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The Devil You Don't Know: A Spatial Analysis of Crime at Newark's Prudential Center on Hockey Game Days

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Cover Page Footnote
We truly appreciate the assistance provided by Newark Police Department whose support made this project possible.

Introduction

Event-related crime, disorder, and security problems are not a modern phenomenon. These issues have a long-standing tradition that dates back as far as Ancient Greece (Circa, 420 B.C.) and Rome. Such problems and the interventions put in place to prevent them are well documented (Cameron, 1976; Guttman, 1986; Simons and Taylor, 1992; Faulkner 2012). For instance, during the Olympic games of ancient Greece (Circa, 420 B.C.), two distinct types of security personnel were present in an attempt to maintain order among spectators: the mastigophoroi (who carried whips) and the rabdouchoi (who carried truncheons). Legislation at the time was even passed that prohibited the consumption of alcohol within a stadium because of the unruly behavior associated with its use among spectators (Guttman, 1986).

Problems persisted during the Roman Empire (Circa, 59-532 A.D.) when tensions between supporters of rival chariot-racing teams frequently led not only to confrontations, but violence. Indeed, spectators repeatedly set fire to the wooden Hippodrome, burning it down several times. Ultimately, the emperor Justinian commissioned a new stadium of marble to avoid rebuilding yet again. Prior to this incident in 59 A.D. the Roman Senate banned gladiatorial fights in Pompeii for ten years not because of the brutal nature of the battles that frequently ended in death, but because of the spectator violence that such battles generated (Simons and Taylor 1992; Crowther 2007, pp. 142).

Conflicts in stadia during this period between rival factions frequently overflowed into the streets and affected the surrounding local population. For example, during the Nika riots in 532 AD, rival supporters of chariot race teams united in response to the social and political pressures of the time and turned their violence towards a common enemy, Justinian's palace. The Roman military was subsequently called in to quell the violence that lasted for five days and resulted in an estimated 30,000 deaths (Guttman, 1986).

Fast-forward through time to Medieval Britain and the introduction of "folk football" where details of violence, disorder, and general mayhem that was generated by spectators is evident not only in historical written accounts, but in the form of formal measures and decrees by the state and local municipalities between 1314 and 1660 (Strutt 1801; Dunning 1999). The first, issued in 1314 by the Lord Mayor of the City of London, Nicholas de Farndone, on behalf of King Edward II, explicitly prohibited football since the game caused, "great uproar in the City, through certain tumult arising from great footballs in the field of the public, from which many evils perchance may arise" (Marples 1954: 439-41). Further attempts to control these sporting-event related security and crime problems led to the establishment of Britain's first sporting-related specialized police unit in 1618 (Cox, Russell and Vamplex, 2002).

Another skip ahead in time to Britain and Europe (to a lesser extent) immediately following the Second World War makes clear that the crime and disorder associated with sporting events from the ancient world persisted and remains problematic even today. Various theoretical accounts of the problems, primarily conducted by those in the social sciences in the U.K. have attempted to explain the problem (for a review see Frosdick and Marsh, 2005), and until recently, these have been largely transfixed on explaining the behavior of criminally predisposed fans. While interesting, such approaches tend to offer little practical value for securing and preventing crime, disorder, and security-related

problems in the contexts of large-scale sporting events. Fortunately, a new stream of research in this area, again primarily driven by academic research emanating from the U.K. has begun to take shape that seeks to increase our understanding of how the rapid (and episodic) change in the environment around stadia associated with crowds may affect crime and disorder patterns as well as other crowd-related events (Horn and Breetzke, 2009; Breetzke and Cohn, 2013; Kurland, Johnson and Tilley, 2014, 2017; Kurland, Tilley, and Johnson 2014). We seek to build on this small, but rapidly growing number of studies that focus on understanding the nature of the crime and disorder patterns, but do so with a focus on an American arena, the Prudential Center in Newark, NJ.

The abovementioned studies tested the hypothesis that there would not only be a change in the spatial distribution of crime events on days when stadia or arenas were used, but that the counts would be significantly greater by comparing counts of crime around these facilities on game days, and on equivalent non-game days. Findings from these U.K.-based studies consistently indicated that the distribution (and count) of crime events differed across these two sets of days, with a significantly greater number of crimes occurring in the area on game days and in some instances at distances over 2 kilometers from the stadium (see Kurland, Tilley, and Johnson 2017). In an attempt to replicate the analysis of previous empirical work, thus building a more generalizable empirical base regarding the criminogenic effect of stadia and arenas we test for differences in the spatial pattern (and count) of crime on game and non-game days, with more crime expected on the former than the latter around the Prudential Center.

In the sections that follow we provide background regarding the history of the Prudential Center to further contextualize the study, summarize the data that was utilized and the analytical approach adopted and present the findings. The results are then discussed with respect to their implications for police and security practice.

Background

The Prudential Center, the nearly 20,000-seat arena in downtown Newark, opened for business on October 25th, 2007. Marked with a week of ceremonial shows by New Jersey native John Bon Jovi, the opening of the Prudential Center was the result of many years of political negotiating and planning by City of Newark officials (Farber, 2007). The idea to build an arena in New Jersey's largest city was first advanced by Sharpe James, who served as Newark mayor from 1985 to 2006. James envisioned the arena as an economic generator for the city and consistently lobbied city and state officials to provide funding for such a project. (Jones, 2007). Despite objections from local politicians regarding the cost of this project (Jones, 2007), as well as academic research finding sports stadia typically do not positively contribute to local economies (Delaney and Eckstein, 2003), the Prudential Center was built at a cost of approximately $375 million (Kaske, 2007). While spearheaded by the James administration, the Prudential Center would not open until new Mayor (and now U.S. Senator) Cory Booker took office.

