Original Article

A partial test of the impact of a casino on neighborhood crime

Lallen T. Johnson[a,*] and Jerry H. Ratcliffe[b]
[a]Program in Criminology and Justice Studies, Drexel University, Philadelphia, PA 19104, USA.
E-mail: ljohnson@drexel.edu
[b]Department of Criminal Justice, Temple University, Gladfelter Hall, 5th Floor, 1115 Polett Walk, Philadelphia, PA 19122, USA.
E-mail: jhr@temple.edu

*Corresponding author.

Abstract Ninety-six months of crime incident data were examined to determine the extent to which crime counts changed within the Philadelphia neighborhood of Fishtown after the opening of a new casino. Count modeling regression results indicate that the operation of the casino had no significant effect on violent street felonies, vehicle crime, drug crime or residential burglary in the surrounding community. Weighted displacement quotient analyses suggest that the operation of the casino may be associated with an increase in vehicle crime in the area surrounding the casino neighborhood, indicative of crime displacement. Drug and residential burglary offenses in the area surrounding the casino neighborhood decreased after the casino opened, suggestive of a diffusion of benefits possibly tied to a change in local police patrols. Net of unexamined police patrol changes and casino opening simultaneity effects, the current study is unable to identify a neighborhood level effect of the casino on crime. Additional research is necessary to examine localized effects of casinos on various offenses.
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Introduction

Before the last decade the presence of casinos had been limited to a few well-known sites in the United States. Atlantic City (NJ), Reno and Las Vegas (NV), and numerous Indian reservations have been able to capitalize on this limited presence by becoming central hubs for gaming and associated industries. The American recession of the early 2000s as well as continued national (and international) economic woes have, however, caused many lawmakers to reconsider whether the added tax revenue of the gaming industry outweighs its perceived costs. For example, the Pennsylvania Gaming Control Board (2011b) was charged with the oversight of the casino industry and was the first such state organization created in 40 years. Since then, Pennsylvania has authorized the development of 10 gaming establishments within its borders. This move received substantial (though not unequivocal) support

from local politicians and it is clear why; according to the Pennsylvania Gaming Control Board (2011a), slot machines were responsible for US$2.2 billion in revenue for the state during the 2009–2010 fiscal year. Thus the desirability of casinos in cash-strapped states should come as no surprise.

Notwithstanding expected monetary benefits, anti-casino interest groups have articulated potential costs that are expected to be associated with casino development. Among these include beliefs that gambling will precipitate a host of social problems such as alcoholism, gambling addiction and organized crime, and that the gambling industry will exploit the poor and elderly (Casino-Free Philadelphia, 2012). Social and economic cost concerns have also been expressed by state-level governmental agencies (Pennsylvania Intergovernmental Cooperation Authority, 2007). In Maryland, Attorney General Curran (1995) released a damning opinion of casinos, arguing that they would lead to substantial increases in violent, property, domestic, white collar and organized crime, as well as child abuse.

The federal government also has weighed in on the effects of gambling on American society. In 1996 Congress authorized creation of the National Gambling Impact Study Commission (1999). The Commission was charged to ' … conduct a comprehensive legal and factual study of the social and economic impacts of gambling on (A) Federal, state, local, and Native American tribal governments; and (B) communities and social institutions generally, including individuals, families, and businesses within such communities and institutions' (National Gambling Impact Study Commission, 1999, pp. IV–2). Although it was hesitant to form conclusions on the casino/crime relationship, citing issues with current research, two points are noteworthy. First, the Commission's review of research suggested that studies were disproportionately based on pathological gamblers – individuals that may engage in crime to fund their gambling habit. As such, crimes attributed to pathological gambling may be substantially different from those attributed to non-pathological gambling. Second, in order to accurately associate crime with the casino industry, one must distinguish the gaming industry from the larger tourism industry (see also Miller and Schwartz, 1998).

Unfortunately, research to address the perceived disorder and crime-producing effects of casinos has been limited to the municipality and county levels, leaving our understanding of more micro-level neighborhood impacts limited. When the *SugarHouse Casino* opened its doors in September 2010, just outside of downtown Philadelphia and in the largest city in the United States to host a representative of the gaming industry (Associated Press, 2010), we had an opportunity to examine the criminogenic impact of casinos within a more localized environmental context.

The contributions of the current study are threefold. First, we examine the relationship between the location of an urban casino and its immediate surrounding neighborhood, rather than focusing on a larger areal unit such as the city or county. Second, we provide a new perspective on the casino/crime link by considering it within the context of Philadelphia. Urban casino research to date has overwhelmingly focused on cities historically known for their expansive gambling/entertainment districts. Philadelphia has no such district with legal gambling, which allows this research to avoid the need to theoretically or empirically disentangle the effect of tourism from any crime-generating effects of the casino. Third, the availability of geolocated crime data allows us to examine any changes in crime volume in the immediate neighborhood environment of the casino alongside potential displacement or diffusion of benefits effects (Clarke and Weisburd, 1994).

