

**The Effect of Large-Scale Economic Development on Violence and Collective Efficacy: A
Natural Experiment**

by

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Abstract

Background: Violence continues to be one of the leading public health problems in the United States (US). Increased importance is placed in understanding how developments change the neighborhood environment particularly violence. Partnering a legally-binding community benefits agreement (CBA) with a development attempts to ensure services for local residents. We examined the link between violence and the casino opening in the North Side and CBA implementation in the Hill District within Pittsburgh, PA.

Methods: Using a difference-in-difference framework, we estimated the causal effect of changes in violence linked with an arena in conjunction with a CBA (initiated 2011) and a casino (opened 2010). The Pittsburgh Bureau of Police provided violence data for years 2005 to 2015. We gathered demographic, social, and economic covariates from the American Community Survey. We estimated the causal effect of each development using a generalized linear mixed effects model with adjustment for confounding. In 2011, we surveyed neighborhood residents to track changes in social milieu including neighborhood disorder, values, and perception. To form each outcome, we used questions concerning perceived change from five years previously. We fit adjusted models containing basic socio-demographic characteristics models using ANCOVA.

Results: In the North Side (Casino neighborhood), violence increased by 21% (Incidence Rate Ratio (IRR)=1.21; 95% CI: 1.11, 1.32) after the casino opened. In the Hill District

(arena/CBA neighborhood), violence decreased by 23% (IRR=0.77, 95% CI: 0.69, 0.87) after CBA implementation. While Perceived Neighborhood Violence did not change from the opening and operation of a casino ($p = 0.35$) or implementation of a CBA ($p = 0.66$), collective efficacy was reduced of 0.69 ($\beta = 0.69$; $p = 0.02$) by the casino but was not changed by the CBA ($p = 0.25$).

Conclusion: These studies demonstrated the development of a casino may increase crime and reduce levels of collective efficacy in communities most likely to be affected. The implementation of a CBA reduced violence but had no effect on collective efficacy or perceived neighborhood violence.

Public Health Significance: This research study demonstrated the addition of a large-economic development or a community agreement was associated with changes in social and violence characteristics within a neighborhood.

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Preface

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1.0 Introduction

Aggravated assault and robbery, two components of violent crime, currently occur at higher levels in the United States (US) when compared to modern European countries and to US historical lows from 1940 to 1960.¹ Further discussion of the Public Health Significance regarding the burden of violence in the US and relevant sub-populations can be found in Section 1.1.

This dissertation takes advantage of the introduction of two specific interventions, a sports and entertainment arena along with a CBA and a casino. Concurrent with a Community Benefits Agreement (CBA), a new sports and entertainment arena opened in August 2010 within the Hill District neighborhood.² The Hill District is a relatively well-organized neighborhood with strong community groups, but experiences high rates of poverty, unemployment and limited access to services.^{3 4} To ensure benefits to the neighborhood, a CBA was signed between the Hill District community leaders and developers.⁵ In August 2009, a new casino opened in the North Side;⁶ a diverse area with some thriving communities but relatively high unemployment and poverty, in conjunction with high rates of violence and segregation.⁷ Further details regarding these interventions are available in Section 1.2.

Section 1.3 discusses the theoretical underpinnings including a short review of literature linking large-economic developments with violence. Then, we review the effect of large-economic developments on economic indicators such as income and unemployment. Finally, collective efficacy (defined as “social cohesion among neighbors combined with their willingness to convene on behalf of the common good”⁸) and perceived neighborhood violence are reviewed and linked with the previously described large-economic developments.

1.1 Public Health Significance

Violence continues to be one of the greatest health problems in the United States, and tends to disproportionately affect neighborhoods with a higher percentage of African American males. However, markers such as race are better thought of not as a cause of violence, but rather as a measure of differentially allocated societal factors summarized by the racial measure.”⁹⁻¹¹

1.1.1 Violent Crime in the US

The FBI defines aggravated assault as “unlawful attack by one person upon another for the purpose of inflicting severe or aggravated bodily injury.” Also, the FBI defines robbery as “attempting to take anything of value from the care, custody, or control of a person or persons by for or threat of force by putting the victim in fear”.¹² When larceny and assault occur together, the incident is classified as a robbery.¹² Here, we define, violence as aggravated assault and robbery. Due to reporting limitations, we control for potential discrepancies by integrating multiple data sources to provide increased understanding of each rate. Main data sources include: Web-based injury Statistics Query and Reporting System (WISQARS), National Crime Victimization Survey (NCVS), and Uniform Crime Reporting (UCR).

The Bureau of Justice Statistics conducts a National Crime Victimization Survey (NCVS) of representative US households which tracks self-reported crimes to measure crimes reported and not reported to the police. In 2014, the crude rate of violence was 658.66 victims per 100,000 individuals. When reporting limitations were measured, 60.9% of robberies were reported to police and 58.4% of aggravated assaults were reported to police.¹³

In 2014, non-fatal hospitalizations and emergency department visits due to violence occurred at the age-adjusted rate of violence of 479.03 instances per 100,000 people.¹⁴ Over \$20 billion was spent on costs related to assault or \$149,281 per victim when the injury was severe enough to require hospitalization.¹⁵

1.1.2 Violence by Age and Race

Rates of violence are not distributed uniformly but tends to concentrate in specific high-risk populations. In the WISQARS data, violent crime rates as a function of age have a strongly right skewed distribution, Figure 1-1. Rates of violence reach their zenith in the 20 to 24 age group with a rate of 1160 victims per 100,000 individuals. Rates of violence fall to their nadir at the extremes of the age spectrum with 66.70 per 100,000 people in children aged 0 to 4 and a rate of 30.05 per 100,000 people in older adults aged 85+. Young adults suffer from assault injuries at a 38 times higher rate than older adults aged 85+.¹⁴

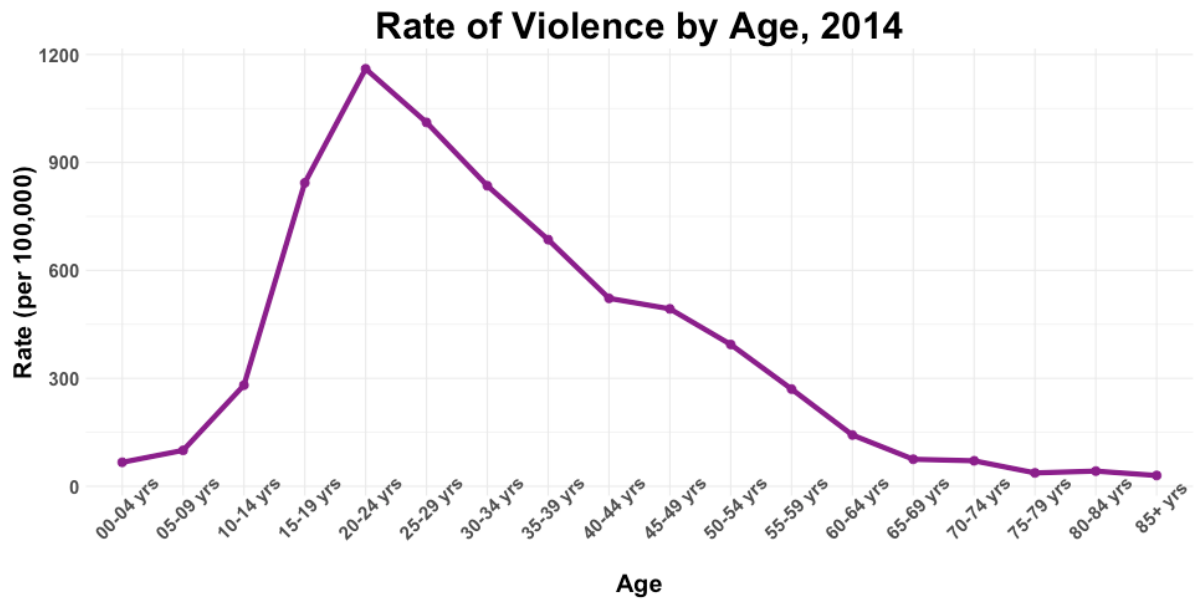


Figure 1-1 Differences in Violence Rates by Age Group, 2014 from WISQARS

The dramatic differences in age-specific crime rates shown in Figure 1-1 is demonstrated by a characteristic shape, named the age-crime curve.^{16 17} The age crime curve's shape reflects the disparities in the risk of violence across a lifespan.¹⁸ This effect is found to vary but remain consistent across period and cohort effects.¹⁷ Across all racial subgroups, the age-crime curve has the same shape; however, the location and height of peaks vary by race.¹⁸⁻²² The rate of assault in the 2014 African American population is 823.47 victims per 100,000 individuals.¹⁴ In 2014, the rate of assaults were four times higher in the African American population than in the white population.

1.1.3 Violent Crime by SES

Socioeconomic status is commonly viewed as a central determinant of violence.^{11 23 24} The National Center for Education Statistics defines SES as “one’s access to financial, social, cultural,

and human capital resources.”²⁵ Sanchez-Jankowski and Andersen suggest that people with lower SES experience exclusion from education and employment opportunities.^{26 27} The American Psychological Association suggests to measure SES as a “combination of education, income, and occupation.”²⁸

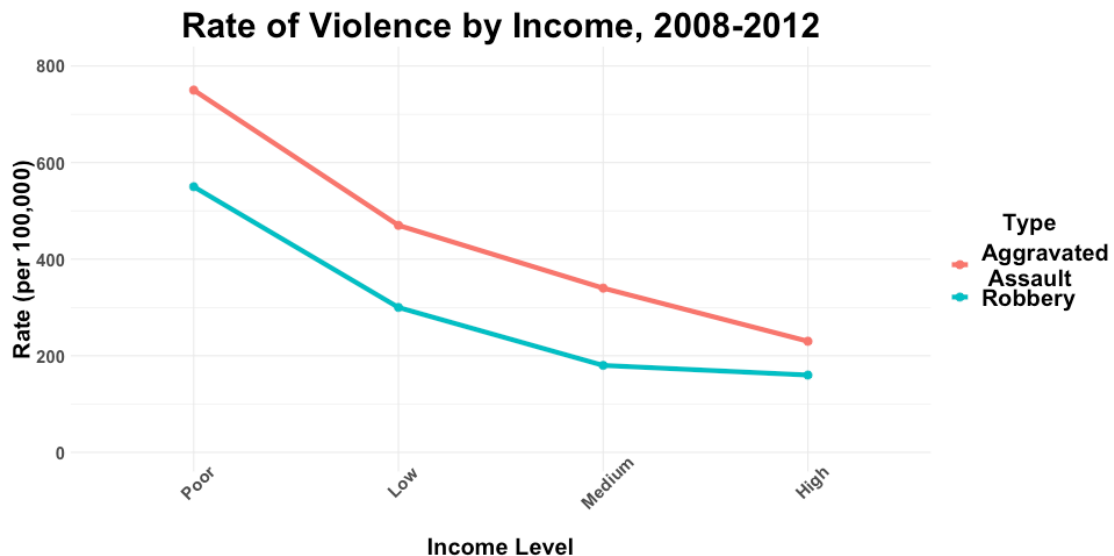


Figure 1-2 Rates of Robbery and Aggravated Assault by Income-Level, NCVS

In Figure 1-2, note that previous research has established that individuals with lower levels of income tend to more likely be victims and perpetrators of violence compared to those with higher incomes.²⁹⁻³³ This figure illustrates disparities in violence by income level as defined by the guidelines of the Bureau of Justice Statistics. Income is measured as the total household income in the 12-months before the interview. On the x-axis, income-level is discretized from low to high based on income percentage in relation to the poverty line: poor is 100% of the poverty line or below; low refers to 101% to 200% of the poverty line; medium is 201% to 400% of the poverty line; and, high is 400% or above the poverty line.³⁴ The rate of aggravated assault in the poor group is 750 per 100,000 individuals and the rate of robbery is 550 per 100,000 individuals.

