final model examines whether agglomeration economies explain any of the remaining variance. The four theoretical explanations are: (1) local demand; (2) concentrated disadvantage; (3) social disorganization; and (4) destination nodes of routine activities of potential illegal drug users. Agglomeration economies will be ascertained by examining whether the spatial lag term explains a significant amount of the remaining variance, once the previous four factors are statistically accounted for. Each of these factors is introduced into an analytical model in the following discussion.

Model 1: Demographic Features of the City

Local Demand

Advertising campaigns for a legal retail product often begin by determining the demographic profile derived from the general population to "pitch the product"
to. This demographic profile is the characteristic of potential customers to whom the product is targeted toward. In the case of illegal drugs, we are interested in the demographic characteristics of those most likely to use this product. The most comprehensive information comes from the National Household Survey (U.S. Department of Health and Human Services, 2001) which reports that those most likely to use illegal drugs are:

(1) Young people between the ages of 15 to 29,
(2) Unemployed individuals, and
(3) High school dropouts.

If these individuals are not distributed uniformly across the metropolitan region, then an illegal drug dealer will make more profit if he/she can determine where these people are clustered spatially and establish a retail outlet in their midst. In other words, the illegal drug dealers will attempt to establish outlets that minimize the amount of aggregate travel required for their customers to reach the retail outlets (Rengert et al., 2000). This is a measure of the local demand in the area. It is expected to vary across the urban landscape.

Not only is a local demand necessary for an illegal drug market to be established, but there must also be individuals willing to undertake the risk associated with selling this illegal product. Not all individuals are willing to undertake this risk, especially, if legal employment opportunities are available to them.

Concentrated Disadvantage and the Availability of Drug Sellers

Legal employment opportunities are not uniformly available across urban landscapes. Rather, there are areas of "concentrated disadvantage" where legal employment opportunities are rare (Fagan, 1993; Wilson, 1987, 1996). These communities in post-industrial cities no longer contain low-skill, high paying jobs. Rather, legal employment, that is available, tends to be minimum-wage service jobs in fast food restaurants for example. For young individuals in these communities, alternative illegal jobs may be enticing (Reuter & MacCoun, 1992).

Several studies have focused on the characteristics of communities that are characterized as "concentrated disadvantage" (Morenoff, Sampson, & Raudenbush., 2001; Sampson, Raudenbush, & Earls, 1997; Warner, 2003). Most commonly these studies focus on the following factors:

(1) Percent African-American
(2) Female headed households with children under 18 years of age
(3) Percent of families below the poverty line
(4) Percent of households on public assistance.

Even if the demographic characteristics of a community point to the existence of local demand for illegal drugs and the presence of individuals willing to
engage in illegal drug sales, not all communities will allow these noxious activities in their neighborhoods. Those least able to resist the establishment of illegal drug markets tend to be those that lack social organization.

Social Disorganization

There is a vast literature that stems from the seminal work of Shaw and McKay (1942) focusing on the ability of neighborhoods to come together to resist noxious activities and facilities (Sampson et al., 1997; Bursik & Grasmick, 1993). Furthermore, there is evidence that illegal drug use and dealing are noxious activities that negatively impact urban communities (Fagan, 1993; Rengert, 1996). Shaw and McKay (1942) identified the following community characteristics as associated with social disorganization making it difficult to resist noxious activities such as illegal drug dealers;

(1) Ethnic heterogeneous population
(2) High population turnover
(3) Low median income.

Neighborhoods with these characteristics were thought to lack the social capital necessary to resist unwanted activities, such as illegal drug sales.

Operationalizing the Theoretical Constructs

All the above independent variables are taken from the 2000 US census for the City of Philadelphia (GeoLytics, 2002). Since these variables cannot be combined into scales because they do not rise to acceptable levels of reliability as shown by low Cronbach’s alpha values, it was decided to enter each into the analysis individually. This also has the benefit of allowing each variable to be interpreted individually.1

The dependent variable is the size of the illegal drug market. Weisburd and Green (1994) discussed the issues involved in identifying illegal drug markets. Since the concern of the present analysis is with the size of an illegal drug market, this variable is measured by the number of drug sales arrests in each of Philadelphia’s 1816 census block groups between the years of 2002 and 2003. These data were supplied by the Philadelphia Police Department.