While the Arena would host a diverse set of events such as Seton Hall University basketball games, concerts, family shows and local university graduations, the main tenant is the New Jersey Devils franchise of the National Hockey League. Beginning with the 2007-2008 season, the Devils play all 41 of their regular season home and playoff

games at the Prudential Center each year, including 3 games as part of the NHL Stanley Cup Championship series in 2012. While celebrated as a positive development by City leaders, the opening of a arena in New Jersey's largest (and highest crime) city initially worried some observers. Many wondered whether public safety concerns would prevent middle class and more affluent suburban residents from frequenting the Prudential Center (Jones, 2007). Such concern was articulated by Barry Melrose, a Hockey analyst for the ESPN television network. In describing the newly opened Prudential Center during a webcast, Melrose stated "It looks great on the inside but don't go outside, especially if you got a wallet or anything else because the area around the building is awful" (Mays, 2007).

Despite the worry, public officials ensured that Prudential Center patrons would be safe during their time in the city. In particular, the Newark Police Department (NPD) pointed to the creation of an "arena unit" tasked with policing the geography immediately surrounding the Prudential Center during all event days. Periodically, statistics released by the NPD supported claims that downtown Newark was a safe environment for visitors. For example, over a 4-day period in 2011 the NCAA East Regional Basketball Tournament was held at the Prudential Center, police data suggested that crime was "virtually nonexistent" in the downtown area (Queally, 2011). However, high-profile crime events that did occur around the Prudential Center called into question the true safety afforded to event attendees. For example, six people walking to a parking lot were assaulted by a group of at least a dozen teenagers after a Britney Spears' concert (Adarlo, 2009) and 5 people were beaten and robbed about 2 blocks from the Arena following a Red Hot Chili Peppers concert (Queally, 2012). While high profile acts of crime were not reported following any hockey games, the most frequently occurring events at the Prudential Center, the implications of crime in the surrounding area did not seem to be lost on the local media. Indeed, reports of serious crime occurring in Downtown Newark often described these events as occurring "within close proximity" or "nearby" the Prudential Center, irrespective of their connection to arena events (e.g. Star Ledger, 2011, 2012a).

Data and Methods

Hockey games were played at the Prudential Center on 333 dates during the 2007/08—2015/16 seasons. For 216 of these, a comparable non-game day was identified via a Java-based program. The program identifies the seven days before and the seven days after a given hockey game day, selecting one optimal comparator date in each week. If no game occurs on either date and if neither has already been selected as the comparison day for another game, the earlier date is selected as the game comparator to leave sufficient comparison days for games occurring later in the schedule. However, if both dates are unavailable due to games or prior selection, then the program search parameters are first expanded to the fourteen days before and fourteen days after the game, and if no match is found then twenty-one days and if no match is found again then the search parameters are expanded to twenty-eight days. If no suitable comparison days were found within this twenty-eight day period from the game day that particular game was excluded from the sample game day dataset. Ultimately, a total of 89 comparison days fell within seven days of a hockey game; 33 comparison days fell within the fourteen-day period; 36 were

within twenty-one days; whilst (while) 58 were within 28 days of a hockey game. It should be noted that other events besides hockey matches take place at the Prudential Center. These other events were included in the date selection process to ensure that the comparison dates were days when the Arena was not used.

This paired-date approach makes it possible to determine whether the patterns of crime in and around the Prudential Center vary between hockey game days and non-game days. Appendix 1 provides a full listing of the game days and comparator dates used in the study. The current study made use of all police-recorded crime events that took place across the city of Newark. The original dataset of police recorded incidents provided by the Newark Police Department included a total of 105,197 geocoded crimes between January 1, 2007 and July 19, 2015. The dataset was then cleaned for purpose to include all the crime events that took place on the 216 game days and the 216-matched comparison days. This aims to provide a more thorough estimation of how spatial patterns of crime and disorder may be differentially associated with game and non-game days across the entire city.

At first blush analyzing crime patterns (and counts) across the entire city of Newark may seem unreasonable, particularly given previous empirical findings that suggest a more localized spike in levels of crime around stadia. However, it is equally true that no two contexts will be identical and so while patterns in and around stadia in the U.K. indicate there are no significant changes that can be tied directly to a game taking place beyond a certain distance this may (or may not) be the case for the Prudential Center for a variety of reasons. For one, the approach to policing large-scale crowd-related events in the U.K. and the U.S. are different, and how the additional resources are pooled together by law enforcement may differ. More specifically, special services policing in the U.K. (see Kurland, Johnson, and Tilley 2011[a-e]) is provided, in part, by the professional sport franchise giving greater latitude to the budgetary constraints of those forces. However, this is not the case in Newark. In practical terms, this means that policing resources that may typically be utilized to patrol in areas farther away from the Prudential Center may have fewer officers thus leading to weaker potential deterrence in other areas of the city.

For ease of analysis and reporting, the crime data were also cleaned and disaggregated into their respective categories yielding 10 crime-specific groups: aggravated assault; auto theft; burglary; murder; rape; robbery shots fired; theft; theft snatch; and theft from auto; and one general crime grouping that combined all categories. In total, there were 11,691 usable crimes occurring on game (N=6,946) and non-game days (N=4,745) respectively[1].