The remainder of the article is structured as follows. First, we review prior literature on casinos and crime, organized by spatial unit of analysis. Second, the study site is described. Third, a methodology for examining the relationship between casinos and neighborhood crime is presented. After results are outlined, we conclude with a discussion of the implications of neighborhood level investigations of the casinos and crime link.

Literature Review

City-level research

The most common research on casinos and crime has focused on the effects of casino development on cities and towns in the Atlantic City (NJ) region. Albanese (1985) was among the first to investigate the role of casinos on urban crime, using index crime data from 1978–1982 for murder, forcible rape, robbery, aggravated assault, burglary, larceny and motor vehicle theft. Results indicated that there was a positive correlation between casinos and index crimes, but after controlling for the population at risk the correlation was negligible. This suggested that crime increases were likely due to increases in Atlantic City's population over time. Police manpower and state crime rates also had negligible effects.

Research suggests that towns more accessible via road networks tend to have higher rates of crime than those less accessible (Groff *et al*, 2014). Furthermore, property values in accessible communities appear to be negatively affected by violence, burglary, robbery and vehicle theft rates to a greater extent than in non-accessible communities (Buck *et al*, 1991). This may explain why towns accessible to the casino resort of Atlantic City via major roads tended to have higher crime rates than non-accessible towns[1] (Friedman *et al*, 1989). Studies of casinos in Biloxi (MI), however, provided inconsistent findings on the casinos and crime linkage. While one study found no effect of casino introduction on city crime rates (Chang, 1986), a subsequent study, however, did identify statistically significant increases in larceny theft and motor vehicle theft after the introduction of riverboat gambling (Giacopassi and Stitt, 1993).

Matched *quasi*-experimental designs have been used to compare monthly crime rates in municipalities with and without casinos, pre- and post-casino introduction (Stitt *et al*, 2003).[2] Non-parametric tests revealed that the addition of casinos was associated with marginally significant increases in larceny, liquor violations, homicide and prostitution; however, when controlling for the population at risk these marginal differences disappeared. Time series analyses of Part I crime in two Indiana towns with riverboat gambling have yielded divergent results (Wilson, 2001): In Hammond, the introduction of riverboat gambling had no discernible effect on crime, but in the case of Rising Sun the post-intervention period demonstrated significant increases in assaults and thefts.

More recent scholarship has employed spatial and temporal analysis to describe hot spots of disorder offenses possibly associated with casinos. Casino hot spots in Reno (NV) were more likely to be associated with public drunkenness, drugs and trespassing as well as reports of suspiciousness, than non-casino hot spots (statistical tests lacking) (Barthe and Stitt, 2009a).[3] Related research looking at the distribution of disorder crimes by hour in casino versus non-casino hot spots indicated little temporal disagreement between hot spot types (Barthe and Stitt, 2009b).

County-level research

At the county level, casino presence appears to be related to significant increases in violent and property crime in the state of Wisconsin (Gazel *et al*, 2001). Furthermore, spatial lag modeling suggested non-casino counties adjacent to casino counties should have higher crime rates as a result of their proximity. Such findings may be related to the statistical technique employed. For example, while a panel-design study found significant adjacency effects when using an ordinary least squares regression model, the use of the more robust generalized estimation model indicated no real effects (Koo *et al*, 2007). Research considering temporal lag effects found that the effect of casino presence on county crime shortly after opening was minimal (Grinols and Mustard, 2006); however, as time increased from the intervention date the presence of the casino was associated with significant increases in crime.

In addition to index crimes, the association of gambling with social deviance and socially undesirable conditions has been a focus of anti-casino interest groups (Casino-Free Philadelphia, 2012; CBS News Miami, 2012). While some concerns are difficult to substantiate, others may have merit. In particular, the serving of alcohol at most casinos may have implications for the prevalence of driving under the influence of alcohol. Counties with casinos have tended to have more alcohol-related fatal accidents than non-casino counties (Cotti and Walker, 2010). And, counties adjacent to casino counties also experience higher levels of alcohol-related fatal accidents. The relationship between alcohol-related fatalities and gambling may not be surprising considering that pathological gambling and alcohol abuse tend to be co-occurring disorders (Grant *et al*, 2002). On the other hand, research appears inconsistent in validating assumed linkages between certain negative social conditions and locations of the gaming industry. A study matching casino counties to non-casino counties found no relationship between the presence of the gambling industry and suicide rates, and differences in divorce rates between casino and non-casino counties were statistically non-significant in half of the matched pairs (Nichols *et al*, 2004). Other research found no relationship between casinos and unemployment and bankruptcy (Koo *et al*, 2007); yet, a matched design methodology of eight counties revealed significant increases in casino county bankruptcies post-intervention (Nichols *et al*, 2000).

In summary, the extant literature has concentrated on spatial units that are larger than the neighborhood level, examining crime rates at the city and county scale, often with conflicting findings. The dearth of literature on spatial effects of crime at the immediate neighborhood or sub-neighborhood level suggests that the impact of a casino on local conditions is difficult to predict. With the development of the *SugarHouse Casino* in a Philadelphia neighborhood, we have an opportunity to examine the introduction of the casino using pre–post intervention neighborhood crime data.