In the high income group the rates of aggravated assault are 230 per 100,000 individuals and robbery at 160 per 100,000 individuals.³⁴ In the poor group, the rate of robberies is three and a half times higher and the rate of aggravated assault is three times higher when compared to those in the low-income group.

Another construct of SES includes education level: as individuals who complete higher education are thought have better access to community resources leading to lower rates of violence.³⁵ The rates of violence (including both simple and aggravated assault) are lower for individuals who complete a high school education or greater than for individuals who have completed less than a high school education (less than high school: 1,030 per 100,000 individuals, high school: 960 incidents per 100,000 individuals, and completed at least some college: 1,020 per 100,000).³⁵ In 1997, two-thirds of all prison inmates had not completed high school.³⁶

Individual employment status is also an indication of access of an individual to human cultural and financial resources.^{30 37} In school-aged individuals, both older drop-out age and increased presence at school versus time at a job was associated with reduced violence.³⁸⁻⁴¹ In non-school age populations, higher level of education completed was associated with reduced violence arrest rates.⁴²⁻⁴⁴ Studies strongly support the assertion that SES factors such as education and income tend to have a large effect on rates of crime.

1.1.4 Violence by Neighborhood SES and Racial Composition

Geographies, like neighborhoods, are increasingly understood to play an important aspect in understanding contributions to violence.⁴⁵ The term neighborhood itself refers to geographic areas such as census tracts or city neighborhoods.⁴⁶ Many of the same factors, such as race or SES, that cause violence disparities at the individual-level repeat at the neighborhood-level.

Various geographic sizes can be used to define neighborhoods; in a review of articles published in *Criminology*, units of analysis included institution, micro-place, meso-place, macro-place, situation, and person.⁴⁷ Schnell et al examined street segments clustered within census tracts then clustered within community groups and showed the largest variation of violence (56% to 65%) occurred at street segments.⁴⁸ While violence trends vary considerably by geographic area, the social dynamics through which violence operates risk of violence is commonly thought to operate at moderately-sized bounded geographic areas called neighborhoods.⁴⁹

The effect of neighborhood-level SES on violent crime is independent of the effect of individual-level SES, and neighborhoods with low SES are at higher risk of violence than those with high SES.⁵⁰⁻⁵⁶ Individuals living in neighborhoods classified as poor or low income are at higher risk for violent crime than those living in high income neighborhoods.^{8 52}

Neighborhood-level racial composition affects risk for violence, but should not be thought of as causes of violence, but rather as a marker for other factors that are “differentially allocated by racial/ethnic status in American society” such as power and access to resources.⁹⁻¹¹ Individuals living in neighborhoods that were predominantly African American were 1.25 times more likely to commit violence than those living in predominately white neighborhoods.¹⁰

1.1.5 Violence in Pittsburgh Neighborhoods

These disparities in neighborhood-level violence occur by geographic location, such as between neighborhoods in Pittsburgh. Figure 1-3 shows these disparities in Pittsburgh for rates of robbery. Rates of robbery are highest in the neighborhoods of North Side, Homewood, and Hazelwood. Other neighborhoods with high crime rates include neighborhoods with high numbers of individuals traveling into the neighborhoods for commercial activity. These neighborhoods

include the Central Business District, South Side Flats, and Strip District. Neighborhoods with low crime include Squirrel Hill, Morningside, Fairywood, Brookline, and Highland Park.⁵⁷

Rate of Robbery in Pittsburgh Neighborhoods

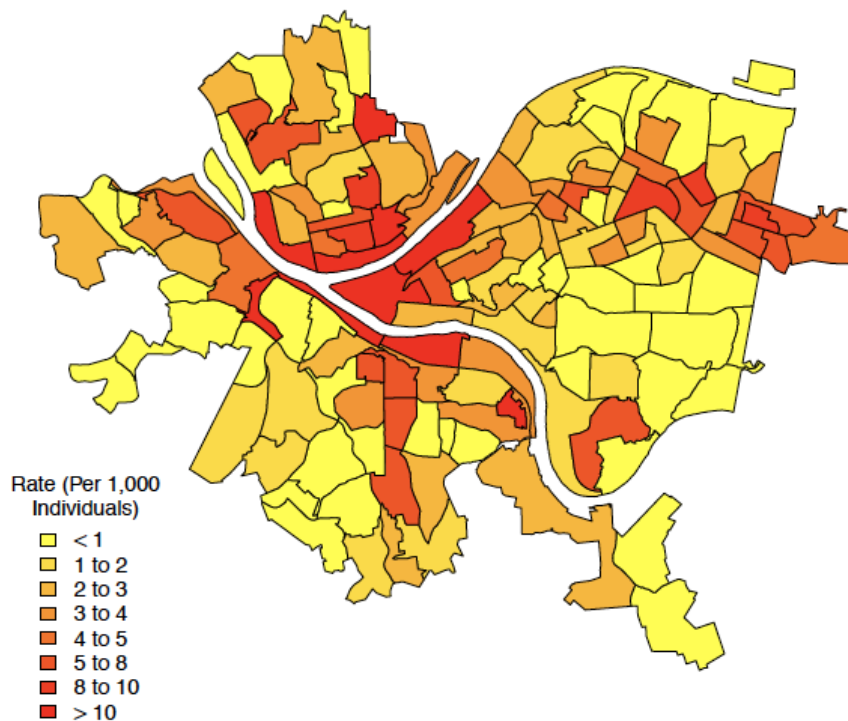


Figure 1-3 Rates of Robbery by Neighborhood in Pittsburgh, 2015

Corresponding with differences in robbery, in Pittsburgh similar disparities exist for aggravated assault. As seen in Figure 1-4, neighborhoods with high rates of aggravated assault include Homewood, Larimer, North Side, and Knoxville. High rates of aggravated assault are also in the commercial neighborhoods, Central Business District, South Side Flats, and the Strip District. Areas with low rates of aggravated assault include Morningside, Squirrel Hill, East

Carnegie, and Lincoln Place.⁵⁸ In Pittsburgh, aggravated assault follows similar geographic patterns to robbery.

Rate of Aggravated Assault in Pittsburgh Neighborhoods

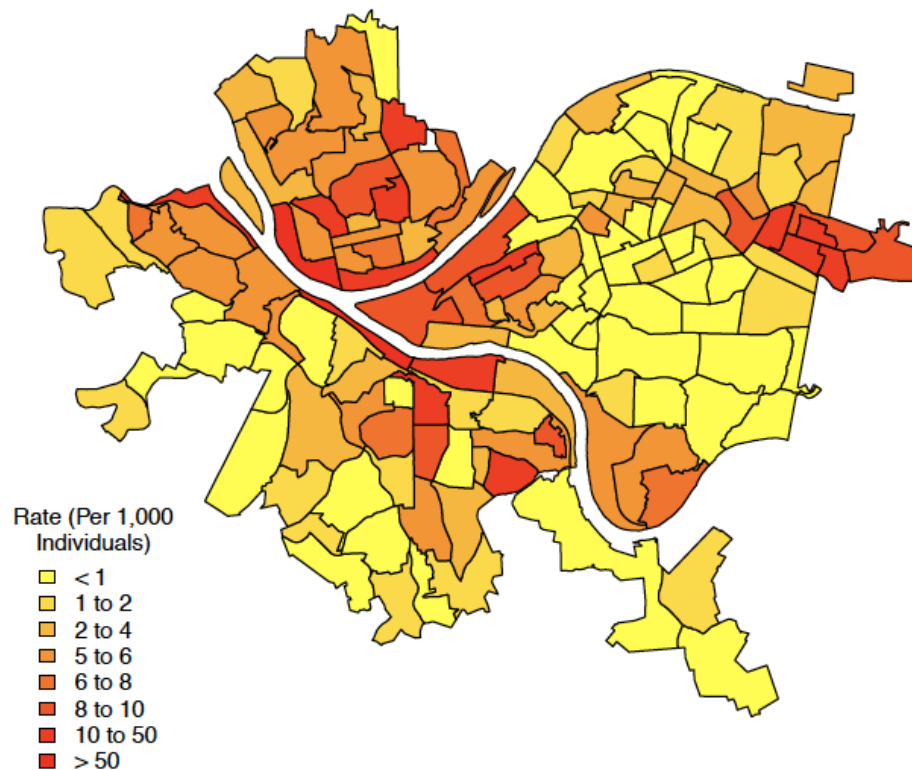


Figure 1-4 Rates of Aggravated Assault by Neighborhood in Pittsburgh, 2015

Neighborhood-level racial factors did not appear to have an effect on differences of violent crime after other neighborhood factors were controlled for.^{59 60} However, measures related to SES such as percentage of families in poverty, neighborhood's residential instability, and neighborhood percentage unemployed were associated with higher rates of violence.⁶⁰

1.1.6 Violence Over Time

Overall, both violent crime and robbery have decreased from 1995 to 2014 in the US. Using data from UCR, Figure 1-5 shows the rates of aggravated assault and robbery in the US from 2005 to 2015. For robbery, the greatest decrease in rates occurred from 1995 to 2000, then rates plateaued from 2000 to 2005, and finally decreased after 2006. Rates of aggravated assault followed a similar pattern to robbery where rates decreased from 1995 to 2004, then increased slightly from 2004 to 2006, and finally decreased after 2006.¹² From 1995 to 2014 rates of robbery decreased by roughly half from 220.0 per 100,00 individuals in 1995 to 102.2 per 100,000 individuals in 2014. Over the same time period aggravated assault decreased by roughly one and a half times from 418.3 per 100,000 individuals in 1995 to 232.5 per 100,000 individuals in 2014.¹² Robbery and aggravated assault follow similar trends during the time period, but overall rates of robbery are roughly half those of aggravated assault.

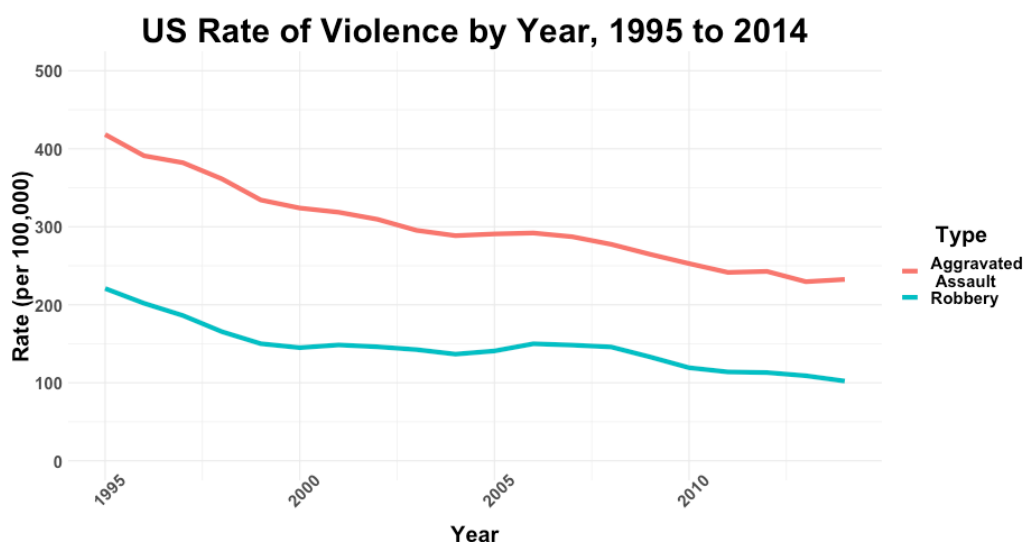


Figure 1-5 Rate of Violent Crime by Year, from FBI UCR

1.2 Descriptions of Large-Scale Economic Developments

Details of the opening and operation of the casino is described in 1.2.1 while the opening and operation of the arena in conjunction with the CBA is described in 1.2.2. Each development was built and subsequently operated in a neighborhood within the City of Pittsburgh.