A different spatial unit of analysis—the Newark downtown area—was also utilized in the study. This smaller area encapsulates the Prudential Center and Newark Penn Station, along with various other facilities that may influence crime patterns such as bars and restaurants. This smaller unit of analysis is consistent with other studies on the spatial pattern of crime and disorder around stadia and arenas (see Kurland, Johnson, and Tilley 2014) and importantly may account for the distance decay effect that is associated with the distribution of crime events around the Prudential Center. That is, previous empirical studies on stadia have repeatedly found a significant relationship between

[1] There were a total of 93,506 unusable crimes. Crimes that were not included in the analysis were those that did not take place on either a game or non-game day.

crime and the stadium/arena of interest, but as this distance increases the effect of distance on crime decreases and becomes non-significant (see Kurland and Johnson, 2017). Figure 1 provides both an overview of the larger study area, which includes the entire city of Newark, along with a boundary for this second, smaller unit of analysis that is also used.

See Figure 1. Maps of Newark, Newark Downtown, and the Prudential Center

The same 10 crime-specific groups were included to uncover differences in the game to non-game day patterns that may (or may not) exist across this smaller area. In total, there were 513 usable crimes occurring on game (N=318) and non-game days (N=196) respectively.

To begin to understand the point patterns associated with both sets of days both the game and non-game days sets of crime data (for each respective crime category) are geo-coded and plotted on the maps. Next, to further explore differences that may exist between categories of crime across both game and non-game days kernel density estimation (a smoothing function) is used to generate "hotspot" maps. Such maps can provide greater insight into the general distribution of crime and disorder events and help visualize where differences may (or may not) occur across game and non-game days. Statistical tests were then used to examine the reliability of spatial patterns and differences in the counts of crime events across game and non-game days.

More specifically, two non-parametric permutation tests were used to examine whether the overall count of crime events was higher on game days than on non-game days. In the first instance, for such a test we compared the overall difference between the total count of events observed on game days and non-game days with what would be expected if the probability of a crime event occurring on either type of day was the same. The aim was to compute the probability of seeing a difference in crime counts, beyond that which was observed, if the probability of a crime occurring was independent of whether a game took place or not.

To compute the probability, first we took the observed difference for the total count of crimes between game and non-game days. Next, we summed the total number of observed crimes that took place on both game and non-game days and obtained a sample distribution by randomly generating pairs of numbers that when summed equalled the total number of observed crimes. To increase the reliability of our estimates, this procedure was performed 1,000 times computing a difference for each permutation. Finally, to determine the statistical significance, we used our sample distribution to calculate the fraction of the observed differences that had a difference equal to or greater than the original observed difference between the game and non-game comparison days.

One assumption of the above approach is that the difference in the total observed count of crimes for game and non-game comparison is roughly equivalent, and hence that what is observed in the aggregate will generally apply for each pair of game-to-non-game day comparisons. This may or may not be a reasonable assumption. In the extreme, it is possible that for a single game-to-non-game comparison there may be a huge difference in the counts of crime events for the game day and it's associated non-game comparison day (e.g. 5 vs. 100 crime events). For this reason, we used a variation of the above test that was based on different assumptions. Thus, for each game-to-non-game comparison

we calculated the difference in the observed counts. We then compared this with what would be expected if the observed daily counts were preserved, but the type of day on which they occurred (game versus non-game) was random.

To compute the probability, we first took the sum of the observed differences for the count of crimes between game and non-game day pairs. Next, we randomly reassigned each of the preserved game and non-game day pair counts into either a pseudo-game or pseudo non-game day sample to generate the distribution for the observed differences. Again this was performed 1,000 times with the sum of the observed differences between pseudo-game and pseudo-non-game day pairs computed for each permutation. As with the first abovementioned permutation test, we determined statistical significance by calculating the fraction of the observed pseudo-game and pseudo-non game day differences that had a difference equal to or greater than the original observed difference between the game and non-game day pairs.

The two approaches tell us different things. The first approach answers the question "in total were there more crimes on game days than non-game days". The second approach concerns the question "in general, is it the case that more crimes consistently occur on game days than on comparable non-game days". By using both approaches we can triangulate the results. Where consistencies are observed we can therefore be more precise about what the results mean, and more confident in our conclusions.

Finally, a smaller unit of analysis—the street segment—is used to develop a more complete understanding of the crime patterns that exists across the city of Newark on days that the Arena is used for Devil's games as opposed to days when it is not. There are a total of 5,077 street segments in the city (as measured within a Geographic Information system) and all 11,691 crimes occurring on game (N=6,946) and non-game days (N=4,745) were used to uncover differences at this resolution. Like the abovementioned techniques employed to identify unique patterns to distinguish what occurs on game days versus a similar set of days in Newark when nothing takes place all ten crime categories are used to generate choropleth maps of the crime counts at the street segment level. However, for the final analyses only the amalgamated total crime category was used. First, a map was generated by taking the difference in count per street segment between game and non-games before utilizing the first permutation test described above to determine which, if any, of the specific street segments had a significantly greater count of crimes occur on game days. The latter is then mapped to better visualize this pattern across the city of Newark and to offer spatially explicit guidance to both the Newark Police Department and the private security responsible for maintaining spectator safety at the Prudential Center.

Results

The first set of analyses sought to provide a clearer picture of the pattern of crime that took place across the city of Newark when the Prudential Center was used for Devil's hockey games. Figure 2 provides an overview of the point patterns for each respective crime category for both sets of days, with the right column representing the pattern for days that hockey games take place and the left for comparison days. It is fairly clear from looking at each map that game days appear to have a larger number of crime events

regardless of the crime category.