Theoretical Perspective at the Neighborhood Level

The more socially active members of local communities often view the introduction of facilities such as casinos as likely to have a negative effect on crime rates in the immediate neighborhood, with expectations of increased street and property crime. Other concerns include worries about traffic upheaval, public intoxication, more raucous activity late at night

and a general perception of increased disorder. With these concerns being paramount in the minds of local residents and the police, an environmental criminology/crime science perspective that examines the introduction of a casino as a potential crime generator or crime attractor is appropriate. According to Brantingham and Brantingham (1995) *crime generators* are places to which a large volume of people are drawn for non-criminal reasons (such as coming to a casino to gamble), yet their collective presence provides increased opportunities for offenders to interact with potential victims or to exploit criminal opportunities. *Crime attractors* are places where people are specifically drawn for the opportunity to commit crime or engage in deviant behavior (bar and entertainment areas with known lax enforcement standards can be an example).

It is also important to consider the role of routine activities in casino-related crime. In this sense crime is a function of the extent to which casinos provide opportunities for motivated offenders and potential victims to interact in an environment absent capable guardians (Cohen and Felson, 1979). Criminal opportunities abound and potential offenders are likely to be aware of them. First, casinos serve alcoholic beverages, which may lower the vigilance of potential victims and serve to boost the confidence of potential offenders. Second, they are locations that exchange large amounts of money with patrons, and patrons on the receiving end of cash winnings may be seen as potential targets. Third, the nature of casino gaming requires individuals to make economic decisions about how much money should be invested in playing. Individuals with low self-control may be less judicious in their playing decisions and as a result more likely to find themselves in compromised economic situations. In turn, casinos may be attractive places to those with low self-control because they encourage risk-taking behaviors, a characteristic found to be associated with criminal behavior (Gottfredson and Hirschi, 1990). Such individuals may engage in criminal activity to compensate for their losses.

In response, casinos employ a number of strategies to prevent criminal behavior. For example, the use of place managers (Eck, 1995) such as table attendants, supervisors and bartenders directly or indirectly set behavioral norms for the casino premises. Furthermore security guards and law enforcement may provide a sense of formal guardianship over potential victims, deterring motivated offenders. The presence of place managers may also displace criminal activity away from the casino grounds. For example, crime prevention at and around the immediate casino location may cause motivated offenders to rob pedestrians of their winnings after they have left the casino. If this is the case, localized crime prevention at a casino may result in an increase in neighborhood violence and crime. Conventional thinking suggests that focused crime intervention and prevention strategies as well as highly monitored environments may merely push crime to surrounding areas; however, some modest displacement may indicate that crime prevention tactics are working – if matched with significant crime reduction at the target site. In other words *opportunity reduction* (or the removal of the most optimal offense locations) may cause some crime to be displaced to surrounding, less advantageous areas, yet still result in a net decrease in overall crime (Reppetto, 1976).

Alternatively, it may be that the removal of opportunities at one site spreads a crime reduction side-effect to nearby locations. Crime reduction evaluations of Camden, New Jersey (Ratcliffe and Breen, 2011) and Philadelphia, Pennsylvania (Lawton *et al*, 2005) hot spots policing strategies not only found decreases in target area crime but also a diffusion of benefits, whereby surrounding areas not the target of any additional prevention also experienced decreases in crime. Thus a crime science theoretical perspective suggests that place management and guardianship at a casino might displace offender behavior or diffuse

reduction benefits to surrounding streets to a lesser or greater degree. While violent offenders may seek out potentially wealthy casino patrons on the way to or from the casino in nearby streets, given that identifying casino patrons (from non-casino-attending citizens) becomes increasingly difficult as distance from the casino increases, this effect is likely to be measured as a local neighborhood disturbance rather than a citywide impact.

In the next sections, we describe the study site and the security arrangements at the casino, and then explain the methodology employed to assess the local crime impact of the opening of the casino.

Study Site and Evaluation Design

SugarHouse Casino is located on the Philadelphia waterfront in the 26th police district, just north of Philadelphia's downtown area. The neighborhood is known to locals as Fishtown for its historical prominence in the fishing industry (see Figure 1). The area north and west of Interstate-95 is composed of row homes common to the city, while the area south and east of the interstate is less residential with a number of old factory buildings.