1.2.1 Description of Casino Development

In 2004, Pennsylvania passed the Pennsylvania Race Horse Development and Gaming Act legalizing casino gambling and authorizing 61,000 slot machines at 14 locations including 5 slot parlors and 2 casino resorts.⁶¹ As part of this legislation, one gaming license was granted to Pittsburgh for development of a casino containing slot machines.⁶² As a bidding process commenced, several sites were proposed within the city of Pittsburgh.⁶⁴ When the North Side was proposed as one of the sites, neighbors and local businesses worried about increased community harm through crime or gambling addiction.⁶⁵ However, opponents were subsequently unable to prevent development of the casino as the North Side site was selected in December 2006.⁶⁴

The chosen site was 17 acres of riverfront property that previously was the site of a steel mill and a warehouse, but was adjacent to an entertainment destination as the site of two major sporting stadiums.⁶³ Many residents of the North Side felt ignored or left behind by these previous developments, but were hopeful to gain benefits for the neighborhood from the new casino.⁶⁶ The North Side is a diverse neighborhood with some thriving communities while others struggle with unemployment, poverty, few units of affordable housing, high rates of violent crime, and segregation. In a previously calculated disadvantage score following guidelines set by Wikstrom and Loeber⁶⁷ the communities in the North Side were categorized as disadvantaged or average.

In 2006, the Northside Leadership Conference took advantage of an opportunity to negotiate for benefits from the community.⁶⁶ A formal legal agreement was reached on April 24, 2007 between the Northside Leadership Conference along the Hill District Growth Development Fund and the Casino developers to provide \$1 million a year for three consecutive years to the North Side and Hill District.⁶⁸ The Northside Leadership Conference used the money on environmental projects including renovation of North Side business district buildings, building of housing, and sidewalk improvement.⁶⁹

Ground was broken for the casino in December 2007 and the casino opened on August 9th, 2009. In July 2010, gambling at the casino was expanded to include table games.⁶ As part of the gaming license, the casino eased property taxes for local residents and required the casino to pay a 55% overall tax rate of which 34% goes to the state and \$10 million goes to the city of Pittsburgh.⁶

64 70

1.2.2 Description of Arena Development and CBA Implementation

To replace an aging sports arena built in 1961, a professional hockey team proposed the new arena in geographic proximity to the existing aging arena within the Hill District located adjacent to the downtown corridor.⁷¹ The Hill District is known for neighborhood activism with the first community groups formed before World War 2 united by shared experiences and similar needs from Pittsburgh.³ As part of the construction in the late 1950s, the business district in the Hill District was removed through the loss of approximately 400 businesses, and pulling out of residences displacing 1,500 families or approximately 8,000 residents.^{3 72} Community groups attempted to block demolition of these buildings and relocate the arena development, but ultimately failed.⁷³ Policy makers' original goals were to inspire redevelopment within the cleared

area to bring increased economic activity. In the years after the arena opening in 1961, economic gains were not realized and the development is now generally regarded as harmful to the neighborhood.^{72 74 75} Environmental features of the development contributed to the harm by the areas around the arena consisting of “moats of parking” disrupting traffic-flow into the neighborhood further leading to isolation.⁷⁶

The site chosen for the new arena was 28 acres of real-estate a few blocks from the aging arena near downtown Pittsburgh. The Hill District remains a relatively well-organized neighborhood with strong community groups who have a history of successfully engaging with the local leaders to improve neighborhood life.^{3 4} However, the neighborhood experiences high rates of poverty, unemployment and limited access to services.⁷⁷ When the new arena was proposed, these community groups started negotiations to ensure that the developers met needs within the neighborhood. After a year of negotiations, community leaders and local officials signed a legally-binding community benefits agreement (CBA), in 2008, that legally defined benefits for the community.⁵ These benefits included development of a Hill District grocery store; required the city and county to help fund a master plan; created a neighborhood partnership that gave businesses state tax credits in return for contributing to Hill District development projects and established a career center.^{5 78} In addition, the CBA required hiring from this new community resource center.⁵

Shortly after this agreement was signed, in 2008, construction of the new arena started and the arena opened in August 2010.² In 2012, the old arena was demolished and replaced with a parking lot; and, in 2013 the final aspect of the CBA was implemented when first grocery store opened in the neighborhood in 30 years.^{79 80}

1.3 Theoretical Basis of Large Economic Developments and Violence

In this section, we discuss the social theoretical rationale behind the effect of large-economic developments and violence.

1.3.1 Routine Activities Theory

When movement and locations of victims of violence are compared to time-matched non-victim controls, victims tended to visit areas with different environmental features when compared to controls.⁸¹ Often, this victimization occurred immediately after arrival to a new location.⁸¹ By recognizing that structural features may shape behavior, routine activities theory can help understand this place-based violence.⁸²⁻⁸⁴ The theory states that three elements must intersect temporally and geographically for violence to occur; an accessible target must meet a motivated offender in the absence of capable guardians.⁸²

1.3.1.1 Arenas with a CBA in Theory

Routine activities theory and rational choice theory generate a hypothesis about the effect of sports and entertainment arenas on violence.⁸⁵ As suggested by routine activities theory, several features of an arena, such as the way the facility is managed effect rates of violence. Previous studies have shown that additional guards are associated with reduced violence including robbery, even when socioeconomic factors were controlled for.^{86 87} Informal guardians may be increased, if the surrounding area is developed thus increasing flow of people in a neighborhood.^{88 89} These developments may additionally reduce violence if they replace locations that attract violence such

as dilapidated apartment buildings.^{90 91} If the arena increases empty areas, such as parking lots, this decreases available guardians and increases violence.⁹²

In contrast, violence could be decreased if an arena increases individual employment thus decreasing motivated offenders.^{30 37 93} Along with the arena itself, additional jobs might come in the form of increased restaurants and accommodations to serve visitors to the arena.^{94 95} Additionally, behavior of employees themselves may reduce violence at arenas, by controlling behavior at an arena such as how alcohol is served.⁹⁶

After considering these theoretical arguments, no clear picture of the expected effect arena construction can be hypothesized. Therefore, the CBA may drive any changes in violence after completion of this arena. We expect the CBA to reduce rates of violence by increasing social measures in the neighborhood.⁸

1.3.1.2 Arenas and Neighborhood Community Organizations

Benefits are of the arena may be kept within the geographic area by engagement with the community. We are not aware of any studies that quantitatively examined the effect of community benefits agreements with an arena on any public health or economic outcomes. However, several narrative stories connected to previous stadium developments provide guidance on the impact of a socially organized neighborhood.

Many large economic developments may meet the developer's goals, but adversely affects a community.⁷⁵ However, development is generally less harmful in neighborhoods with higher levels of social organization.⁹⁷ Not surprisingly, effectively engaging community groups is associated with better use of resources and better health outcomes.⁹⁸ This is theorized to occur by communicating neighborhood needs to local leaders which can lead to improved neighborhood characteristics.⁹⁷ Even after failures, these community organizations can succeed and have a large

effect on development. After the failure of preventing the arena redevelopment in 1961, Pittsburgh community organizations successfully prevented the demolition of 60 buildings and removal of 125 businesses to build a downtown entertainment district in Pittsburgh, PA.⁷³

Community groups can be united by shared geographic experience and proximity to the development.⁹⁹ Shared experiences within a bounded geographic area by sports facilities' negative effects to the local area such as traffic, pollution, changing land values, and disruption in their neighborhood.¹⁰⁰⁻¹⁰² Community groups have managed to influence location and mitigate potential negative effects of arenas, but politically weak neighborhoods are usually chosen as development sites because politically stronger neighborhoods are able to block arena development.¹⁰³⁻¹⁰⁶

Interestingly, these facilities continue to be funded despite strong opposition from local stakeholders and lack of economic benefits.^{107 108} A potential explanation is that proponents of these developments are local elites who are comprised of the team owners, business community, media and politicians with large political capital.¹⁰⁹ A CBA hopes to avoid harm to the neighborhood by legally defining benefits to the community in a legal agreement.⁵ A CBA is a relatively new idea with the first signed in 1998 between a LA community organizations and unions and the developer of a large-development.¹¹⁰

Previous studies regarding the effect of CBAs on local communities are either case-series or case studies, and suggest CBAs are highly sensitive to neighborhood effects.¹¹⁰⁻¹²¹ In a review conducted by Wolf-Powers of 27 CBAs, she summarized the specific effects as: "local politics of organized labor; the accountability of the community benefits coalition to affected community residents; and most importantly, the role of local government in negotiation and implementation".¹¹¹

1.3.1.3 Casinos and Routine Activities Theory

The effect of a large-economic development, such as a casino, on geographic and temporal trends in violence can be hypothesized using routine activities theory. In a geographic area, casinos provide a location and time where potential targets can meet motivated offenders with lowered barriers. Open display of money and individuals who win large amounts of money are plentiful and easily identifiable as potential targets. Motivated offenders can be those who lose large amounts of money or broke, addicted gamblers who need money to continue to gamble. Additionally, barriers are often lowered with easy availability of alcohol.¹²² Using these theoretical relationships, casinos are hypothesized to increase neighborhood violence.

While routine activity theory suggests that local violence should increase by the introduction of a casino, results of studies examining casinos and violent crime, specifically robbery and aggravated assault, are inconsistent.^{91 123-138} However, these inconsistencies may be because of study design limitations. These limitations can be summarized by large experimental geographic areas (ie, cities or states), missing a suitable comparison group, and inadequate time-series data to account for overall trends of violence.

1.3.2 Economic Development: Casinos and Violence

Many of these studies use large geographic levels such as county, state, or large cities such as Atlantic City. Using the large areas can be misleading because violent crime rates “vary substantially at different levels of spatial and temporal resolution”.¹³⁹ Using county data, Mays found county rates of robberies and aggravated assaults in New Mexico from 1991 to 1999 were not associated with construction of casinos.¹²³ Johnson used neighborhood-level data from 2004 to 2011 to track the 2010 building of casino in a Philadelphia neighborhood. Violent street

felonies, such as aggravated assault, did not increase by the opening of the casino in the neighborhood, but the authors only followed violence for a little over one year after the opening of the casino which Grinols and Mustard suggest is too short.^{126 140}

In many of these studies, authors emphasize that the population at risk should include the number of visitors.^{88 128 134} Albanese examined crime in Atlantic City from 1978 to 1982 after the introduction of the first casino in 1978 and subsequent building a total of 9 casinos by 1982. While there was a strong correlation between the increase in index crime and casinos in Atlantic city (0.96) the correlation switched when the increased daily population was taken into account (-0.34).¹³⁴ Like Albanese, Curran and Scarpitti again examined Atlantic City and similarly found that while overall index crime increased after the introduction of the casinos. However, this effect disappeared when controlling for violent crime attributed to casinos and daily population.¹³⁵

In contrast to studies conducted in single cities, Stitt et al. compared changes in violence after the construction of a casino in six cities to six, matched cities without casino construction. Stitt et al. compared data for 4 years before the casino to 4 years after the casino. Results for aggravated assaults and robbery were inconsistent using both populations at risk.¹²⁸ These results might be due to unclear which features of control communities are important to match to intervention communities. Reece tracked violent crime from 1994 to 2004 in Indiana's counties. After visitors were taken into account, robbery initially decreased then no effect was found, but assault statistically significantly decreased after 2 years.⁹¹ When number of visitors were included in the modeling of robbery or aggravated assault rates, each did not increase in communities with casinos, but residents of these communities will experience an increase in violence.