See Figure 2. Point Pattern Maps for Devils Hockey Games and Comparison Days for Each Crime Category

While the patterns across the city do appear to suggest that there may be some underlying differences a closer visualization of the patterns across the downtown area enable a clearer picture of some of these differences. For example, it is obvious from conducting a simple count of aggravated assault locations in Figure 3 that there are more incidents that take place on game days (N=16) than on non-game days (N=10) across the downtown area of Newark. This appears to be the same for all crime groups across the area that encapsulates the Prudential Center.

See Figure 3. Hotspot Maps for Devils Hockey Games and Comparison Days for Each Crime Category

To gain a better understanding we utilize a series of Kernel Density Estimate Maps, more commonly referred to as "hotspot" maps for each crime category across the entire city of Newark on both sets of days. Figure 4 highlights the differences in these crime patterns. More specifically, we can see that the volume of auto theft that occurs in the area surrounding the Prudential Center appears to be much greater than what is experienced on relative comparison days. This is not surprising given the number of additional vehicles brought into Newark by fans attending Devil's games. A similar pattern emerges when examining the distribution of all type of theft offenses that occur across the city of Newark, with what appears to be a greater intensity of all theft offenses in the area most proximal to the Prudential Center. The hotspot maps shed further light on what appears to be a greater intensity of burglary incidents that appear to take place in the far western section of the city when Devil's games take place.

See Figure 4. Point Pattern Maps for Devils Hockey Games and Comparison Days for Each Crime Category

Hotspot maps of the Downtown area in Figure 5 serve to further illustrate the difference in the distribution of crime offenses that occur on both sets of days. Indeed, for this smaller area that encapsulates the Arena there is a noticeable difference for all theft categories even if there are relatively few incidents that have occurred such as in the case of theft – snatching. While, the total crime category serves to illustrate the severity of crime problems that emerge on days when hockey games take place as opposed to those days when they do not.

See Figure 5. Hotspot Maps for Downtown Newark Game and Comparison Days for Each Crime Category

The overall count, and the intensity of each respective crime pattern for both sets of days appears to be different upon visual inspection and to establish this more confidently we turn to the non-parametric permutation test results in Table 1. The total

count for each crime category is listed for both game and comparison days along with the associated *P*-value that indicates the chance of seeing a difference in the total count for each respective type of day for each crime category. Not surprisingly, given the overall point pattern and hotspot maps all categories of crime with the exception of murder, rape, shots fired, and theft-snatch are significantly different. Closer examination of the difference in the total counts of crime in Table 1 for these other crime categories brings to light the severity of the crime and security-related problems that appear to plague the city when Devil's games take place.

Table 1. Permutation Test for Difference in Game and Comparison (N=216) Crime Count Totals Across Newark

	Game Day	Comparison Day	*p*-value
Agg. Assault	549	385	.001
Auto Theft	1878	1298	.001
Burglary	1139	786	.001
Murder	42	29	.086
Rape	28	19	.120
Robbery	1112	696	.001
Shots Fired	6	3	.267
Theft	883	583	.001
Theft - Snatch	20	13	.142
Theft F/A	1289	993	.001
Total	*6946*	*4745*	*.001*

Results from the second non-parametric permutation test set out to examine the differences found in aggregates across all days was also true when assessed for each respective day and was nearly identical to the results found for the total count. That is, only murder, rape, shots fired, and theft-snatch were not significantly different. More specifically in Table 2 the average count per day for each respective crime category, along with the standard deviation in parentheses, is found for the game and comparison day samples along with the associated *P*-value for these comparisons. Perhaps, most striking is the fact that on average there are an additional 10 offenses that occur (that are actually recorded) across the city of Newark on days when the Devil's play.

Table 2. Permutation Test for Difference in Game and Comparison Day Crime Count Totals Across Newark

	Game Day	Comparison Day	*p*-value
Agg. Assault	2.54 (1.55)	1.78 (2.01)	.003
Auto Theft	8.69 (4.29)	6.00 (6.08)	.003
Burglary	5.27 (2.49)	3.63 (3.37)	.003
Murder	0.19 (0.41)	0.13 (0.38)	.079
Rape	0.12 (0.37)	0.08 (0.32)	.128
Robbery	5.14 (3.12)	3.22 (3.15)	.003
Shots Fired	0.02 (0.21)	0.01 (0.15)	.296
Theft	4.08 (2.29)	2.69 (2.71)	.003
Theft - Snatch	0.09 (0.38)	0.06 (0.29)	.168

Theft F/A	5.96 (3.23)	4.31 (4.18)	.003
Total	*32.15 (8.21)*	*21.96 (17.88)*	*.002*

Note: Standard deviation in parentheses.

To determine if these patterns hold true in the areas more proximal to the Prudential Center the same set of analyses were conducted for the downtown area. Results in Table 3 suggest that only counts of robbery, theft, theft from automobiles, and the total crime categories are significantly different at the aggregate level. The total counts for each crime category for both game and comparison day samples highlight these differences in count and the degree to which we can confidently conclude that the change in count to the area is not something spurious, but is indeed a function of Devil's games taking place. For example, there were a total of 53 robberies that took place across this area on days when games took place, but only 36 on respective comparison days. The non-parametric permutation test suggests that this difference is systematic and not simply due to chance.