In May 2011, we had an opportunity to tour the facilities, as well as conduct semi-structured interviews with the Director of Security and the Director of Communications regarding crime and security inside the casino and on its grounds. These interviews

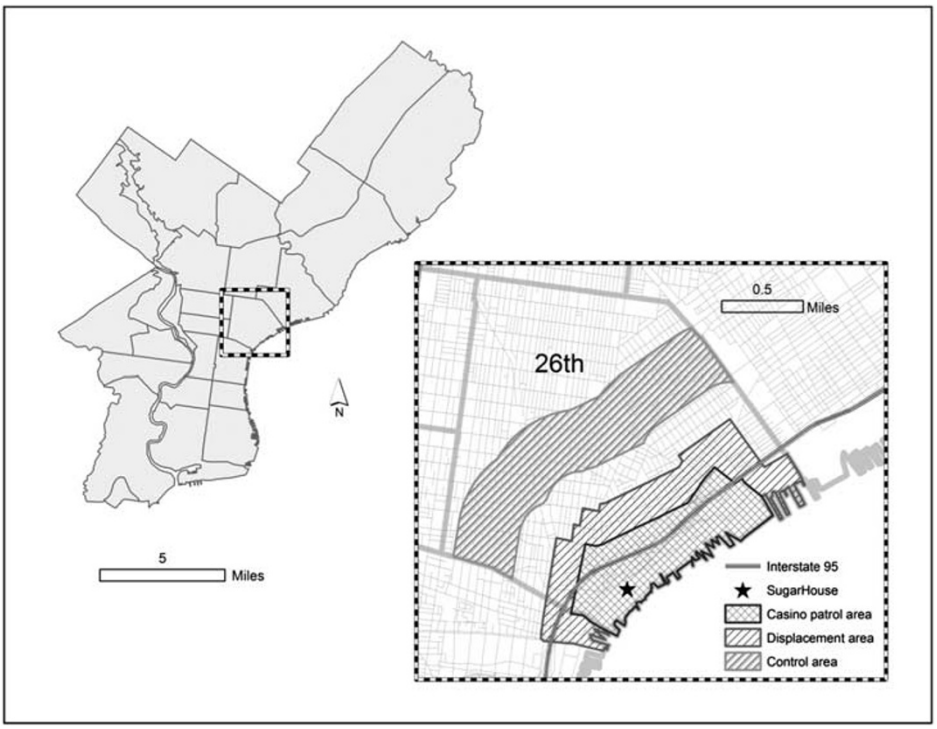

Figure 1: *SugarHouse Casino* area map.

(summarized below) were predominantly used to gain insight into the security arrangements in the area, and revealed a collaborative relationship with the local and state police departments, transportation arrangements and environmental characteristics that may collectively contribute to increased safety.

Transportation

Respondents reported that 2 million visitors enter the casino in a year, with peak time being during the weekend. About 50 visitors per day arrive by taxi Sunday through Thursday and about 75–100 on Friday and Saturday. The local public transportation agency, the Southeastern Pennsylvania Transportation Authority (SEPTA), has a bus route that provides service to the main road at the casino. About 150 people per day arrive, and 205 depart, via SEPTA bus. Valet service parks about 13 cars per day in a lot with approximately 1800 spaces. In addition to the public bus routes that service the casino, the casino operates its own shuttle with pick-up and drop-off locations throughout the city. Its two bus routes operate from Sunday to Thursday, 14:00–22:30, and weekends 23:00–12:00 (*SugarHouse Casino*, 2011). Interviewees estimated that 55–100 patrons arrive by walking[4] and about 1–2 private hire bus trips arrive per week.

Local, state and private policing

Policing on the property of *SugarHouse Casino* is divided between the Pennsylvania State Police and the Philadelphia Police Department. The Pennsylvania State Police has exclusive policing jurisdiction over the gaming floor of the casino. The casino has its own State Police office with a local commanding officer, and a regular detail of plain-clothes officers has been assigned to police the gaming floor. In addition to possessing typical police powers, the State Police is also responsible for gaming violations that occur inside the casino. Both respondents reported that disorderly conduct is the most common offense, albeit rare.

As the municipal law enforcement agency, the Philadelphia Police Department has jurisdiction over the casino neighborhood outside of the casino building. The 26th Police District has been provided with a radio that is connected to the casino radio system, making it easier to provide assistance as necessary. Respondents agreed that the local police can be seen daily patrolling through the parking lot. In spite of their official jurisdiction being limited to the outdoor areas of the casino, officers can sometimes be seen on the casino floor and can be summoned when a uniformed presence is desired. The Philadelphia Police provide backup assistance to the Pennsylvania State Police as necessary, most commonly with the coordination of protection for armored truck money deliveries and exchanges.

The Pennsylvania Gaming Control Board mandates a minimum of three security officers at the front entrance and two in the parking lot, 24 hours a day. After dark, as many as seven security personnel may be stationed in the parking lot to provide an additional presence. Additionally, two to three security officers patrol the outdoor grounds via bike patrol. The Director of Security reported that security resources are shifted as necessary to assist employees during shift changes. The security detail also maintains two golf carts and a small SUV to escort employees and guests to their vehicles upon request. An extensive

closed-circuit television (CCTV) camera system is used to monitor the outdoor decks, gaming floor and parking lots. Emergency call boxes are also stationed throughout the parking lots.