1. Inclusion of numerous demographic variables runs the risk of multicollinearity. During the early phases of this analysis, the authors considered collapsing several of the demographic variables into the three key theoretical constructs. Analysis of Cronbach’s alpha, however, demonstrated that these scales did not attain minimum internal consistency requirements ($\alpha > 0.70$). Review of both the VIFs and tolerances indicated that there were no issues with multicollinearity. Additionally, the large number of cases made it possible to include all the demographic variables separately while maintaining the necessary degrees of freedom.
Some may view drug sales arrests as simply a measure of police activity rather than a measure of where illegal drug sales are taking place. In previous research, this critique was examined by measuring the spatial association of drug sales arrests and drug related calls for service from the public (Rengert et al., 2005). It was discovered that drug sales arrests mirrored almost exactly the drug related calls for service. Furthermore, the majority of calls for service originated from inner city minority communities, which the previous scholars predicted may not rely on police to solve their neighborhood problems (Anderson, 1999). The main cluster of illegal drug sales arrests in Philadelphia, as illustrated in Figure 2, centers on the most economically disadvantaged section of the city. These findings illustrate that inner city residents do rely on the police to address illegal drug sales in their neighborhoods and the police are making arrests where the most calls for service originate. Weisburd and Green (1994, p. 74) similarly found that: "...more serious street-level drug markets are identified in official reports." If these arguments are accepted, drug sales arrests can be considered a reliable measure of the spatial location and size of illegal drug markets.

Neighborhood demographics related to local demand, concentrated disadvantage, and social disorganization are analyzed in Model 1. Once the statistical variance associated with these variables has been removed, we consider other features of the urban environment that may cluster illegal drug customers in space and thus potentially clustering illegal drug dealers in the surrounding area. These are considered in Model 2.

Model 2: Features of the Built Environment

There is a final feature of the urban environment not contained in census data that may aggregate in space and time individuals with the demographic characteristics associated with illegal drug use. These are facilities of the built environment that are used on a routine basis by individuals who may be potential customers for illegal drug dealers. They form the nodes and pathways of routine activities (Cohen & Felson, 1979).

Features of the Built Environment

Features of the built environment that aggregate customers in space and time for illegal activities have been termed "crime generators” and "criminal attractors” (Brantingham & Brantingham, 1995). Crime generators are facilities that attract a large number of individuals so that if a percentage is crime prone, the surrounding area will experience an increased crime rate. In case of the consumption of illegal drugs, a subway station may be a crime generator since a percentage of the passengers are potential drug users. A criminal attractor is a facility that specifically attracts criminals. Clearly, a facility can be both a
crime generator (clustering in space illegal drug users) and a criminal attractor (clustering in space illegal drug dealers) as in the case of a subway station. Other such locations are around facilities that attract potential drug users on a routine basis, such as a tavern or liquor store for poly drug users, drug treatment centers and homeless shelters that provide social services to populations that may contain large numbers of drug users, and check cashing centers and pawn shops that provide cash necessary for illegal drug transactions. For customers traveling to a drug market from outside the region, places of aggregation may include exits of limited access highways and regional rail and subway terminals. The following analysis will examine these facilities to determine if illegal drug dealing is clustered in their vicinity.

Care must be taken so that a spurious association is not identified. For example, a facility may be opened in an already drug infested neighborhood rather than the facility making the neighborhood drug infested. Drug treatment centers are one example where this is likely to occur. The question then becomes: is the facility located in a bad neighborhood, or did the facility make the neighborhood bad? The following routine is used to disentangle this issue.

Location quotients are used to determine whether illegal drug sales are clustered in the vicinity of these facilities. Location quotients were developed in Economics and Regional Science to determine whether a region contains more than its share of a particular commodity compared to a larger control region. Within Criminology, location quotients have been used to determine whether the "mix of crimes" within a region differs from that of a larger control region (Rengert, 1996; Robinson, 2003). A location quotient is determined from the following formula:

\[
LQ = \frac{c_i/a_i}{c_R/a_R}
\]

where \(LQ\) = location quotient
\(c_i\) = total amount of crime in a study area \(i\) (where \(i\) is a sub-area of the larger region \(R\));
\(a_i\) = the area of study area \(i\);
\(c_R\) = total amount of crime in the larger region \(R\);
\(a_R\) = the area of the larger region \(R\).