Table 3. Permutation Test for Difference in Game and Comparison (N=216) Crime Count Totals Across Downtown Newark

	Game Day	Comparison Day	P-value
Agg. Assault	19	10	0.080
Auto Theft	41	28	0.075
Burglary	19	15	0.306
Murder	1	1	0.754
Rape	0	0	-
Robbery	53	36	0.037
Shots Fired	0	0	-
Theft	106	61	0.001
Theft - Snatch	4	0	0.078
Theft F/A	75	44	0.003
Total	*318*	*195*	*0.001*

Results from the final set of non-parametric permutation tests set out to uncover differences across the downtown area of Newark encapsulating the Arena seen in Table 4 indicate the same overall pattern of significant differences that were found when looking at crime categories in the aggregate. That is, robbery, theft, theft from automobile, and the total crime categories were also found to be significantly greater on game days than on respective comparison days. In other words, on any given game day across this downtown area we can expect approximately 1.5 crimes to occur, whereas roughly .9 crimes are expected on similar days when games do not take place. Again, the average count and the standard deviation, found in parentheses, is given for all categories along with the associated *P*-value for these comparisons.

Table 4. Permutation Test for Difference in Game and Comparison Day Crime Count Totals Across Downtown Newark

	Game Day	Comparison Day	P-value
Agg. Assault	0.087 (0.29)	0.046 (0.21)	0.069
Auto Theft	0.189 (0.43)	0.129 (0.39)	0.101
Burglary	0.087 (0.28)	0.069 (0.25)	0.269
Murder	0.004 (0.74)	0.004 (0.06)	0.748
Rape	-	-	-
Robbery	0.245 (0.52)	0.162 (0.42)	0.046
Shots Fired	-	-	-
Theft	0.490 (0.72)	0.282 (0.56)	0.002
Theft - Snatch	0.018 (0.13)	0 (0.00)	0.070
Theft F/A	0.347 (0.64)	0.203 (0.46)	0.007
Total	*1.472 (1.32)*	*0.898 (1.21)*	*0.002*

Choropleth maps, in Figure 6, shows the crime count for each respective category across the entire city of Newark at the street segment level. These maps bring to light differences that exist between the groups at a level of resolution that has hitherto been explored in the context of sports and entertainment venues. The patterns that emerge from these maps largely reflect what was uncovered in the other maps, which looked at the patterns more generally. That is, that there appears to be a difference in the overall volume of crime events particularly for auto theft, robbery, theft, theft from automobile, and total crime.

See Figure 6. Choropleth Maps at the Street Segment for Devils Game and Comparison Days for Each Crime Category

To help envisage these differences more clearly Figure 7 illustrates a segment by segment breakdown of the entire city of Newark for the total crime count between game and comparison days. Those blue colored street segments represent those street segments that experienced fewer crimes on games days, with the yellow, orange and red colored lines representing those that experienced more on games days. The total number of segments that experience a difference are attached to each respective difference category. For example, there were 128 street segments across the city that experienced 4 additional crimes on game days. What is also clear from this map is that there are by far many more street segments that experience a greater number of crimes on days that games take place than on respective comparison days. In fact, of the 5077 street segments in the city of Newark, 1902 of them or approximately 37% of them experienced a higher number of crime incidents on game days.

See Figure 7. Difference in Total Count Between Game and Comparison Day Map for Newark

Finally, in an effort to bring this together the same non-parametric test used to uncover differences in the total count of crimes at both the city-wide and downtown unit of analysis was used to not only uncover that systematic differences occurred at the street segment level, but to pinpoint where these differences were and the precise street segments. Figure 8 demonstrates the distribution of 69 street segments where a significantly greater number of crime events take place when Devil's games occur and their location relative to the Prudential Center. It is not surprising to find that 10 of these segments occur within 1km of the area that surrounds the Arena. However, what was unexpected was that several street segments that experienced a significantly greater number of crime events occur in areas that extend over 5km from the Prudential Center.

See Figure 8. Non-parametric Permutation Map of Street Segments with a Significantly Greater Count of Crime on Game Days for Newark

Discussion

This analysis addresses a series of research questions related to the spatial distribution of crime incidents across the city of Newark on days that Devil's hockey games take place. This work is intended to contribute something new to the small, but growing body of research on crime and security-related problems around stadia and arenas. The findings differ from the majority of research in this area, which has focused primarily on the social, demographic or historical factors of crime in the vicinity of sporting events. In what follows, we discuss policy implications that stem from these findings, practical suggestions directly related to the analyses herein which can assist in developing preventive strategies for the area around the Prudential Center, and suggest some potentially fruitful research in this area.

Policy Contribution

As litigation between the city of Newark and the New Jersey Devil's persists, a more evidence-based approach to determining the allocation of policing and criminal justice costs for the city is timely. The crime associated with hockey games (and potentially other events that take place at the Arena that were not tested in this study) should be considered a form of "crime pollution" (Farrell and Roman, 2006): an unintended and unwanted side effect of activity that occurs as a result of a positive move in building the Prudential Center. Recent efforts by the Association of Chief Police Officers (ACPO) in the U.K. have attempted to quantify the full extent of "crime pollution" in and around stadia in a concerted effort to make professional soccer clubs responsible for additional policing, security, and criminal justice related costs (see Kurland, Johnson, and Tilley, 2011[a-e]). Further, there have been wider calls by those in the crime science community for a "market-based incentive" approach towards businesses that generate crime (Eck and Eck, 2012; Mazerolle and Ransley, 2012; Sparrow, 2012; Tilley, 2012). The approach is reasonable in theory. That is, motivate businesses through incentives to reduce the crime and security-related problems linked to their particular establishments. Practically, however, measuring and attributing this "crime pollution" is extremely challenging. More specifically, separating the criminogenic impact of a specific nightclub or bar from the

constellation of other facilities that may be operating in similar locations and times is difficult. Fortunately, for large-scale sporting and entertainment venues such as the Prudential Center, this is simply not true. Because these facilities, unlike the majority of other businesses, are used episodically. Methods such as those used in this paper can be utilized to quantify where this "crime pollution" occurs.