Patrons are able to receive free drinks as long as they are gambling, but are limited to two drinks per hour. Staff members receive Responsible Alcohol Management Program training.[5] The Director of Communications noted that inebriated persons are not allowed to play or leave the premises driving a vehicle; instead, they are offered coffee and water and a staff member will call a cab or relative to transport them home. Disruptive patrons (that are not inebriated) are asked to leave the establishment in lieu of prosecution. Those who return are charged with trespassing.

Methodology

When the casino opened in September 2010, the 26th Police District created a special casino patrol area. This area of slightly less than half a square mile (shown in Figure 1) is patrolled by one sergeant and 13 officers who provide coverage 24 hours a day, 7 days a week. An area adjacent to the patrol area was selected to examine potential displacement and diffusion of benefits effects. This area is roughly two city blocks wide and is comparable in size to displacement areas used in prior urban hot spots research (Weisburd and Green, 1995b). It is also similar in size to the casino patrol area (0.49 square miles), but not so large that it incorporates areas with crimes that are unlikely to occur due to displacement (Ratcliffe and Breen, 2011). A control area of 0.77 square miles was selected within the 26th Police District that is 2000 feet wide, and set 1200 feet away from the displacement area. This was done to reduce the possibility of contamination effects (Weisburd and Green, 1995a). In other words, the spatial separation of the control and displacement areas was designed to create a control area that retained much of the neighborhood demographic and structural characteristics, but would be free from influence of processes related to the casino.

Crime data were sourced from the Philadelphia Police Department's Incident Transmittal System. Crime incidents that occurred between January 2004 and December 2011 were considered in the analyses and aggregated by month. For the time series analysis, this permitted 80 pre-casino data points and 16 post-casino opening measurements. Analysis was limited to four specific offense categories theoretically relevant to casino operation as described in the literature review. 'Violent street felonies' was a category that included homicides, aggravated assaults and street robberies. Given the proximity of residential housing in the neighborhood as well as the concerns of residents, we also include a 'residential burglary' category. Monthly vehicle theft reports and monthly theft from vehicle reports were examined. These two data sets were analyzed together as a 'vehicle crime' category. Finally, we included a 'drug crime' category to represent all detected illicit drug activity in the area (buying and selling) in case the opening of the casino was associated with an increase in illicit drug crimes in the immediate vicinity of the facility.

Analytical strategies

We chose two analytical strategies: weighted displacement quotients (WDQs) and time series analysis. First, we adopted the WDQ of Bowers and Johnson (2003) in order to

address two of the perennial questions that are raised with regard to potentially criminogenic facilities: Has the casino's presence led to increased crime in the immediate area (Ratcliffe, 2012), and if not, has crime been simply displaced to nearby locations (Cornish and Clarke, 1987)?

The WDQ is a ratio measure designed to compare the change in crime before and after the introduction of a crime prevention initiative relative to both the change in crime in a potential displacement area and a control area (Bowers and Johnson, 2003). First, a success measure compares the change in crime after the introduction of a crime prevention initiative in relation to a control area. If there has been an improvement in the target intervention area relative to any change in the control area, then it can be claimed that the intervention was a success. In this case, the researcher can continue to examine the relationship between the displacement area and the control area. This will indicate whether any of the crime reduction in the target area was potentially the result of a shift of criminal activity to the displacement area. This second calculation is termed the buffer displacement measure (also termed the displacement measure in Bowers *et al*, 2011). Finally, the WDQ is calculated using the success measure as the denominator and the buffer displacement measure as the numerator. The WDQ indicates whether any displacement has been greater or less than the amount of crime reduced in the target area. The full equation is as follows, using the terminology from Bowers *et al* (2011):

$$\mathrm{WDQ} = \frac{\frac{D_a}{C_a} - \frac{D_b}{C_b}}{\frac{R_a}{C_a} - \frac{R_b}{C_b}} \tag{1}$$

where the crime count in the intervention (target) area is represented before the intervention (R_b) and after (R_a), the crime count in the control area is measured before (C_b) and after (C_a) the intervention, and the crime count in the buffer (catchment) area is measured before (D_b) and after (D_a) the intervention. In our case, we replaced the area targeted by a theoretical crime prevention initiative in the above discussion and equation with the timing and neighborhood of the area likely to be affected by the introduction of the casino. With regard to the success measure (the denominator in equation 1), we would expect this value to be positive if crime had increased in the area after the opening of the casino. For a time period, we chose 1 year before and 1 year after the casino opening, a time period described by Bowers and Johnson (2003)as a 'reliable sampling frame' (p. 284).

While the WDQ allows us to determine crime change and estimate any displacement (or diffusion of benefits) it is less clear on whether any changes in crime are statistically significant. To reinforce this analysis we included a second approach, a time series analysis employing a non-linear regression using time-varying covariates to model temporal trends.