Before a location quotient can be computed, small sub-regions must be constructed within which this value is determined. In the present analysis, this is done with a Geographic Information System. A Geographic Information System is used to create buffers around each facility in 400 feet increments. Four hundred feet is chosen since it is the average length of a city block in Philadelphia (see Figure 3). As mentioned above, a problem arises since several of these facilities (such as drug treatment centers or homeless shelters) are located in areas that are likely to contain high levels of drug sales, whether or not the facility is located there. To account for this problem of regional
explanation rather than facility explanation, a requirement that the location quotients decrease or increase in a monotonic manner with each succeeding buffer from the facility is required. This orderly change provides evidence that it is the facility rather than the region within which it is located that is associated with the clustering of illegal drug sales. Table 1 lists the location quotients for each facility by buffer zone.

Notice that those that change monotonically are beer-selling establishments, check cashing and pawn shops, subway stations, and major streets. A surprising finding is that in Philadelphia, major streets are negatively related to drug-sales arrests as these arrests are denser with increasing distance from these streets. This is contrary to the findings in other studies (Eck, 1994; Olligschlaeger, 1997). This relationship will be discussed in more detail later.

The facilities that are associated with a monotonic change in their associated location quotients are the facilities that will be entered into the final analysis.
The unit of analysis is the census block group. Using the 400 feet buffer around each facility identified above, the proportion of each census block group that is covered by this buffer for each facility type is recorded as an independent variable. This varies from 100 percent, if an entire block group is covered by the 400 feet buffers around a facility, to zero percent if there is no buffer for the facility in the block group. This is preferable to using counts of facilities since an establishment near the boundary of a block group will count in each block group within which its buffer covers some area. Using counts, it is recorded in only one block group.

Figure 4 demonstrates the benefits of using buffers over the more simplistic count method. The count method would ascribe a zero value to Block Group 1 (indicating no facilities) and a value of 2 to Block Group 2 (indicating two facilities). However there is no reason to expect the criminogenic effects of a facility to stop at artificially defined census boundaries. The buffer method utilized here allows for a more nuanced understanding of the effects of facilities upon localized crime. While facility A is in Block Group 2, it still has an effect upon Block Group 1. This method is less hampered by administratively defined census geographies.

These are the variables analyzed in Model 2. Once the variance associated with the first model (demographics) and second model (facilities) is removed, we are in a position to determine whether agglomeration economies explain any of the remaining variance. This is done in Model 3.

### Table 1  Location quotients by facility type

<table>
<thead>
<tr>
<th>Facility type (n)</th>
<th>0-400 feet</th>
<th>400-800 feet</th>
<th>800-1200 feet</th>
<th>1200-1600 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beer establishment (146)</td>
<td>6.8</td>
<td>3.4</td>
<td>2.4</td>
<td>1.7</td>
</tr>
<tr>
<td>State liquor store (53)</td>
<td>2.5</td>
<td>1.9</td>
<td>1.8</td>
<td>1.9</td>
</tr>
<tr>
<td>Check cashing store (96)</td>
<td>4.9</td>
<td>3.7</td>
<td>2.8</td>
<td>2.2</td>
</tr>
<tr>
<td>Pawn shop (30)</td>
<td>7.2</td>
<td>4.7</td>
<td>3.3</td>
<td>2.3</td>
</tr>
<tr>
<td>Halfway house (41)</td>
<td>5.2</td>
<td>6.1</td>
<td>4.1</td>
<td>4.1</td>
</tr>
<tr>
<td>Homeless shelter (39)</td>
<td>2.5</td>
<td>2.8</td>
<td>2.9</td>
<td>2.3</td>
</tr>
<tr>
<td>Outpatient drug treatment (20)</td>
<td>3.6</td>
<td>4.7</td>
<td>4.9</td>
<td>3.2</td>
</tr>
<tr>
<td>Major streets (22)</td>
<td>0.4</td>
<td>0.6</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>Expressway off ramps (120)</td>
<td>0.2</td>
<td>0.3</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Subway station (49)</td>
<td>4.6</td>
<td>2.5</td>
<td>1.9</td>
<td>1.5</td>
</tr>
<tr>
<td>Bus station (1)</td>
<td>2.5</td>
<td>2.0</td>
<td>0.2</td>
<td>0.6</td>
</tr>
<tr>
<td>Regional train stations (78)</td>
<td>0.6</td>
<td>0.3</td>
<td>0.2</td>
<td>0.7</td>
</tr>
</tbody>
</table>