Other studies have suggested that length of time after the casino opened may have an effect on the violence rates. In Biloxi, Mississippi in 1992 the first casino opened followed by an

additional 9 by 1994. Comparing 1 year before to 1 year after, Giacomassi and Stitt found no effect on rates of aggravated assault or robbery.¹²⁵ Using data from 1986 to 1994 in the same location, Chang found assault was not associated with the introduction of casinos, but in contrast to Giacomassi and Stitt robbery statistically significantly increased. However, when estimated daily visitors were taken into account, the violent crime rate decreased during the opening of the first casino, but after the first year these rates returned to pre-casino levels.¹³⁶ In a study with particularly long follow-up, Grinols and Mustard used US county-level data from 1977 to 1996. The effect on crime was low shortly after the casino opened and grew over time, and by 1996 8% of the violence in counties with casinos was attributable to casinos. For aggravated assault, the increase was only statistically significant after the third year of the casino opening, but for robbery rates increased immediately after the casino opened.¹³² In contrast to what other authors contend where the violence is merely caused by increased visitors, this trend did not follow visitor's patterns to a casino suggesting the casino itself increases violence.¹⁴¹ Longer follow-up time appears to be important when testing the effect of a casino, but Grinols and Mustard used counties which may lead to misleading results.

Other studies examined violence including surrounding areas. Hakim and Buck used data from 1972 to 1984 from Atlantic City and surrounding communities in New Jersey. In all communities, the violent crime-rate increased after the introduction of the casinos after economic and social factors were controlled for. However, farther travel time away from the center from Atlantic City was associated with less robbery and violent crime. This suggests that if crime did spill over from Atlantic City into surrounding communities the effect was concentrated around Atlantic City.¹³¹ Examining the same area, Friedman et al. similarly found violent crime increased after the introduction of the casino in localities around Atlantic city and along the major non-toll

routes to Philadelphia and New York City up to 30 miles from Atlantic City.¹⁴² In Michigan, Gazel et al. found the presence or opening of a casino in counties and adjacent counties rates of robbery or aggravated assault and forcible rape did not increase. However, in counties next to 2 or more counties with casinos aggravated assault or forcible rape increased 47.1%, but robbery did not increase.¹³⁰ Among Michigan counties, Falls and Thomson used data from 1994 to 2010 to find the introduction of a casino did not increase rates of robbery in casino counties or adjacent counties.¹²⁹ These studies suggest that violent crime from casinos may be “leaking” into surrounding communities, but many of these studies had methodological shortcomings such as usage of large areas or inadequate length of follow-up.

1.3.3 Economic Development: Effect on Economic Indicators

Concentration of poverty such as low neighborhood-level income is associated with increased risk for violent crime.^{8 52} In addition, lower individual-level economic measures such as income or unemployment are associated with increased risk for violent crime.^{29-33 37} In an effort to increase economic activity in these neighborhoods, local leaders argue that placement of large economic developments in these neighborhoods can improve the neighborhoods by increasing employment and tax revenue.^{74 143}

1.3.3.1 Arenas with a CBA and Economic Indicators

Many officials argue construction of new arenas and the necessity of cities burdening the costs by arguing that these arenas will bring large benefits to a region.^{144 145} Arena construction is exploding with US cities spending \$15.6 billion on 73 new arenas from 1990 to 2000.^{145 146} Officials argue these benefits occur not only through the arena itself but through wealthy fans

injecting money into hotels, restaurants, and businesses which additionally benefit residents by increasing jobs and income.¹⁴⁷ However, reviews of local impacts of stadiums found that the literature consistently shows that arenas have no effect on reducing unemployment or increasing income in an area.^{95 145 147}

In the first study to ask if the presence of a new or renovated stadium impacted personal income, Baade and Dye examined 9 metro areas from 1965 to 1983. Control groups were the surrounding metropolitan region. In 7 of the 8 metropolitan areas arenas had an insignificant impact on income after adjusting for income trends and population in an area.¹⁴⁸ Comparison groups were matched based on definition as a metro area. In a subsequent study to Baade (1990) Baade expanded his original study by including additional cities, 36 with new arenas and 12 control areas without stadiums but were not matched on any characteristics, and additional time, 1958 to 1987. Within the 30 areas that added a new sports stadium 27 showed no significant relationship between trend-adjusted per capita income, and in the other 3 areas per capita income decreased. Additionally, no trend was found by location of the arena.¹⁴⁹ In the final study by Baade, the authors examined the effect of employment by sectors. Using regression and accounting for temporal trends, new stadiums were not related to increase in income.¹⁵⁰

In a subsequent study to the set by Baade et al., Santo examined the impact of arenas using data from 1984 to 2001 in 19 metropolitan areas that had gained/lost a team or constructed a stadium. Older stadiums were excluded as they tended to be more multi-use. Using cross-sectional time-series analysis, the construction of a baseball stadium increased income in some areas while for others it did not. In addition, the results were inconsistent with 6 of the 10 MSAs finding statistical significance, and of these areas with a significant effect 2 of the 6 income decreased while in 4 areas income increased.¹⁵¹ All of the studies of sports development included larger

metropolitan statistical areas rather than smaller areas. In fact, Baade argued that these larger areas should be used to account to the leakage effects out of central cities, but also pointed out that using too large of cities the small effect of the arena was unlikely to be related to a statistically significant effect on local economy due to the large size of the local economy.^{149 150} A limitation of Santo is missing of a concurrent comparison group to control to economic trends. Previous authors have commented the length of the study is important, and only by using a long time-series can any effect be found.^{149 151-153}

In a set of three studies arenas were associated with a decrease in income. Using 24 metropolitan statistical areas, cities were excluded if the metro area was too large or wealthy for the stadium to have a large enough impact or if two teams played together. Arenas were not associated with change in income from 1979 to 2009, but for arenas built from 2001 to 2009 they were associated with a small decrease in income.¹⁵⁴ In a series of studies by Coates et al., the authors examined the effect of an arena for only 10 years or the “novelty factor”. The authors examined change in per capita personal income in 37 metropolitan areas from 1969 to 1994. Using both fixed and random effects and adjusting for year, the addition of an arena was statistically significantly related to a decrease of per capita personal income.¹⁵² In a subsequent study, the authors included additional years and corresponding stadiums: 1969 to 2011, added the sports hockey and soccer, and additional economic variables. Additionally, sample size was increased by including all US metropolitan statistical areas in contrast to just those with major franchises. Using a regression model that estimated the effects of the panel data, the effect was variable on income, wage, and salary and in cities where the effect was significant the effect was negative. The effect varied based on if the comparison group was host or non-host cities to sports teams and by type of stadium.¹⁵³

In the only study that concentrated on the effect of arenas on smaller areas, arenas were associated with a small increase in income. In a study that examined the effect of arenas that tended to be in smaller metropolitan areas, the authors used a dynamic panel data model to examine 238 metropolitan areas between 1985 and 2006. Surprisingly, the authors found that the construction of a stadium for any minor league team was associated with positive income change (AAA team: increase of \$67.25, A+: \$117.57) and the effect was stronger during the first 5 years of the period with an increase in \$201.99 for rookie, AA \$160.83.¹⁵⁵

1.3.3.2 Casino's and Economic Indicators

Casinos, a large economic development, are strongly perceived by both local leaders and residents to provide jobs and positive economic benefits even when the overall perception of the casino is low.^{122 156-158} This may help explain why the number of states with legalized gambling has exploded and new casinos continue to be built.^{159 160}

Even though casinos are argued to provide positive economic benefits, such as increased wages, few studies examine these economic effects to the local areas.^{161 162} To examine direct effects to individuals in a community, previous authors have suggested using economic indicators unemployment and income.^{88 160 163} The few studies that have looked at these economic indicators used large geographic areas such as the country or state and these studies are inconsistent in their conclusions.

Many early studies argue that casinos will not increase economic activity unless sufficient numbers of visitors come to the community and the money spent on gambling by the locals will simply be substituted from other business types in the area.¹⁶⁴⁻¹⁶⁸ Additionally, Morse argued that casinos do not impact wages and jobs generated are poor quality.¹⁶⁹ In contrast, Eadington used a historical perspective to argue that Atlantic City, Monaco, and Nevada were dying areas before

casinos and from these casinos grew to be economically strong destinations for tourism.¹⁶⁰ In general, these early studies tended to be qualitative and provide little empirical evidence.

1.3.3.3 Recent Studies

Other authors have examined if there is a long-term effect of casinos on local areas and if these casinos provide continued economic growth to these areas. Using US data, Cotti used fixed effects regression and adjusted for local economic trends. Casinos in counties were associated with increased employment (+3.12% vs. control group) and income. Using intertemporal estimation, there was no effect of the casino on employment before opening or in the year of opening, but employment increased by 4% in next two years, the effect ended. Employment growth in counties with casinos was greater in counties with smaller populations, and these employment effects had little impact on employment in neighboring counties.¹⁷⁰ Using a similar design in Canada, Humphreys tracked data from 1991 to 2005 in the seven provinces which contain casinos. Casinos in Canada tend to not be tourist destinations as in the US and are consequently more evenly distributed. Using ordinary least squares estimation employment increased in areas where casinos opened, but only over five years after the opening of a casino.¹⁶¹ Using Mid-Atlantic states (DE, MD, NJ, NY, PA), Economopoulos used a Spatial Durbin model to capture the effects of a casino. While initial employment increases in private, total, and retail employment, the longer the casino is in area the more employment decreases. The effect changed by county type, and in contrast to other studies, income was raised in urban areas while lowered in rural areas. Any positive benefits of the casinos are limited to casino counties and do not spread into surrounding counties.¹⁷¹ These studies suggest that, there may be an early effect of employment at a casino, but these effects dissipate over time. The issue of urban vs. rural is raised, but the effect is inconsistent.