Time-varying covariates were employed to model particular dimensions of temporal trend and seasonality, as well as the opening of the casino in the study area. A *linear* variable represents the sequential position of the particular month in the data set, starting in January 2004. This centered variable captured any long-term temporal trend in the data. If crime were generally increasing over time then this variable would be positive, and if the general trend were downward it would be negative. Similarly a centered *quadratic* variable was included to capture non-linear changes to any long-term trend. Some types of crime display a significant seasonal component, especially robbery (Sorg and Taylor, 2011). As a result, it is important to model seasonal effects. One option is to include 11 dummy variables

representing each month except a reference month (Greenberg and Roush, 2009), or to include a measure of temperature in the analysis to represent the seasonality displayed in some street crime data (Ratcliffe *et al*, 2009). In the current study we address both perspectives by modeling a linear month sequence variable, as well as an average monthly temperature variable. Data for the latter indicator were obtained from the historical archives available at www.wunderground.com. Daily weather observations for the zip code 19102 were downloaded and the monthly mean temperature was calculated. A dummy casino variable was coded 0 before the opening of the casino and 1 from September 2010 onwards.

Data for the casino area were modeled using a *quasi*-experimental time series design. The advantage of a time series design is that it can compare multiple observations of a pre-intervention period to a post-intervention period, and account for temporal autocorrelation (Shadish *et al*, 2002). Count data, however, are inherently problematic for time series analysis. Real-valued time series models, such as autoregressive integrated moving average (ARIMA) models (Box and Jenkins, 1976; MacCleary and Hay, 1980; Chatfield, 1989), have been applied to crime data for many years (Krimmel and Mele, 1998; Novak *et al*, 1999; Degenhardt *et al*, 2005; Chamlin and Myer, 2009). Unfortunately, when attempting to model non-negative integer-valued data such a low volume crime counts, ARIMA processes may be inappropriate given a key assumption of ARIMA time series modeling is of normality in the random shocks of the underlying error structures (Quddus, 2008; Greenberg and Roush, 2009). Simply put, the inability of recorded crime data to exhibit negative values truncates low volume crime counts such that the data more often exhibit Poisson or negative binomial distributional qualities.

While crime count data tend to be non-negative and integer, and often follow a generalized Poisson distribution, they are usually over-dispersed where the variance is not found to equal the mean as in a true Poisson distribution. As such, a negative binomial regression model can also be appropriate. Examples of negative binomial modeling of low count crime data can be found in the crime analysis literature (Greenberg and Roush, 2009).

Results

Table 1 shows the monthly descriptive statistics of the dependent variables for the casino area over the time period 2004–2011 inclusive. As shown in Table 1 the casino-area crime count variances are greater than the respective means, suggesting over-dispersion of the data. Graphing the data series (not included in the article but available from the authors on request) showed that most of the series remained stable during the study period, with the exception of vehicle crime, a series that appeared to have a long-term trend increase over the period of

Table 1: Descriptive statistics of dependent variables (casino patrol area, 96 months)

Series	*Minimum*	*Maximum*	*Mean*	*Standard deviation*	*Variance*
Violent street felonies	0	8	2.92	1.92	3.70
Vehicle crime	1	30	12.89	5.82	33.87
Drug crime	0	6	1.26	1.24	1.54
Residential burglary	0	6	1.21	1.20	1.43

2004–2011. This potential increase over time is dynamically modeled by the linear time-varying covariate.

WDQ results

Table 2 shows the pre/post crime counts for the 12 months before and after the opening of the casino, the success measure, buffer measure and the WDQ value. In the immediate casino area, violent street felonies increased by seven in the year following the casino opening, and vehicle crime also increased. Detected drug crime was down, as was residential burglary. The buffer area saw a decrease in drug offenses, but increases in all other crimes examined. The control area, representing the overall trend of the region, showed an increase across all crime types except drug offenses.

The success measure for the four crime types showed that the casino area performed worse than the control area in violent street felonies (indicative of a relative crime increase) but better than the control area in residential burglary, vehicle crime and drug crime. As Bowers and Johnson (2003, p. 285) note in regard to the assessment of a crime prevention initiative, 'If the denominator is positive then this means that the scheme has been unsuccessful, and it is difficult to relate any change in the buffer zone to the scheme. Moreover, it would be theoretically inappropriate to look for displacement/diffusion of benefit, and therefore, in this case, the weighted displacement quotient should not be used'. While we are not examining a crime prevention initiative in this article, we would argue that this line of thinking is equally applicable, though in a different way. If crime has increased in the target area then there is no reason to expect displacement to the buffer area, given the apparent increase in criminal opportunities in the intervention neighborhood. As such, we concur with Bowers and Johnson that reporting the buffer measure of WDQ results is inappropriate. The buffer measure for the remaining three crime types shows a negative value for both residential burglary and drug crime, indicative of a diffusion of crime prevention benefits to the surrounding buffer area, though some displacement for vehicle crime.