The effect of agglomeration economies is tested using a spatial lag term. A spatial lag term might best be explained using the analogy of a temporal lag term often used in criminology. A temporal lag term tests whether the level

---

**Model 3: Testing the Effects of Agglomeration**

The effect of agglomeration economies is tested using a spatial lag term. A spatial lag term might best be explained using the analogy of a temporal lag term often used in criminology. A temporal lag term tests whether the level
of crime in one time period is partly explained by the level of crime in the previous time period for the same area. In other words, crime at time \( t \) is partly assumed to be related to crime at time \( t-1 \) for the same area. A similar assumption is tested for a spatial lag term. A spatial lag term tests whether the level of crime in area \( i \) is partly explained by the level of crime in the areas immediately surrounding area \( i \). In other words, the level of crime in area \( i \) is partly explained by the number of criminals living in the

\textbf{Figure 4} Example of block groups and facility buffers.
surrounding areas, or some other characteristic of the surrounding area
(Rengert, 1989b).

Spatial lag terms implicitly assume that crime at one location is likely to
affect crime at nearby locations. Spatial lag variables can be thought of as
accounting for the spatial diffusion of crime (Baller, Anselin, Messner, Dean,
& Hawkins, 2001; Kubrin, 2003; Land & Deane, 1992). The spatial extent of
the spatial lag term (one spatial unit away, or two or more units away from a
specific area) is generally left up to the discretion of the researcher. In this
analysis, a second order spatial lag term with queen contiguity is utilized.
Figure 5 illustrates the type of spatial lag term utilized in these analyses.

Figure 5  Spatial lag utilized to measure the effects of agglomeration economies.
Spatial units up to two units (block groups) away are considered as the “neighborhood” of the target block group. In other words, the number of drug sales arrests in a block group is predicted using the number of drug sales arrests in surrounding block groups up to two block groups away in any direction.

Sampson et al. (2002: 447) point out the importance of considering the spatial lag term: “...location seems to matter. The next logical questions are: Why does ... (it) matter, for what, and to what degree.” These are issues addressed in the present analysis, particularly why the size of illegal drug markets in surrounding neighborhoods are important in determining the size of illegal drug markets in a specific neighborhood. In other words, why the size of illegal drug markets matter as well as why the location of illegal drug markets matters.

The Analysis

The above three models are examined in turn. Negative binomial regression was determined to be the proper model for the analysis given the over dispersion of the dependent variable. Prior to analysis, variables were checked for multicollinearity and were found to be within acceptable limits with no variance inflation factor over 2.7 or tolerance value below .38. Table 2 provides the results of the negative binomial regressions.

Using a 0.05 confidence level, three of the four variables associated with concentrated disadvantage: percent African-American, families with income below the poverty line, and households on public assistance were positive and significant as theorized. This implies that the lack of legitimate employment opportunities is spatially associated with illegal drug dealing. Concerning local demand, only education is statistically related to the size of illegal drug sales arrests, the higher the percentage of those over 18 years of age without a high school diploma, the greater the number of drug sales arrests in each census block group. Finally, of the variables associated with the theory of social disorganization, all are statistically significant, but the sign on the variable “percent tenure less than five years” in not in the expected direction. The variable “area” controlled for the relative size of each census block group. It was decided to use the size of the area rather than the population since the buffers used in the present analysis are sensitive to the size of a census block group in determining the proportion of its area that is covered by the buffer.