1.3.4 Perceived Neighborhood Violence

In addition to rates of violence, measuring individual's perception of violence adds additional insight into the effect of a large, economic development on a neighborhood by understanding the community's response.^{172 173} Consistent with measures for rates of violence, perceived neighborhood violence has been associated with a negative effect on economic indicators and health outcomes¹⁷⁴⁻¹⁷⁶, but is thought as a distinct measure from rates of violence that should be measured separately.¹⁷⁷⁻¹⁸¹ Aspects such as designs of buildings can affect perceived neighborhood violence and well-designed, large, economic developments are thought to decrease perceived neighborhood violence.^{182 183}

Perceived neighborhood violence is defined as the amount of violence that survey participants report seeing within a community.⁷⁷ Similarly to rates of violence, the distribution of perceived neighborhood violence is not uniform along space and time but tends to concentrate in certain geographic areas.^{139 184-189} Perceived neighborhood violence can be affected by social factors, such as public drunkenness or drug addicts, and physical factors, such as vacant lots or public housing.^{183 190 191}

Neighborhood-level factors can change perceived neighborhood violence. Violence rates within an individual's neighborhood strongly influenced levels of perceived neighborhood violence, but violence rates in neighboring neighborhoods had only a small effect.¹⁹² Neighborhood factors such as such as a specific buildings or reputations of elements in neighborhoods can increase or decrease an individual's perception of violence in a neighborhood.¹⁸¹

1.3.4.1 Casinos and Perceived Neighborhood Violence

A casino is an example of a neighborhood factor that impacts perceived neighborhood violence. In cross-sectional surveys that compared communities perceived impact of casinos and perception of violence found that perception of change in violence varied dramatically between communities.^{193 194} In contrast, a cross-sectional study conducted in rural communities with an existing casino found all communities reported perceived violence increased from the casino.¹⁵⁸

In a cross-sectional study individuals residing in seven communities in the mid-west and south where casinos had recently opened, were surveyed regarding how perceived violence had changed in their community since the introduction of the casino.¹²² In three of the seven communities, individuals perceived violence either increased or stayed constant. However, in one community, residents perceived violence fell as a consequence of the casino. In the city where the casino proportionally accounted for the greatest dollar contributor to the economy, residents believed the casino had worsened perceived neighborhood violence to a greater extent than any other city within the study.¹²²

In a secondary informal study in Nichols et al., the authors compared changes in perceived neighborhood violence corresponded to violence rates. In two of the studied cities where violence rates increased perceived neighborhood violence also increase, while in the one city where crime rates decreased perceived neighborhood violence decreased. In the other cities where violence rates did not consistently increase or decrease across neighborhoods, residents' change in perceived violence was not statistically significantly associated with the opening of the casino. The authors concluded that changes in perceived neighborhood violence tracked with changes in rates of violence after the addition of a casino.^{122 195}

In longitudinal studies, results were inconsistent. One study compared different communities and examined the perceived impact of the casino. The study found the effect varied by how long the casino has been in the community. The authors picked communities who had had the casinos for various period of time: three “early stage” gaming communities and one “later stage” community. These “stages” were based on length of time the casino had been in the community. The authors found that improved community safety in casino communities was associated with improved quality of life.¹⁹⁶ In a longitudinal study on a community where a casino opened, residents were repeatedly surveyed on perceived impact of the casino on violence. The first survey was conducted immediately after the opening of the casino in 1992, the following a year later in 1993, and the final three years later in 1995. After every follow-up survey, residents perceived impact of casino on violence worse.¹⁵⁷ These inconsistent results may be explained by methodological shortcomings in these studies.

These studies found several individual-level factors have been associated with changing perceived neighborhood violence and include working at the casino, support of gambling, personal income, and engagement in gambling.^{122 194} For instance, gamblers are 18% less likely than non-gamblers to report that casino’s had increased violence.¹²² Interestingly, distance lived from a casino did not affect individuals change in perceived neighborhood violence.¹²²

1.3.5 Collective Efficacy

According to Sampson et al. Collective efficacy is “social cohesion among neighbors combined with their willingness to convene on behalf of the common good.”⁸ This measure helps to explain why violence can vary between neighborhoods when economic or health characteristics alone cannot explain differences.¹⁹⁷

In cross-sectional studies, Sampson et al. and Morenoff et al. found that increased collective efficacy was strongly correlated with reduced violence in a neighborhood.^{8 197 198} Lower collective efficacy is related to behaviors associated with violence¹⁹⁹⁻²⁰¹ and different types of violence.²⁰²⁻²⁰⁴ For instance, a study in New York, NY found that while residents of high collective efficacy neighborhoods experienced violence victimization at 3.5 per 100 individuals, residents of low collective efficacy neighborhoods experienced violence victimizations at 4.0 per 100 individuals higher after neighborhood factors such as SES were controlled for.²⁰⁵

1.3.5.1 Collective Efficacy and Large-Economic Developments

In neighborhoods without large economic developments, Schmidt et al. found that collective efficacy did not change over 4 years in 38 Boston neighborhoods.²⁰⁶ Similarly, in Chicago, Sampson et al. found that collective efficacy did not change for 7 years in neighborhoods without large changes.²⁰⁷

Few studies have examined which interventions and community characteristics can change collective efficacy, and most of these studies found that these interventions are not successful at improving collective efficacy.^{208 209} In one study, Carlson et al., studied an intervention aimed at educating children and adults on HIV/AIDS and found that while collective efficacy did not increase adults felt increased collective efficacy towards children.²⁰⁹ Hipp further examined how changes in exposures in the neighborhood can change collective efficacy. Using North Carolina counties, Hipp tracked changes in violence rates and collective efficacy over 3 time points over a 2-year period, and found that in communities that perceived an increase in violence over the previous time period correspondingly perceived decreased collective efficacy.²¹⁰

Even though violence events are relatively events that happen quickly, these events can have an effect on large-economic developments. For example, people may be less likely to visit a

place with a reputation for violence. Higher neighborhood collective efficacy is thought to protect against these negative effects.^{210 211} Studies that examined collective efficacy and developments tended to concentrate on smaller developments rather than a large economic development.

Another study looked at the effect of a Business Improvement District (BID). A BID is a geographic area where local businesses are taxed for services such as private security or development of a neighborhood redevelopment plan. The authors compared the effects of this BID and collective efficacy on violence and found that while lower collective efficacy was associated with higher violence in neighborhoods in LA, the BIDs had no effect on changes in violence.²¹²

In Las Vegas, a city where a large portion of the economy is related to gambling, Las Vegas developments paid little attention to forming neighborhoods. Such development resulted in weak community connections, but neighborhoods with more collective efficacy had stronger community connections.^{99 213}

Using neighborhoods in Los Angeles, CA, Cohen et al. studied which aspects of community type were associated with higher collective efficacy. Neighborhoods with more parks was associated with higher collective efficacy while more alcohol outlets decreased collective efficacy, but the effect disappeared when neighborhood-level disadvantage was included in the model. This indicates the effect was due to disadvantage within a region and not due to the environmental feature itself. Fast food outlets and elementary schools were not related to levels of collective efficacy.²¹¹

1.3.5.2 Collective Efficacy and Casinos

For casinos, no studies used collective efficacy to measure a casino's impact on a community. Existing studies used related social measures like quality of life or opinion of a

casino's impact on the community.^{122 156 157 193 194 196} If these social measures are compared, the results are mixed. For instance, in a group of studies that estimated the social costs of casino's found that the impact ranged from \$2000 to \$30,000 (units: cost of problem gambler per person per year).^{141 166 214 215} While previous studies have linked positive collective efficacy with positive quality of life and neighborhood satisfaction, the variety and non-standardization of measures used provide little guidance on the effect of casinos on collective efficacy.²¹³

2.0 Causal Diagram of Aims

2.1 Specific Aim 1

We aimed to ascertain if the collective benefits agreement implementation decreased violence when combined with an arena redevelopment in the Hill District compared to other neighborhoods in Pittsburgh during the same time period.



Figure 2-1 Causal Diagram for Aim 1, Arena/CBA and Violence

2.2 Specific Aim 2

We aimed to assess the rates of violence measured by police offense reports in the North Side with a Casino compared to all other neighborhoods in Pittsburgh during the same time period.



Figure 2-2 Causal Diagram for Aim 2, Casinos and Violence

2.3 Specific Aim 3

We aimed to determine if collective efficacy and perceived neighborhood violence changed in the North Side and Hill District when compared to four neighborhoods over the same time period.

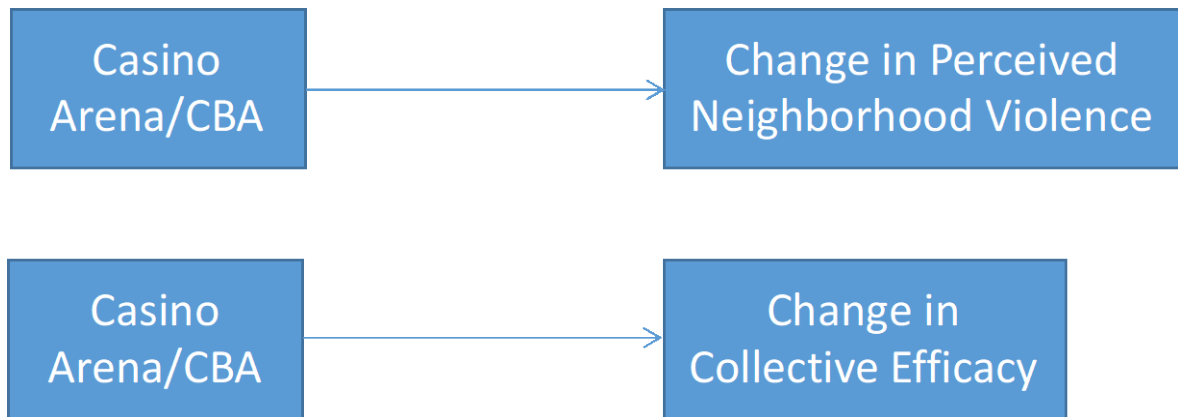


Figure 2-3 Causal Diagram for Aim 3, Casino and Arena/CBA Concerning Collective Efficacy and Perceived Neighborhood Violence

3.0 Manuscript 1: The Effect of a Community Benefits Agreement on Violence: The Neighborhood Component

3.1 Abstract

Introduction: Violence continues to be one of the leading public health problems in the United States. Developments are increasingly partnered with legally-binding Community Benefits Agreements (CBA) to ensure benefits to local residents by providing negotiated aid and services. While previous research recognizes the potential of engaging community groups to improve resident's health, little is known regarding the effect of these CBAs. We examined the association between violence and the implementation of a CBA and arena opening in the Hill District neighborhood within Pittsburgh, PA.

Methods: To create a causal estimate of the effect of the implementation of the CBA in the Hill District on violence, we implemented a difference-in-difference natural experiment framework. Incidents of violence, aggravated assault and robbery, for the years 2005 to 2015 were acquired from Pittsburgh Police offense reports. Neighborhood demographic, economic, and social factors for the pre-intervention years 2005 to 2009 and post-intervention years 2010 to 2014, were taken from the American Community Survey. We fit a generalized linear mixed effects model with adjustment for economic, social, and demographic characteristics.

Results: Violence declined by 29% (Incidence Rate Ratio (IRR): 0.71; 95% CI: 0.69, 0.73; $p < 0.0001$) over the study period. Violence was estimated to be 19% lower (IRR: 0.81; 95% CI: 0.73, 0.90; $p = 0.0002$) after the CBA and arena than would be expected without its implementation

when compared to other city neighborhoods. Changes in neighborhood characteristics did not explain the effect of a CBA and arena on violence.

Conclusion: This research study demonstrated that the implementation of a CBA was associated with the level of violence in the communities most likely to be affected.

3.2 Introduction

From 1950 to 2010, \$59 billion (adjusted for 2006 dollars) was spent on 234 new stadiums. Construction of new arenas is accelerating because over half of these facilities were built since 1990.²¹⁶ A few previous studies have concentrated on understanding the economic benefits of arenas to neighborhoods,¹⁴⁸⁻¹⁵⁵ but little is known how these results extend to other public health outcomes. Violence continues to be one of the biggest public health issues in the United States; in 2010 over \$20 billion (\$149,281 per victim) was spent on hospitalizations related to assault.¹⁵ While violence declined by 48% since 1990 (729.6 per 100,000 people), an increase of 1% is suggested by recent five-year violence trends (2013: 379.1 per 100,000 and 2017: 382.9 per 100,000).^{217 218} An increased focus on neighborhood disparities contributing to violence has led to an increase in application of place-based initiative violence prevention approaches.²¹⁹ Place based initiatives are interventions designed to improve health within neighborhoods through engagement of stakeholders like community members and businesses.²¹⁹

As part of place-based initiatives, community benefits agreements (CBA) may provide benefits to the community by introducing legal agreements between developers and community leaders. CBAs can also enumerate benefits such as grocery stores and jobs.^{5 113} By 2018 approximately 30 of these agreements were implemented in conjunction with new developments across the United States, and their use is growing.¹¹³ However, little is known regarding the effect of CBAs on health measures within the local neighborhoods.^{110-112 114 117-121} These neighborhoods can be thought of as moderately sized bounded geographic areas where social dynamics contributing to violence is understood to be concentrated.^{11 49 220 221} In a recent review of implemented CBAs, Wolf-Powers discussed that a CBA is signed between local community

groups to provide benefits as part of a development.¹¹¹ Therefore, the CBA is expected to provide health benefits for the local neighborhood.