The WDQ is the last value reported in Table 2. This shows values greater than one for residential burglary and drug crime, but less than −1 for vehicle crime. For a summary of the overall results we can cross-reference Table 1 of Bowers and Johnson (2003) and summarize the WDQ analysis as follows. Violent street felonies increased in the target area compared with the control area. Vehicle crime decreased in the target area relative to the

Table 2: Success measure, buffer measure and WDQ results

	Violent street felonies	*Residential burglary*	*Vehicle crime*	*Drug crime*
Target before (R_b)	35	19	180	15
Target after (R_a)	42	16	207	13
Buffer before (D_b)	37	45	286	26
Buffer after (D_a)	64	51	353	18
Control before (C_b)	109	81	345	110
Control after (C_a)	121	114	405	97
Success measure	0.03	–0.09	–0.01	–0.002
Buffer measure	—	–0.11	0.04	–0.05
WDQ	—	1.15	–4.01	21.68

control area; however, there was substantial displacement indicating that the introduction of the casino made the vehicle crime problem in the combined treatment/buffer area worse than before the casino was opened. Residential burglary and drug crime decreased in the target area relative to the control area; furthermore, there was substantial diffusion of benefits to the surrounding areas indicating that the introduction of the casino made the residential burglary and drug crime problem in the combined treatment/buffer area better than before the casino was opened with an overall positive net effect.

The issue of increasing violent street felonies would clearly be of concern to casino management, local residents and the police; however, the question remains as to whether this increase is statistically significant or could be attributed to the natural fluctuation that is partially associated with most crime patterns. We are unable to address this issue with the ratio measure; therefore, we turn to the regression component of the analysis.

Casino area regression results

The issue of data over-dispersion was examined statistically. For the most part, Poisson goodness of fit χ^2 values were statistically significant, indicating over-dispersion (violent street felonies $\chi^2 = 115.182$, $P = 0.04$; drug crime $\chi^2 = 120.598$, $P = 0.02$; vehicle crime $\chi^2 = 148.849$, $P<0.01$). The exception is residential burglary ($\chi^2 = 112.736$, $P = 0.061$). As a result, over-dispersed models were fitted using negative binomial regression and the residential burglary series fitted using Poisson regression. Because of the issue of the experiment-wise error rate problem, the standard social science level of statistical significance ($P<0.05$) was adjusted using a Bonferroni correction to $P<0.0125$ for the independent variables. In the statistical model tables below, the β coefficients are replaced with the incidence rate ratios to ease interpretation. Regression coefficients in count models represent the change in the log of expected counts of the response variable with a one unit change in the predictor, but rather than interpret logged values we focus on the incidence rate ratios. Standard errors are also converted.

Table 3: Regression results for the four studied crime types

	Violent street felonies[a]	*Vehicle crime*[a]	*Drug crimes*[a]	*Residential burglary*[b]
Intercept	1.529	6.460*	1.147	0.572
	(0.390)	(0.898)	(0.431)	(0.217)
Average monthly temperature	1.0098	1.0099*	1.0046	1.0135
	(0.004)	(0.002)	(0.006)	(0.005)
Linear trend	1.0001	1.0069*	0.9892	1.0023
	(0.0037)	(0.0020)	(0.0060)	(0.0053)
Quadratic trend	1.00009	1.0001	0.9996	0.9999
	(0.0001)	(0.00007)	(0.0002)	(0.0002)
Casino	1.001	1.055	1.412	1.155
	(0.328)	(0.180)	(0.772)	(0.531)

Notes: *$P<0.0125$.

Incident rate ratios reported, with standard errors in parentheses. $N = 96$ months with 16 months post intervention.

[a]Negative binomial regression.

[b]Poisson regression.

Table 3 displays the results of negative binomial models estimating violent street felonies, vehicle crime and drug crime in the casino patrol area. It also shows the Poisson regression results for residential burglary. As can be seen from the results of the violent street felonies regression, none of the variables achieve statistical significance. Changes over time were unrelated to violent street felonies in the casino patrol area suggesting that the area had a relatively stable violent street felonies trajectory over time. The constant, average monthly temperature variable and linear trend variables were statistically significant for vehicle crimes. These indicate that for every 1 degree Fahrenheit increase in monthly average temperature there is an expected 1 per cent increase in the count of vehicle crimes in the casino area, and that across the entire time series, controlling for other factors, there was a monthly 0.6 per cent increase in expected vehicle crime counts. Importantly however, the opening of the casino had no statistically significant impact on any of the crime types assessed.

Discussion

This study evaluated the effect of a new casino development on four crime types at the neighborhood level. *SugarHouse Casino* opened its doors in the Fishtown section of Philadelphia in September 2010. Results of multiple time series analyses using 96 months of crime incident data and a WDQ analyses indicated mixed effects. The combined results indicate that while violent street felonies increased at a rate slightly greater than violence in the control area, this increase was not statistically significant when examined in the context of the longer trend since 2004. Vehicle crime reduced in the target area; however, there was substantial displacement and the reductions in vehicle crime were not statistically significant over the long term. Both residential burglary and drug crime reduced in the casino area (again though, not significantly from a statistical perspective) and there were reductions in these crimes in the buffer areas. In summary, there is no evidence that the opening and operation of the casino had a significantly detrimental effect on the immediate neighborhood in terms of vehicle crime, drug activity, residential burglary or violent street felonies. These findings are contextualized below.