In the second model, built facilities are added to the analysis and the results are listed in Table 2. Check cashing and pawn shops that Anderson (1999) refers to as “banks for criminals” are statistically significant. Also, beer-selling establishments (delis, corner markets, and bars that are only licensed to sell beer) are statistically associated with the size of illegal drug sales arrests. Neither major streets nor subway stops rose to the level of statistical significance.
Also, with the addition of built facilities, the local demand variable of "individuals aged from 15 to 29" becomes statistically significant. The final question now turns on whether a spatial lag term that measures the association of the size of an illegal drug market in terms of the size of neighboring illegal drug markets is statistically significant. Keep in mind that the first two models removed much of the variance associated with the poverty stricken area of North Philadelphia. The question turns on whether agglomeration economies as operationalized in this study can explain any of the residual variance from the above analyses.

The third model enters the spatial lag term. The spatial lag term means that the size of illegal drug markets in all spatially contiguous census block groups (out to two block groups) are used to explain the size of the illegal drug market in a specific census block group. As can be seen in Table 2, the

<table>
<thead>
<tr>
<th>Demographic variables (%)</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>African-American</td>
<td>0.007***</td>
<td>0.007***</td>
<td>0.011***</td>
</tr>
<tr>
<td>Female headed HH with children &lt; 18</td>
<td>0.001</td>
<td>0.003</td>
<td>-0.000</td>
</tr>
<tr>
<td>families below poverty</td>
<td>0.022***</td>
<td>0.021***</td>
<td>0.009*</td>
</tr>
<tr>
<td>HH on public assistance</td>
<td>0.032***</td>
<td>0.030***</td>
<td>0.012*</td>
</tr>
<tr>
<td>Age 15-29</td>
<td>-0.008</td>
<td>-0.012*</td>
<td>-0.011*</td>
</tr>
<tr>
<td>Unemployed</td>
<td>0.000</td>
<td>0.002</td>
<td>-0.003</td>
</tr>
<tr>
<td>Below H.S. education</td>
<td>0.015***</td>
<td>0.014***</td>
<td>0.008**</td>
</tr>
<tr>
<td>Racial heterogeneity</td>
<td>0.650**</td>
<td>0.754***</td>
<td>0.802***</td>
</tr>
<tr>
<td>Tenure &lt; 5 years</td>
<td>-0.008*</td>
<td>-0.011***</td>
<td>-0.011***</td>
</tr>
<tr>
<td>Median income</td>
<td>-0.000***</td>
<td>-0.000***</td>
<td>-0.000***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Facility variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beer establishment</td>
<td>0.017***</td>
<td>0.014***</td>
<td></td>
</tr>
<tr>
<td>Check cashing</td>
<td>0.016**</td>
<td>0.009</td>
<td></td>
</tr>
<tr>
<td>Pawn shop</td>
<td>0.019*</td>
<td>0.021**</td>
<td></td>
</tr>
<tr>
<td>Main street</td>
<td>-0.003</td>
<td>-0.004*</td>
<td></td>
</tr>
<tr>
<td>Subway stop</td>
<td>0.010</td>
<td>0.021**</td>
<td></td>
</tr>
</tbody>
</table>

| Agglomeration effect |                     |                |                |
|----------------------|----------------------|----------------|
| Spatial lag          | 0.067***              |                |                |
| Area size (control)  | -0.000***             | -0.000*        | -0.000         |
| Pseudo $R^2$         | 0.095                 | 0.102          | 0.121          |
| AIC                  | 7815.203              | 7766.805       | 7602.415       |
| BIC                  | 7886.760              | 7865.884       | 7706.998       |
|Likelihood ratio $X^2$| 815.67***             | 874.07***      | 1040.46***     |

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.
Note: census block groups ($n = 1816$).
spatial lag term is significant indicating that neighborhoods of high drug sales arrests are surrounded by other neighborhoods of high drug sales arrests and vice versa.²

A common concern with non-parametric models revolves around the low pseudo $R$-squared values. There are two responses to this concern. First, this analysis utilized negative binomial regression. These non-parametric models do not generate true $R$-squared values such as would be found in typical linear regressions. As such, the only true utility of pseudo $R$-square is in comparing the relative values generated by the specification of several different models. Pseudo $R$-squared values can only be compared against other pseudo $R$-squared values of the same type, generated from the same data, on the same outcome (Long & Freeze, 2006). Thus the absolute values of the generated pseudo $R$-square is irrelevant. To further allay concerns, Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values were also calculated. Both the AIC and the BIC will produce lower numbers when the model is (1) more parsimonious, (2) fits the data better, or (3) both.