Place based initiatives are thought to operate through noticing that features of the environment, including deteriorated buildings are associated with higher rates of violence and negative social consequences.^{222 223} Specifically, developments are generally believed to harm neighborhoods by interfering with the neighborhood's social fabric through increased traffic, pollution, changing land values, and disruption in the neighborhood.¹⁰⁰⁻¹⁰² To increase benefits to local residents recent interest is concentrated around promoting stakeholder engagement through partnering a development with a CBA.^{111 113} As CBAs are increasingly applied, CBAs have evolved from an de novo approach (each agreement negotiated separately for each project) to an institutionalization and formalization of the process.²²⁴

To replace an aging sports and entertainment arena in the Hill District, a new sports and entertainment arena opened in August 2010.² In conjunction with the arena redevelopment, a CBA was signed between the Hill District community leaders and developers, including the City of Pittsburgh.⁵ The Hill District is a relatively well-organized neighborhood with strong community groups who have a long history of successfully engaging with Pittsburgh officials to improve neighborhood life.^{3 4} However, the neighborhood experiences limited access to services, high rates of poverty, and unemployment.⁷⁷ To bring benefits to the community, the CBA included legally-binding benefits for the Hill District.^{5 78} We analyzed the impact of the CBA and arena redevelopment in the Hill District over the time period 2005 to 2015, using the quasi-experimental difference-in-difference study design.²²⁵ We aimed to ascertain if the CBA implementation decreased violence when combined arena redevelopment in the Hill District yielding an

improvement in residents health compared to other neighborhoods in Pittsburgh during the same time period.

3.3 Methods

To examine the effect of the of the CBA and arena redevelopment on violence, we implemented a difference-in-difference quasi-experiment. We formed a causal estimate by comparing changes within the intervention group to the control group over the same time period. We included a set of potential confounders (both time invariant and time dependent) as both baseline covariates and time-varying covariates. In each census tract, we defined the outcome variable as cumulative incidence of aggravated assault or robbery by year.⁶ Aggravated assaults are occurrences by which an attacker causes serious bodily injury, and robbery includes attempts to take an object of value by threat of force.²¹⁷

3.3.1 Data Sources and Preparation

Police offence reports for 2005 to 2015, acquired from the Pittsburgh Bureau of Police, held address, offense type, date, and time for each instance of violence. Each offense data entry contained data regarding each single incident of crime even if multiple individuals were involved. Data was processed by using Esri's Streetmap engine and address database to geocode addresses to 2000 census tracts. Our primary outcome, counts of violence, were calculated yearly for each census tract by aggregating robbery and aggravated assault.

Social, demographic, and economic characteristics for the 141 Pittsburgh census tracts were acquired from the American Community Survey. The years before the implementation of the CBA were assigned to the 5-year estimate for the years 2005 to 2009. The years after the implementation of the CBA were assigned the 5-year estimate for the years 2010 to 2014. While the 2005 to 2009 ACS data and police data were based on 2000 census tract boundaries, the 2010 to 2014 5-year ACS data was based on meaningfully different 2010 census tract boundaries. To convert 2010 census tract boundaries to 2000 census tracts we selected the Longitudinal Tract Data Base (LTDB) Crosswalk files.²²⁶ These files use weights calculated from population concentration and land-area differences between 2000 and 2010 census tracts to generate 2000 estimates. Based on the differences between the two years, weights were calculated for changes within census tracts and consequently used to transform the data between the 2010 and 2000 census tracts.²²⁷ A detailed description of covariates (as listed in Table 3-1) as formed from the ACS variables is provided in the Section 3.6.

3.3.2 Natural Experiment

As defined by the 2000 census 141 census tracts compose the City of Pittsburgh. Our intervention neighborhood, the Hill District, contained six census tracts.⁸⁰ Pittsburgh neighborhoods are culturally defined with stable social and geographic boundaries formed by adjacent census tracts.

Construction of the arena started in August 2008 and concluded during August 2010. Since the CBA was implemented and arena opened in August 2010 the first year of the intervention was defined as 2011. To account for outlier years common in violence data, we used a time-series

consisting of 10 years.²²⁸ As the CBA was implemented and arena opened in 2011, the pre-intervention time was as 2005 to 2010 and the CBA period was 2011 to 2015.

We applied a difference-in-difference experimental design to test our hypothesis and estimate the impact on violence of the CBA and arena opening. To account for accurately measured and correctly modeled confounders, by using this framework, we formed a counterfactual through identification of a comparison group without the CBA. Suitability of the control was validated by examination of similarity of the pre-CBA time trends between the intervention and control neighborhoods. By evaluating differences in time trends, divergent social or economic processes could be identified and accounted for in the analysis.²²⁹ A plot of unadjusted time trends Figure 3-1 demonstrates suitable similarity of time trends between intervention and control neighborhoods.

3.3.3 Statistical Analysis

As shown in the results section, a plot of yearly counts of violence is displayed. For the CBA and control neighborhoods, the median, first and third quartiles were calculated of relevant social, demographic characteristics during the before and after time period. To model counts of violence, the units of observation were census tracts (n) per year of the study (t), we implemented a generalized linear mixed effects model (GLMM). As each model's outcome was counts of violence, Y_{nt} , we used the log link function with a poisson distribution in this GLMM.

$$\ln(Y_{nt}) = \beta_0 + \beta_1 * hill_n + \beta_2 * CBA_t + \beta_3 * hill_n * CBA_t + \beta_4 * year_t + \beta_5 * tractpop_{nt} + Z_{nt}b_n$$

Equation 3-1 Difference-in-Difference Model

As shown in Equation 3-1, the time-varying, indicator variable CBA was assigned 0 before 2011 and 1 after, while the indicator for *hill* was set to 1 for the Hill District census tracts and 0 in other Pittsburgh census tracts. The interaction term $hill_n * CBA_t$ parameterized the difference-in-difference term. The coefficient, β_3 , demonstrated the estimated overall effect of the intervention regarding violence and the incidence rate ratio is found by e^{β_3} .²³⁰ Each of the models included the indicator for the Hill District Neighborhood, the CBA before and after implementation, a yearly time term, and the census tract population, $tractpop_{nt}$, for each of the census tracts and changing by time period. The coefficient, b_n , represented each neighborhood random intercept term.

We fit all models in PROC GLIMMIX in the SAS System Version 9.4 (Carey, NC) for Windows.²³¹ Assessment of model fit occurred using Best Linear Unbiased Prediction (BLUP) plots. A random intercepts model was chosen after addition of random slopes for neighborhood and assessment did indicate improvement of model fit. Overdispersion, suspected from extreme variation in violence counts by census tracts, was evaluated first using Pearson statistics then (BLUP) plots.²³²

Covariate adjustment was accomplished by inclusion of principal components calculated from the 12 social, economic, and demographic characteristics obtained from the US Census. Principal components analysis (PCA) was selected based on number of covariates and high correlation between covariates.²³³ To ensure independence of components, we choose varimax, the orthogonal rotation.²³⁴ For proper weighting, census characteristics were re-scaled when needed. Score weights, w_j , were generated using PROC FACTOR in the SAS System Version 9.4 (Carey, NC) for Windows.²³⁵ Covariate adjustment was first taken from baseline or pre-intervention characteristics scores. Then, differences between the before and after intervention

scores were calculated to generate a second set of “difference” scores. Additional information regarding calculation and selection of PCA factors are contained within the Section 3.6.

3.4 Results

Table 3-1 displays descriptive statistics of neighborhood social, economic, and demographic characteristics. Before the CBA implementation, the Hill District varied from the other Pittsburgh neighborhood characteristics, most especially in terms of percent African American, single mothers, families with children, poverty level, employment, and homeowner occupied housing. The largest changes observed in the Hill District occurred in college graduates and median age. Striking changes in other Pittsburgh neighborhoods arose in median income, high school graduates, college graduates, population, vacancies, home-ownership, age, and employment.

**Table 3-1 Summary of Social, Economic, and Demographic Characteristics from the Implementation of the
CBA**

Covariate	Hill District		Outside Hill District	
	Before CBA	After CBA	Before CBA	After CBA
	Median (Q1,Q3) ^a	Median (Q1,Q3)	Median (Q1,Q3)	Median (Q1,Q3)
Tract Population	1721 (1203, 2048)	1728.8 (1175, 1929)	2121 (1404, 2872)	2073 (1350.9, 2897.6)
Income (\$)	13,306 (10,444, 20,951)	15,912 (12,096, 17,764)	35,642 (27,721, 45,284)	38,918 (30,484, 50,264)
Ratio Ages 15 to 24 vs. 29 to 44	1.16 (0.67, 2.02)	0.93 (0.81, 1.28)	0.60 (0.42, 0.92)	0.55 (0.36, 0.82)
Median Age	40.0 (25.5, 44.9)	34.3 (25.1, 41.8)	38.5 (32.9, 43.1)	36.7 (31.0, 40.4)
Male (%)	41.5 (35.7, 49)	39.2 (36.6, 44.5)	47.5 (43.5, 50.6)	48.0 (44.8, 51.1)
African American (%)	90.4 (79.4, 97.6)	83.5 (78.9, 90.8)	17.6 (4.9, 46.3)	16.1 (6.4, 48)
Female-Headed HH with Child (%)	77.7 (68.5, 94.3)	82.2 (81.2, 89.3)	38.6 (19.2, 64.5)	39.9 (19.1, 63.4)
Married Families with Child (%)	5.1 (0, 12.7)	8.1 (5.3, 16.9)	47.8 (24.9, 75.0)	47.1 (29.1, 67.0)
High School Grad (%)	82.1 (73.5, 90.1)	81.6 (79.5, 82.5)	88.0 (81.1, 91.6)	90.9 (87.1, 94.3)
College Grad (%)	19.3 (14.4, 25.9)	10.1 (5.5, 13.8)	21.7 (12.5, 43.0)	30.0 (15.7, 46.2)
Below Poverty Line (%)	46.2 (26.4, 48.2)	45.7 (32.5, 69.7)	20.0 (11.1, 33.4)	21.0 (13.7, 31.3)
Unemployed (%)	19.2 (15.7, 22.2)	21.9 (18.1, 38.5)	8.1 (4.8, 12.8)	8.5 (5.5, 13.1)
Homeowner Occupied Housing (%)	16.1 (5.5, 44.3)	16.4 (5.7, 27.3)	53.9 (37.2, 68.9)	51.4 (36.4, 61.6)
Vacant Properties (%)	18.4 (16.3, 25.7)	16.8 (12.0, 20.4)	14.6 (8.1, 24.5)	14.2 (9.0, 19.5)

Note: ^a Q1, Q3: 1st Quartile, 3rd Quartile

Graphical trends of Pittsburgh violence counts by year are visible in Figure 3-1. A distinct pattern of falling violence for the decade studied is noted.