First, we should note that this is not a stand-alone *quasi*-experimental evaluation of the introduction of a casino to a neighborhood, due to the additional complication of the Philadelphia Police Department instigating a dedicated patrol to the neighborhood. The additional patrolling from 14 assigned officers may have acted to provide additional deterrence to any criminal activity. The dosage issue of these officers is an unresolved question here, though the numbers would suggest a limited role for the police in any crime suppression. Even if we consider the inclusion of the sergeant into any patrol activities, there was limited ability to provide substantial round-the-clock policing. If officers worked a 40-hour week, then this averages out at approximately an additional 3.5 officers on duty at any particular time in the patrol area. In reality, with refreshment breaks, vacation, sickness and so on, the actual level of dedicated patrol activity is likely to be less. Whether this is sufficient additional patrol for an area to have any impact cannot be tested here but it is clear that any additional resources were modest at best.

The results do at least suggest that neighborhood concerns that the introduction of a casino will herald significant increases in local crime rates appear unfounded. This first examination of local crime rates at the sub-neighborhood level would appear to support the notion that crime rates are largely unaffected by the introduction of a casino, or at least any

significant increases can be held in abeyance by the reassignment of modest police resources from an existing pool of staff (the district was not assigned additional personnel for the casino but instead reassigned officers from within the police district).

One further threat to the validity of this research worth mentioning is instrumentation. Semi-structured interviews with casino management revealed that the inside of the casino is supervised by the Pennsylvania State Police, while all outdoor areas fall under the jurisdiction of the Philadelphia Police. The conclusions and results of analyses presented here are relative to data derived from the Philadelphia Police Department. We find this to be a minor limitation as we are most interested in linkages between the presence of the casino and crime in the surrounding neighborhood, rather than activity that takes place within the location. Relative to the availability of appropriate data, future research should explore the nuances of casino-related crime. Specifically, separately analyzing crime types occurring within the casino and specifically related to the nature of casinos (such as thefts from dealers) versus crime associated with casinos occurring outdoors (such as car thefts) would enable a richer understanding of casinos, crime and deviance.

With regards to the crime counts, we have two different measures. It could be argued that the WDQ results are meaningful on their own given that we are examining the total population of crime events in the target, displacement and control areas, and thus there is no need for a statistical test. But as Fotheringham and Brunsdon (2004) point out, statistical tests are useful for not just sample inference but also process inference. The longitudinal time series analysis was designed to determine if changes detected by the WDQ were indicative of more than simply modest random variation in crime patterns. The statistical tests modeled no statistically significant changes in crime counts due to the introduction of the casino. This would suggest that the variations in crime counts after the opening of the casino detected with the WDQ are within the parameters of the types of natural fluctuations that we would expect from longitudinal crime series.

Therefore while additional crime opportunities may have increased the pool of potential victims for robbery, and increased the number of potential offenders drawn to engage in burglary or vehicle crime, the presence of added patrons to the neighborhood could also have increased formal as well as informal guardianship. Formal in terms of casino security and additional police patrols, and informal guardianship through the addition of more eyes on the street. These opposing forces (opportunity and guardianship) may have both increased, offsetting each other.

The displacement findings are interesting. In anticipation of the casino opening, the 26th Police District commander created the special patrol district, to which were assigned additional police officers. The increased police attention in the special patrol area may have led to the displacement of vehicle crime to the surrounding area. Officers that were re-assigned to the patrol area were not replaced in the rest of the district. It is possible that the relative reduction in personnel outside of the casino area reduced patrol deterrence in the displacement area, while suppressing crime in the target area.

In the current study we endeavored to analyze neighborhood level criminogenic effects of a casino in an urban environment. Findings here do not settle the debate on casino and crime linkages, but contribute to a growing body of knowledge and suggest a need for more neighborhood level research. At the least, findings demonstrate that oft-stated community concerns regarding local crime conditions with the addition of a casino to a neighborhood

were not borne out by the *SugarHouse Casino* example. Any potential significant crime increases either did not occur, or were effectively controlled by a reassignment of existing local police resources.

Notes

1 Accessible localities were those ' … immediately adjacent to the City or at intersections of major non-toll arterial roads to New York and Philadelphia up to a distance of 30 miles …' (Friedman *et al*, 1989, pp. 616–617).
2 Municipalities include Sioux City, IA; St. Joseph, MO; St. Louis City, MO; St. Louis County, MO; Biloxi, MS; Alton, IL; Peoria, IL and East Peoria, IL (Stitt *et al*, 2003).
3 Casino hotspots are high crime areas, identified by a kernel density estimation analysis, to be within 1000 feet of a casino (Barthe and Stitt, 2009a).
4 It may be difficult to tell who walked from the parking lot versus those who arrive by walking from the surrounding community.
5 'RAMP was created by the Pennsylvania Liquor Control Board to help licensees and their employees serve alcohol responsibly'. It teaches employees how to identify those under the legal drinking age, those visibly intoxicated and suspend drinking service as necessary (Pennsylvania Liquor Control Board, 2012).

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