Much like pseudo $R$-squared values, AIC and BIC values are subject to their own arbitrary metric. And, once again, it is the difference between the AIC (or BIC) for Model 1 and the AIC (or BIC) for Model 2 that is of importance. A general rule of thumb argues that $\Delta i > 10$ are substantially worse-fitting than the comparison model (Burnham & Anderson, 2004). Pseudo $R$-squared, AIC, and BIC values are presented in Table 2. AIC values for the Model 2 are substantially lower than Model 1. AIC values for Model 3 are even lower still, and represent a substantial improvement over both Model 1 and Model 2.

Finally, BIC was also used to compare the same models. It demonstrated results similar to both the pseudo $R$-square and the AIC. The fact that all three diagnostic test runs (pseudo $R$-square, AIC, and BIC) indicate that Model 2 is better specified than Model 1 and Model 3 is better specified than both Model 1 and Model 2 lend support to the conclusions of this analysis. This multi-method evaluation approach has been successfully utilized in other research areas (Baser, Palmer, & Stephenson, 2008).

² As with any statistical analysis, the models constructed here present only a few of the almost infinite number of possible combination of variables. We believe that this process of model building provides the most appropriate method of determining the impact of the included variables. However, at least one reviewer wished to know the unique effect of the spatial lag variable and the effect of excluding facilities from Model 3. Therefore, two additional models were specified. Model 4 specified only the spatial lag variable and the area variable as a control. Model 5 specified all demographic variables, the spatial lag variable, and the area control, but excluded facility variables.

The results of these models (tables omitted) were largely consistent with the results presented. In Model 4 the coefficient for the spatial lag variable was 0.122 ($p<0.001$). This coefficient for this variable is stronger than what was found in model 3. Measures of model fit (pseudo $r$-square, AIC, and BIC) indicate that model 4 is substantially worse than either Model 1, Model 2, or Model 3. Model 5 specified all demographic variables, the spatial lag variable, and the area control, but excluded facility variables.

In Model 5 the percentage of people aged 15-29 became non-significant. The effect of other variables remained unchanged. The spatial lag term was also unaffected with a coefficient of 0.067 ($p<0.001$). Measures of model fit indicated that Model 3 (pseudo $R$-square $= 0.121$, AIC $= 7602.41$, and BIC $= 7707.00$) fit the data better than Model 5 (pseudo $R$-square $= 0.114$, AIC $= 7648.46$, and BIC $= 7725.53$).
Significance of the Findings

This study provides evidence that agglomeration economies exist in the illegal drug markets of Philadelphia. Two important factors are explained by this finding: agglomeration economies illustrate that illegal drug dealers are likely to cluster in space; and second, it explains why focused place-based hot-spot policing will not simply spatially displace crime around the corner (the entire area becomes less profitable with hot-spot policing due to agglomeration diseconomies). Just as removing an anchor store from a shopping center makes the remaining stores less rather than more profitable, removing a hot spot of drug sales makes the surrounding areas less rather than more profitable. These are explanations for factors that were not always clearly understood by past scholars. We are not aware of a previous study that explains why illegal drug dealers will make less rather than more money if competing dealers are removed from their neighborhood.

If these findings are replicated elsewhere, they have important public policy implications concerning focused police attention on large illegal drug market places. Although it cannot be determined in the present panel analysis, it is likely that future time series analyses will find a "diffusion of benefits" to the surrounding communities as discovered by Weisburd et al. (2006), rather than "crime displacement" to the surrounding neighborhoods that previous analysts predicted (Reppetto, 1976). There is further evidence that "hot-spot" policing (Sherman, Gartin, & Buerger, 1989; Rengert et al., 2005) is in fact beneficial to urban neighborhoods, and past practices of containment (Schuerman & Kobrin, 1986; Wallace, 1988) are doomed to failure.