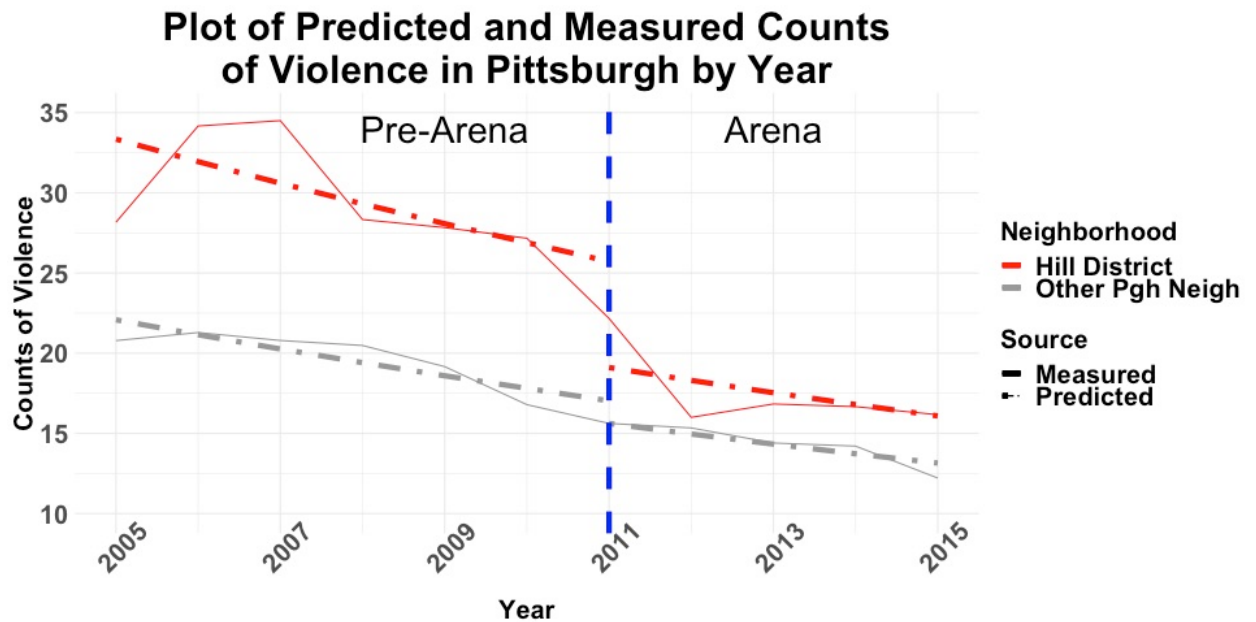


Figure 3-1 Measured and Predicted Counts of Violence in Pittsburgh for the Base Model

Note: Thin lines indicate aggregated mean measured counts of violence, and dashed lines represent model predicted counts of violence.

The Pearson statistic was calculated as 1.67 suggesting overdispersion, but after subsequent assessment from (BLUP) output overdispersion was not present. Note in Figure 3-1, reasonable model fit was concluded based on similarity between plots of predicted and measured counts of violence by year. In the base model (Table 3-2, top panel), violence within the Hill District was assessed to be 19% (IRR = 0.81; 95% CI: 0.73, 0.90; $p = 0.0002$) lower than expected without the implementation of CBA and arena opening. Violence in Pittsburgh estimated to decline by 4% per year during the included time period (Incidence Rate Ratio (IRR) = 0.96, 95% CI: 0.95, 0.97; $p < 0.0001$); after accounting for temporal trend, from 2005-2009 to 2010-2015 violence decreased by 9% (IRR = 0.91; 95% CI: 0.87, 0.96; $p = 0.0003$). Baseline neighborhood characteristics were added (Table 3-2, middle panel) to the model, and the estimated effect did not substantially change from the base model implying that these covariates are unlikely to be confounders. Neighborhood housing access was associated with lower violence, in contrast, negative structural factors

increased violence. When changes for neighborhood characteristics were included (Table 3-2, bottom panel); violence was 23% (IRR= 0.77; 95% CI: 0.69, 0.87; $p < 0.0001$) lower than would be assumed without the CBA and arena opening. Lowering of neighborhood SES and elevation of male proportion (gender) were associated with increased violence rates.

Table 3-2 Unadjusted and Adjusted Results of the Generalized Linear Mixed Effects Models

Covariate	Incidence Rate Ratios	95% Confidence Interval	p-value
Model 1: Base Model			
Year	0.96	0.95, 0.97	<0.0001
Hill District	2.05	0.96, 4.38	0.065
CBA	0.91	0.87, 0.96	0.0003
(CBA)*(Hill District)	0.81	0.73, 0.90	0.0002
Population (per 1,000)	1.02	0.97, 1.07	0.41
Model 2: Adjustment with Baseline Neighborhood Characteristics			
Year	0.96	0.95, 0.97	< 0.0001
Hill District	0.91	0.47, 1.78	0.80
CBA	0.91	0.87, 0.96	0.0003
(CBA)*(Hill District)	0.82	0.74, 0.91	0.0002
Population (per 1,000)	1.06	1.01, 1.12	0.022
Structural Factors	1.024	1.018, 1.031	< 0.0001
SES	1.000	0.988, 1.012	0.94
Housing Access	0.989	0.983, 0.995	0.0010
Gender	0.994	0.985, 1.003	0.18
Model 3: Adjustment for Differences in Neighborhood Characteristics			
Year	0.96	0.95, 0.97	< 0.0001
Hill District	2.03	0.95, 4.35	0.071
CBA	0.91	0.87, 0.96	0.0003
(CBA)*(Hill District)	0.77	0.69, 0.87	< 0.0001
Population (per 1,000)	1.01	0.95, 1.07	0.78
SES Difference	0.992	0.989, 0.995	< 0.0001
Families Difference	1.002	1.000, 1.004	0.11
Structural Factors Difference	1.001	0.998, 1.004	0.59
Age Difference	0.998	0.995, 1.001	0.14
Home-Owner Housing Difference	1.004	1.001, 1.007	0.013
Gender Difference	1.006	1.004, 1.009	< 0.0001

Note: Bold rows indicate the difference-in-difference effect estimate.

3.5 Discussion

Overall, violence fell by 29% over the study period, but no discernable difference was detected before the CBA and arena between the Hill District and other Pittsburgh neighborhoods. The implementation of a CBA and arena opening decreased the level of violence by 19% in communities most likely to be affected. Changes in neighborhood characteristics did not explain the effect of a CBA and arena on violence; therefore, the CBA and arena likely decreased levels of violence in the Hill District. By taking advantage of a natural experiment in Pittsburgh, our study is the first to examine the effect of a CBA on violence.

By suggesting violence was associated with a 19% decrease within the neighborhood than would be otherwise expected, a CBA appeared to provide a large benefit to the Hill District. Previous studies regarding the effect of CBAs on local communities are either case-series or case studies, but suggest CBAs are highly sensitive to neighborhood characteristics such as strong community groups.¹¹⁰⁻¹²¹ A model CBA implemented with an arena redevelopment in Los Angeles, strong community groups were regarded as essential in negotiating for relevant community benefits.¹¹¹ In a survey of participants regarding a CBA connected with a project in New York, the experience was mixed, and depended on stakeholder status. However, only one of the two CBAs Janssen-Jansen and van der Veen reviewed in New York was regarded as successful.

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We tested only a single CBA and by partnering the redevelopment with a CBA provided support positive effects were brought to neighborhood through use of a CBA.⁵ The legally binding

CBA for the Hill District benefits included the addition of a grocery store, a master plan for the neighborhood, and promoting of hiring within the neighborhood was expected to offset the arena redevelopment by increasing residential engagement and bring benefits to the neighborhood.⁸ In contrast to the Hill District CBA which contained clear benefits, many previous “less successful” CBAs contain small concessions and weak enforcement for any benefits.²²⁴

When compared to other Pittsburgh neighborhoods, the Hill District can be thought of as a community affected by institutional and structural factors that have contributed to long-standing inequalities in several economic factors including unemployment, underemployment, and poverty, along with social factors including lower home and land ownership. Previous neighborhood-level studies commonly show violence is related to the specific social and economic characteristics, also contributing to neighborhood’s residential instability.^{55 60 237} Violence appeared higher in the Hill District when compared to other Pittsburgh neighborhoods, but the difference was not statistically meaningful. Temporally in Pittsburgh, we established violence in all neighborhoods declined by 29% over the study period, and similarly, nationwide the overall violence rate reduced by 21% from 2005 to 2015.¹⁴

The Hill District is home to several strong community groups who have a history of effectively negotiating with local leaders to improve neighborhood life, which might suggest why the CBA was effective in reducing violence.^{3 4} In a qualitative review conducted by Wolf-Powers of 27 CBAs, the author summarized important neighborhood effects as: “[1] local politics of organized labor; [2] the accountability of the community benefits coalition to affected community residents; and most importantly, [3] the role of local government in negotiation and implementation”.¹¹¹ For the Hill District CBA, over 100 community organizations, unions, and others banded together to form a single group to sign the CBA ensuring strong community

representation and carefully selected benefits.⁷¹ These specific benefits were legally-enforced with Pittsburgh officials both in the negotiation and as a signatory to formalize the association between the city with meetable goals.⁵

In spite of the strengths of our design and analytical approach, our study possesses a few limitations. Previous research has identified only 58% of aggravated assaults and 61% of robberies were identified by police.¹³ This underreporting may vary by neighborhood or time, so the subset included in the analysis may be different than the data would suggest. Previous research on economic indicators proposes the effect of a the place-based intervention of an arena varies by time^{238 239}, and consequently a single estimate based on 5 years of data may provide an insufficient picture of the effect of the intervention. Within observational studies, there may be unmeasured confounding, but through usage of a difference-in-difference framework this confounding is controlled. The structure of the comparison group allows for controlling of many measured trends and biases. Since we only concentrate on a single community and time period, the results may be different areas or times as suggested by two studies taking advantage of economic indicators.¹⁵¹

¹⁵⁴ Since we choose to use a GLMM with a 0,1 fixed effect of CBA, each census tract was treated as if the effect of the CBA would only benefit the local community and not the surrounding areas.

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By indicating the addition of a CBA reduced violence, we provided support for the hypothesis that harms caused by developments can be ameliorated through communicating neighborhood needs to local leaders leading to improved neighborhood characteristics.⁹⁷ Findings suggest a CBA can improve a community, but since we are only examining the effect of a single CBA future work should determine how this result extends to other neighborhoods.

3.6 Supplemental Information

3.6.1 Supplemental Information Regarding the Methods Section

Listed below are information regarding dataset formation and implementation of the principal component analysis to form the principal components.

3.6.1.1 Additional Information Regarding Police Datasets

Information regarding homicides, robberies, aggravated assaults, and drug and weapons violations were provided by the Pittsburgh Police Department within offense, arrest (suspect), and victim files. Data elements within each file are contained within Table 3-3. To create counts of violence, information about violence incident and location was obtained from the offense file.