A new policy, or policies, can be drafted for not only the Prudential Center but also other large-scale sporting/entertainment facilities that accurately reflect their impact on the local communities that they serve, as opposed to the haphazard revenue sharing schemes that generally overlook the negative externalities associated with their use. Such an approach would also incentivize the professional sports franchises to implement more specific crime and security-prevention initiatives to aid in the reduction of problems they inadvertently generate. Such a policy would not only help to more accurately identify and penalize those professional sports franchises that are indifferent to the potentially negative impact they have on their local communities, but it could also reward those who make a concerted effort to reduce this harm, and in turn endear them to their local communities. Lastly, the development of a data-driven evidence-based approach for more fairly determining policing and criminal justice cost compensation could prevent costly legal proceedings and unnecessary acrimony between sports franchises, law enforcement, local government officials, event security management, and the communities themselves.

Tactical Contribution

Differences in the spatial pattern were identified for nearly every crime category. More specifically, the results suggest that: aggravated assault; robbery; theft; and theft from automobile offenses citywide and downtown are significantly different when games take place, while auto theft and burglary offenses differ significantly at the city-wide level. The most obvious benefit of the earlier set of analyses, and the hotspot maps more specifically, is that law enforcement can position themselves accordingly in an effort to prevent potential incidents from occurring. However, more nuanced approaches to both the allocation of law enforcement and associated policing resources should consider each respective crime pattern more deliberately as the different types of crime vary. Thus the strategy that will be most beneficial for a hotspot should be shaped by what has the greatest potential to prevent a specific crime.

To provide an example of this crime specific approach we turn to Figure 8 where 69 street segments were identified as having a significantly greater amount of crime on game days. Those street segments that fall within 1km of the Prudential Center had a significantly greater number of crime events and includes the respective counts for aggravated assault, automobile theft, burglary, robbery, theft, and theft from automobile can be seen in Table 5.

Table 5. Crime Counts for Street Segments Identified as Having a Significantly Greater Number of Crimes on Game Days within 1km of the Prudential Center

Street	Agg. Assault	Auto Theft	Burglary	Robbery	Theft	Theft F/A	*Total*
Bruen St.	0	4	0	0	1	2	7
Mulberry St.	1	1	0	2	6	0	10

Market St.	2	0	1	7	16	2	28
Broad St.	3	1	0	2	11	2	18
Commerce St.	0	0	0	1	0	6	7
Total	6	6	1	12	34	12	71

A street by street diagnosis is possible where different types of interventions that are specific to a precise crime problem that each segment is experiencing can be undertaken, but herein we will focus on the problem of theft on along these street segments as it appears to be most pervasive and therefore concentrating efforts may yield the largest benefit. Closer examination of the businesses nested along these street segments suggests that both retail outlets and fans attending the game likely furnish additional opportunities for either shoplifting or pick pocketing events to occur. A sensible intervention for game day theft along this street segment may be to situate either additional uniformed officers or private security (with police permission) to help guide fans to the Arena, while simultaneously decreasing the risk associated with committing an offense in this area. In this sense, the Newark Police Departments arena unit may be able to more tightly focus their efforts by deploying officers to the street segments experiencing disproportionate levels of crime, rather than focusing their attention equally across the downtown area. In an effort to increase the associated risk of committing an offense along high risk street segments consideration should be given to the introduction of portable CCTV devices that can be carried by officers on game days in the hours preceding and following games. This would add to the current levels of surveillance in the area, as a number of Newark Police Department's fixed CCTV cameras are currently installed in the downtown area. This approach has gained traction in the U.K. where often even mounted police operate CCTV devices, and while not formally evaluated in the event context, a recent randomized control trial of police-directed CCTV use found significant reductions in crime relative to "stand-alone" camera deployments (see Piza, Caplan, Kennedy, and Gilchrist, 2015). In addition, businesses along these streets may be informed of the spate of thefts that occur there on game days and be provided with a problem-oriented policing guide (see Clarke and Petrossian, 2012) that could help them tackle shoplifting through various measures.

Let us now consider how engaging stakeholders might be beneficial for the reduction of both automobile theft and theft from automobiles around the Prudential Center, which are the most pervasive crimes identified along the more proximal street segments identified in this analysis. One measure to combat these two specific crimes would be to have bike patrols along these street segments (and perhaps adjacent roads as well) where there was an elevated number of these type of thefts on game days. This does not mean, however, that the police should secure the large concentration of unattended vehicles in the fan parking lots owned by the Prudential Center. Instead, private security personnel on bikes could take on a role similar to the one they typically play inside the Arena, to communicate with law enforcement should a problem arise, only watching over these parking lots instead. There are two potential benefits to this problem-solving approach. The first is a reduction in theft of (and from) automobiles in these areas where cars park. The second is a reduction in the overall dependence on law enforcement in the area, thereby reducing the costs associated with policing this area. The effectiveness of particular measures would need to be tested and, if successful, could also be applied

elsewhere with similar problems, but in each instance this will require a coordinated effort between the management of sports and entertainment venues and law enforcement. Trying strategies to address different offenses may eventually yield evidence-based guidance on effective ways of reducing event-related crime and security problems.