Focused crackdowns have further advantages over wide-scale operations that attack drug dealing in a variety of locations. The objective of focused patrol is to produce results so dramatic that a location becomes known as a place not to purchase illegal drugs. Furthermore, residents may view the police as an effective tool for neighborhood revitalization. This leads to co-production of public safety. Such results may not occur if police resources are spread thinly over the city with only slight improvements in many places. Kleiman and Smith summarize the advantages of focused crackdowns over spreading police resources more widely:

> Virtually eliminating drug dealing in one drug-infested neighborhood—thus creating an area where residents feel safe and parents can let their children roam free—may be more valuable than reducing drug activity by 10 percent in each of ten drug-infested neighborhoods, just as picking up all the litter in one filthy park creates one clean park, while picking up 10 percent of the litter in each of ten parks leaves ten slightly less filthy parks, none of them attractive as places to play or relax...The ideal focused crackdown strategy in a big city would move slowly from neighborhood to neighborhood, leaving behind vigilant citizens and residual markets small enough to be controlled with residual enforcement efforts. (1990, p. 89)

Attacking directly the largest drug markets, therefore, can lead to a multiplier effect for a set level of police resources associated with the co-production of
public safety between the police and private citizens. Furthermore, eliminating an especially active drug dealing location is expected to have benefits for surrounding areas as well since the agglomeration economies of the place being known as the location to buy drugs is changed to being known as the location not to buy drugs. Agglomeration economies that accrue to illegal drug dealers operating in large market places thus should be attacked directly.

Major streets are negatively associated with the size of illegal drug markets in Philadelphia in the final model. This is an interesting finding that implies that Philadelphia drug markets are more oriented to local rather than regional demand. Further evidence of this is the fact that neither exits from limited access highways (such as I-95) nor regional rail terminals met the criteria for inclusion in the statistical models. Mapping of the illegal drug markets provided further evidence that the largest concentrations of illegal drug sales tended to be within neighborhoods rather than along major highways.

Conclusion

There is a debate over whether police attention focused on an illegal drug market causes dealers to spatially displace around the corner therefore having no positive impact on the aggregate level of illegal drug sales in the city. The alternative prospective is that focused patrol lowers the rate of illegal drug dealing in urban neighborhoods by taking the largest most profitable sites from illegal dealers, making the entire community less profitable for drug dealers to operate in. In short, the issue hinges on whether illegal drug dealers cluster in space solely for the marketing principles of local demand and the built environment or whether agglomeration economies also play an important role.

The analysis determined that agglomeration economies indeed had an important impact on the spatial clustering of illegal drug dealers in Philadelphia, even when the variance associated with competing factors was removed. This is a very important finding. Since agglomeration economies, as measured by the spatial lag term, are significantly associated with the size of illegal drug markets, this implies that focused police attention to remove these economically favorable places will result in the diffusion of benefits as discovered by Weisburd et al. (2006) in Jersey City, New Jersey. This is contrary to the displacement of crime predicted by many narcotics officers in major police units and the general public, as well as by earlier crime theorists (Reppetto, 1976). Just as the permanent closing of a large anchor store in a shopping mall reduces the profitability of the smaller neighboring stores, so removing a large profitable illegal drug market makes the surrounding places less, rather than more profitable. The same may be true for closing a "red light" district for prostitution. More research is required to determine if this is the case. It remains to be determined if other illegal sales and service activities are equally affected by focused crime prevention activities.
This article only determined that agglomeration economies exist in illegal drug sales in Philadelphia. What is not possible to determine with the panel data used in this study is whether focused police attention will result in a diffusion of benefits rather than a spatial displacement of crime in this city. This issue was addressed directly, however, by Weisburd et al. (2006) in Jersey City, New Jersey. These two studies taken together demonstrate that illegal drug dealers are not expected to "move around the corner" when faced with focused police attention (Weisburd et al., 2006), but rather become less profitable and smaller in size associated with the diffusion of benefits resulting from the attenuation of the agglomeration economy identified in this study.

References