What should be clear from the abovementioned recommendations for tackling the theft problem on these street segments around the Prudential Center is that the solution cannot realistically lie solely with law enforcement efforts. For many years, sports franchises, bars and other premises have resisted the notion that there may be some role for them in addressing event-related crime, disorder, and security problems, with most believing it was simply a problem for law enforcement. Consequently, the first step towards implementing a possible solution identified through this evidence-based approach is to engage these sports franchises and other various stakeholders by actively involving them in the problem-solving process. This is readily achieved with empirical evidence generated from the type of analyses conducted herein and influence stakeholders to take ownership of the problem and assume some responsibility for a solution.

Conclusion

The statistical data analyzed in this article provides evidence of a change in the distribution of crime and security-related incidents that take place on Devil's game days compared to non-game days in the area not only immediately surrounding the Prudential Center but in areas (and street segments) situated in some instances over 5km away. This research is unique in that it is—at least as far as the author's are aware—the first empirical study to employ inferential methods for exploring crime and security-related patterns to the area surrounding stadia or arenas in the U.S. Further, the research is timely in that there has been an increase in the severity of security/safety issues in and around venues across the world over the past several years. Moving forward, those responsible for developing and implementing an event security plan should strongly consider conducting a venue-specific analysis of existing crime and security-related problems. Such an analysis can provide genuine insight into not only how law enforcement and private security can strategically locate their resources, which could help prevent crime and security related problems from occurring. Critics of our approach to analysis (and the recommendations made herein) may contend that "security" and "crime" problems are indeed different beasts, which require contrasting methods of analysis, prevention, and management and consequently our work can be safely ignored would be unwise. Crime and terror-related events are heavily patterned (in space and time) and may even have similar distributions. Consequently, they are both amenable to similar methods of analysis and interventions set out to prevent them from occurring in the future (see Clarke and Newman, 2006). Further, and although beyond the scope of this article, considerable evidence on the utility of comparable methods for the analysis of terrorist attacks (see Townsley, Johnson, and Ratcliffe, 2008; see also, Braithwaite and Johnson 2012) and for evaluating the effectiveness of interventions meant to reduce terrorist incidents (see Perry, Apel, Newman, and Clarke, 2016) have already been established. Unfortunately, those who continue to create "security event plans" in the absence of empirical analyses do so not only at their own peril, but also at the risk of innocent spectators. It is indeed likely that the environmental conditions that make the

area surrounding a particular venue attractive to a pickpocket who takes advantage of the large crowd and the anonymity and egress it can provide will be similar to what a motivated terrorist will look for to inflict the greatest damage as evidenced by both the Boston Marathon bombing as well as the recent Manchester Arena attack.

Along this vein, we hope that this article inspires future collaborations between those with backgrounds in Crime Science, those involved in event security management, and the law enforcement that are invariably the purveyors of the kinds of data required to conduct similar types of analyses. There is no doubt that those who attend sporting and entertainment venues around the world will be safer because of it.

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Appendix 1. New Jersey Devil's Game and Relative Comparison Days

Game	Comparison	Game	Comparison	Game	Comparison	Game	Comparison	Game	Comparison	Game	Comparison
27/10/2007	20/10/2007	09/02/2009	02/02/2009	14/04/2010	28/04/2010	08/03/2012	04/05/2012	25/11/2013	12/02/2013	02/01/2015	23/01/2015
31/10/2007	24/10/2007	11/02/2009	03/04/2009	16/04/2010	05/07/2010	15/03/2012	04/12/2012	27/11/2013	25/12/2013	03/01/2015	24/01/2015
02/11/2007	10/12/2007	15/02/2009	15/03/2009	22/04/2010	15/04/2010	23/03/2012	20/04/2012	04/12/2013	01/01/2014	28/01/2015	02/04/2015
05/11/2007	29/10/2007	26/02/2009	26/03/2009	08/10/2010	22/10/2010	29/03/2012	26/04/2012	06/12/2013	13/12/2013	03/02/2015	24/02/2015
08/11/2007	29/11/2007	01/03/2009	29/03/2009	11/10/2010	10/04/2010	03/04/2012	05/01/2012	20/12/2013	01/10/2014	09/02/2015	02/02/2015
14/11/2007	17/10/2007	10/03/2009	03/03/2009	15/10/2010	17/09/2010	17/04/2012	15/05/2012	31/12/2013	24/12/2013	20/02/2015	20/03/2015
28/11/2007	12/12/2007	12/03/2009	04/09/2009	10/11/2010	12/08/2010	19/04/2012	05/10/2012	03/01/2014	31/01/2014	23/02/2015	16/02/2015
02/12/2007	23/12/2007	17/03/2009	24/03/2009	22/11/2010	12/06/2010	03/05/2012	17/05/2012	07/01/2014	14/01/2014	25/02/2015	18/02/2015
05/12/2007	19/12/2007	28/03/2009	25/04/2009	27/11/2010	25/12/2010	06/05/2012	29/04/2012	09/01/2014	01/02/2014	27/02/2015	27/03/2015
15/12/2007	01/12/2008	03/04/2009	05/01/2009	02/12/2010	25/11/2010	21/05/2012	06/04/2012	11/01/2014	02/08/2014	03/03/2015	24/03/2015
16/12/2007	13/01/2008	07/04/2009	31/03/2009	15/12/2010	01/12/2011	25/05/2012	18/05/2012	21/01/2014	02/04/2014	08/03/2015	03/01/2015
02/01/2008	26/12/2007	15/04/2009	22/04/2009	04/01/2011	01/11/2011	30/05/2012	23/05/2012	24/01/2014	21/02/2014	17/03/2015	31/03/2015
08/01/2008	01/01/2008	17/04/2009	05/08/2009	06/01/2011	02/03/2011	02/06/2012	23/06/2012	26/01/2014	02/02/2014	23/03/2015	16/03/2015
16/01/2008	01/09/2008	23/04/2009	30/04/2009	23/01/2011	20/02/2011	09/06/2012	07/07/2012	03/02/2014	27/01/2014	29/03/2015	04/05/2015
20/01/2008	17/02/2008	28/04/2009	21/04/2009	01/02/2011	22/02/2011	22/01/2013	15/01/2013	07/02/2014	03/07/2014	03/04/2015	17/04/2015
24/01/2008	14/02/2008	03/10/2009	10/10/2009	16/02/2011	16/03/2011	25/01/2013	02/08/2013	27/02/2014	30/01/2014	07/04/2015	21/04/2015
29/01/2008	02/05/2008	05/10/2009	28/09/2009	15/03/2011	04/12/2011	31/01/2013	24/01/2013	02/03/2014	23/02/2014		
04/02/2008	28/01/2008	16/10/2009	10/09/2009	30/03/2011	13/04/2011	05/02/2013	29/01/2013	04/03/2014	03/11/2014		
13/02/2008	27/02/2008	17/10/2009	31/10/2009	01/04/2011	29/04/2011	07/02/2013	14/02/2013	08/03/2014	04/05/2014		
18/02/2008	03/03/2008	28/10/2009	10/07/2009	02/04/2011	23/04/2011	12/02/2013	26/02/2013	18/03/2014	25/03/2014		
20/02/2008	03/12/2008	06/11/2009	30/10/2009	06/04/2011	20/04/2011	15/02/2013	15/03/2013	20/03/2014	04/10/2014		
19/03/2008	16/04/2008	25/11/2009	23/12/2009	10/04/2011	05/08/2011	18/02/2013	02/11/2013	22/03/2014	19/04/2014		
25/03/2008	18/03/2008	04/12/2009	25/12/2009	08/10/2011	29/10/2011	24/02/2013	17/02/2013	23/03/2014	20/04/2014		
28/03/2008	25/04/2008	11/12/2009	01/01/2010	10/10/2011	10/03/2011	05/03/2013	26/03/2013	27/03/2014	17/04/2014		
02/04/2008	23/04/2008	16/12/2009	13/01/2010	13/10/2011	10/06/2011	07/03/2013	14/03/2013	31/03/2014	24/03/2014		
06/04/2008	30/03/2008	28/12/2009	21/12/2009	21/10/2011	14/10/2011	10/03/2013	24/03/2013	04/04/2014	25/04/2014		
09/04/2008	30/04/2008	30/12/2009	27/01/2010	02/11/2011	26/10/2011	13/03/2013	03/06/2013	07/04/2014	14/04/2014		
11/04/2008	05/09/2008	05/01/2010	19/01/2010	05/11/2011	12/03/2011	19/03/2013	04/02/2013	11/04/2014	05/02/2014		
18/04/2008	16/05/2008	20/01/2010	17/02/2010	08/11/2011	11/01/2011	01/04/2013	25/03/2013	13/04/2014	27/04/2014		
10/10/2008	31/10/2008	29/01/2010	26/02/2010	11/11/2011	11/04/2011	06/04/2013	05/04/2013	21/10/2014	14/10/2014		
22/10/2008	15/10/2008	10/03/2010	04/07/2010	23/11/2011	30/11/2011	10/04/2013	04/03/2013	30/10/2014	23/10/2014		
29/10/2008	10/08/2008	12/03/2010	04/09/2010	26/11/2011	24/12/2011	12/04/2013	05/03/2013	04/11/2014	28/10/2014		
01/11/2008	25/10/2008	15/03/2010	03/08/2010	08/12/2011	12/01/2011	23/04/2013	30/04/2013	11/11/2014	18/11/2014		
03/11/2008	27/10/2008	20/03/2010	17/04/2010	20/12/2011	13/12/2011	25/04/2013	18/04/2013	15/11/2014	13/12/2014		
05/11/2008	19/11/2008	23/03/2010	04/06/2010	28/12/2011	21/12/2011	04/10/2013	27/09/2013	28/11/2014	26/12/2014		
09/11/2008	23/11/2008	25/03/2010	04/08/2010	04/01/2012	01/11/2012	19/10/2013	10/12/2013	09/12/2014	16/12/2014		
15/11/2008	11/08/2008	30/03/2010	13/04/2010	19/01/2012	26/01/2012	24/10/2013	17/10/2013	17/12/2014	12/10/2014		
10/12/2008	31/12/2008	02/04/2010	30/04/2010	02/02/2012	16/02/2012	29/10/2013	22/10/2013	20/12/2014	01/10/2015		
23/12/2008	30/12/2008	10/04/2010	05/01/2010	09/02/2012	23/02/2012	10/11/2013	17/11/2013	23/12/2014	20/01/2015		
03/02/2009	27/01/2009	11/04/2010	25/04/2010	26/02/2012	25/03/2012	15/11/2013	29/11/2013	29/12/2014	22/12/2014		