Table 3-3 Police Data Files Elements

Data Elements	Offense File	Arrest File	Victim File
CCR#	X	X	X
Date	X	X	
Time of Day	X	X	
Day of Week	X		
Status (Arrest, Cleared, Pending)	X		
Hierarchy Code	X	X	X
Offense Code	X	X	X
UCR Code	X	X	X
Address	X	X	
Census Tract	X	X	
Police Zone	X	X	
Weapon	X		
Gang	X		
Age		X	X
Race		X	X
Sex		X	X

3.6.1.2 Definition of the Hill District Neighborhood

The year 2000 census defined 141 census tracts within the City of Pittsburgh, then used to form the city neighborhoods. The Hill District, in terms of area names (census tracts) are: Terrace Village (510, 511), Upper Hill (506), Bedford Dwellings (509), Crawford Roberts (305), and Middle Hill (501). As the location of the arena and parties to the CBA, the intervention was expected to affect residents of the Hill District directly.^{78 80}

3.6.1.3 Detailed Description of Covariates

From the American Community Survey, we gathered information regarding formation of the 12 socio-demographic characteristics. The number of residents within a census tract is defined as tract population and unless otherwise noted each of the following variables the percentage was identified within each census tract. The racial composition within census tracts included those who identified as African American or black. Economic measures were median incomes, those unemployed in terms of individuals in the labor force, and percent below poverty line evaluated by those in the labor force. Educational attainment included those who had graduated college in terms of those 25 or over who completed a bachelor or higher degree and high school graduate were those who had attained a high school or higher education. Family structure, percentage of married families with child and female-headed households with child, was assigned in terms of families with children under 18 years. Housing status for each census tract included home-owner occupied housing as defined relative to all types housing occupied types and vacant properties in terms of occupied and unoccupied housing units.

3.6.2 Supplemental Information on Formation of Principal Components

As reviewed in the manuscript, Principal Components Analysis was chosen due to high correlation among covariates.²³³ Two sets of weights were calculated based on assessment of either pre-intervention covariates or changes in covariates. Baseline weights were calculated from pre-intervention characteristics, and a second set of difference weights were composed by differencing the pre-intervention time period covariates from the post-intervention. As shown in Equation 3-2, the difference score was calculated as time-varying and assigned a 0 before the intervention and a weighted average change after.

$$PrincipalComp_{n,t} = \begin{cases} 0, & CBA = 0 \\ \sum_{j=1}^{12} w_j * (char_{af} - char_{bf})_n, & CBA = 1 \end{cases}$$

Equation 3-2 Time-Varying Principal Components

Final selection criteria of principal components included selection based on at least 70% of the variance explained and breaks in the scree plot.^{240 241}

3.6.3 Supplemental Information on the Results Section

The results section below lists p-values for the descriptive statistics then shows results as the model is built.

3.6.3.1 Additional Information Regarding Descriptive Statistics

Table 3-4 displays the descriptive statistics for socio-demographic characteristics and the Wilcoxon Rank Sum Tests to test the difference between baseline medians of demographic characteristics for intervention and control neighborhoods. Before the CBA was implemented, characteristics of the Hill District neighborhood differ from other Pittsburgh neighborhoods, most notably in terms of median income ($p = 0.0013$), percent African American ($p < 0.0001$), single mothers ($p = 0.0042$), families with children ($p = 0.0042$), poverty level ($p = 0.0079$), employment ($p = 0.0059$), and homeowner occupied housing ($p = 0.024$).

Table 3-4 Supplemental Summary of Social, Economic, and Demographic Characteristics Pre-Intervention

Covariate	Hill District	Outside Hill District	p-value*
	Median (Q1,Q3)	Median (Q1,Q3)	
Tract Population	1721 (1203, 2048)	2121 (1404, 2872)	0.25
Median Income (\$)	13,306 (10,444, 20,951)	35,642 (27,721, 45,284)	0.0013
Ratio Ages 15 to 24 vs. 29 to 44	1.16 (0.67, 2.02)	0.60 (0.42, 0.92)	0.057
Median Age	40.0 (25.5, 44.9)	38.5 (32.9, 43.1)	0.98
Male (%)	41.5 (35.7, 49.0)	47.5 (43.5, 50.6)	0.14
African American (%)	90.4 (79.4, 97.6)	17.6 (4.9, 46.3)	<0.0001
Female-Headed HH with Child (%)	77.7 (68.5, 94.3)	38.6 (19.2, 64.5)	0.0042
Married Families with Child (%)	5.1 (0, 12.7)	47.8 (24.9, 75.0)	0.001
High School Graduate (%)	82.1 (73.5, 90.1)	88.0 (81.1, 91.6)	0.26
College Graduate (%)	19.3 (14.4, 25.9)	21.7 (12.5, 43.0)	0.71
Below Poverty Line (%)	46.2 (26.4, 48.2)	20.0 (11.1, 33.4)	0.0079
Unemployed (%)	19.2 (15.7, 22.2)	8.1 (4.8, 12.8)	0.0059
Homeowner Occupied Housing (%)	16.1 (5.5, 44.3)	53.9 (37.2, 68.9)	0.024
Vacant Properties (%)	18.4 (16.3, 25.7)	14.6 (8.1, 24.5)	0.43

Note: *Notable differences between medians shown using Wilcoxon Rank Sum Test.

^a Q1, Q3: 1st Quartile, 3rd Quartile

Descriptive statistics, as displayed in Table 3-5, represents the differences between the before CBA time period from 2005 to 2010 and post CBA from 2011 to 2015. Formal test of differences between the two time periods were tested based using the Signed Rank Test. The largest changes observed in the Hill District occurred in college graduates ($p = 0.063$) and median age ($p = 0.063$). Notable changes in other Pittsburgh neighborhoods occurred in tract population ($p = 0.015$), median incomes ($p < 0.0001$), high school graduates ($p < 0.0001$), college graduates ($p < 0.0001$), median age ($p = 0.0001$), employment ($p = 0.048$), home-ownership ($p = 0.0003$), and vacancies ($p = 0.0398$). The p-values presented in this table for North Side may not be meaningful at the 0.05 significance level but are presented for completeness due to the few census tracts combined with the large variances. The Hill District is defined by only 6 census tracts, and these tracts contain dramatically different characteristics.

3.6.3.2 Additional Information on Principal Components

Four factors were chosen based upon 74% of the variance explained for the baseline characteristics. When the difference PCA factors were chosen 79% of the variance was accounted for in six factors. Names were derived based on names of covariates who possessed loadings over 50 or less than -50.²⁴²

Loadings as shown in Table 3-6, were used to create names for the four baseline factors. The structural factors score was named from covariates than can identify community political resources and socio-economic conditions: college graduate, African American, female-headed household with child, vacant properties, and married families with child.²⁴³ Socio-economic score combines prestige-based and resource-based measures: college graduate, high school graduate, below poverty line, and unemployed.²⁴⁴⁻²⁴⁶ Housing access consists of important demographic

and economic factors related to housing: Ratio Ages 15 to 24 vs. 29 to 44, median age, below poverty line, and home-owner occupied housing.^{247 248}

Names for the difference factors are assessed using the following criteria and following the loadings are listed in Table 3-7. The socio-economic difference score comprises of college graduate, ratio ages 1 to 24 vs. 29 to 44, high school graduate, below poverty line, and unemployed.²⁴⁴⁻²⁴⁶ Families difference score include female-headed families with child and married families with child. The structural factors difference score highlights political resources and socio-economic conditions which includes vacant properties, ratio ages 15 to 24 vs. 29 to 44, and African American.²⁴³ Gender difference, median age difference, and home-owner housing difference scores were each dominated by a single factor.

3.6.3.3 Information on Interpretation of Time and Building of Generalized Linear Mixed Effects Model

Table 3-8 presents the univariate model, the addition of the difference-in-difference estimator, and the addition of linear year. In the univariate model (top panel), violence decreased by 29% over the study period (IRR: 0.71; 95% CI: 0.69, 0.73; $p < 0.0001$). Although the estimated incidence rate of violence was 92% higher (IRR: 1.92; 95% CI 0.90, 4.08; $p=0.094$) in the Hill District compared to other Pittsburgh neighborhoods, violence rates were not significantly different between the two neighborhoods. When the difference-in-difference estimator was added to the model (Table 3-8, middle panel), violence in the Hill District was associated with a 19% decrease than would be expected if the Arena had not opened and operated (IRR= 0.81 95% CI: 0.73, 0.90; $p = 0.0002$). When yearly time was added to the model (Table 3-8, bottom panel), the estimated effect of the arena on violence did not appreciably change from the model in the middle panel.

Table 3-5 Supplemental Summary of Social, Economic, and Demographic Characteristics From the Implementation of the CBA

Covariate	Hill District			Outside Hill District		
	Before CBA	After CBA	p-value*	Before CBA	After CBA	p-value
	Median (Q1,Q3)	Median (Q1,Q3)		Median (Q1,Q3)	Median (Q1,Q3)	
Tract Population	1721 (1203, 2048)	1728.8 (1175, 1929)	0.84	2121 (1404, 2872)	2073 (1350.9, 2897.6)	0.015
Median Income (\$)	13,306 (10,444, 20,951)	15,912 (12,096, 17,764)	0.84	35,642 (27,721, 45,284)	38,918 (30,484, 50,264)	<0.0001
Ratio Ages 15 to 24 vs. 29 to 44	1.16 (0.67, 2.02)	0.93 (0.81, 1.28)	0.44	0.60 (0.42, 0.92)	0.55 (0.36, 0.82)	0.16
Median Age	40.0 (25.5, 44.9)	34.3 (25.1, 41.8)	0.063	38.5 (32.9, 43.1)	36.7 (31.0, 40.4)	0.0001
Male (%)	41.5 (35.7, 49.0)	39.2 (36.6, 44.5)	>0.99	47.5 (43.5, 50.6)	48 (44.8, 51.1)	0.095
African American (%)	90.4 (79.4, 97.6)	83.5 (78.9, 90.8)	0.22	17.6 (4.9, 46.3)	16.1 (6.4, 48)	0.62
Female-Headed HH with Child (%)	77.7 (68.5, 94.3)	82.2 (81.2, 89.3)	0.69	38.6 (19.2, 64.5)	39.9 (19.1, 63.4)	0.77
Married Families with Child (%)	5.1 (0, 12.7)	8.1 (5.3, 16.9)	0.84	47.8 (24.9, 75.0)	47.1 (29.1, 67.0)	0.62
High School Grad (%)	82.1 (73.5, 90.1)	81.6 (79.5, 82.5)	>0.99	88.0 (81.1, 91.6)	90.9 (87.1, 94.3)	<0.0001
College Grad (%)	19.3 (14.4, 25.9)	10.1 (5.5, 13.8)	0.063	21.7 (12.5, 43.0)	30.0 (15.7, 46.2)	<0.0001
Below Poverty Line (%)	46.2 (26.4, 48.2)	45.7 (32.5, 69.7)	0.16	20.0 (11.1, 33.4)	21.0 (13.7, 31.3)	0.17
Unemployed (%)	19.2 (15.7, 22.2)	21.9 (18.1, 38.5)	0.22	8.1 (4.8, 12.8)	8.5 (5.5, 13.1)	0.048
Homeowner Occupied Housing (%)	16.1 (5.5, 44.3)	16.4 (5.7, 27.3)	0.84	53.9 (37.2, 68.9)	51.4 (36.4, 61.6)	0.0003
Vacant Properties (%)	18.4 (16.3, 25.7)	16.8 (12.0, 20.4)	0.56	14.6 (8.1, 24.5)	14.2 (9.0, 19.5)	0.040

Note:

*Signed Rank Test used for notable differences between medians from the implementation of the CBA.

^a Q1, Q3: 1st Quartile, 3rd Quartile

Table 3-6 Baseline Principal Components Analysis Loadings

Covariate	Principal Components Names			
	Structural Factors	SES	Housing Access	Gender
College Grad (%)	-51	62	-35	5
Ratio Ages 15 to 24 vs. 29 to 44	-17	-47	-60	-25
Male (%)	-17	4	-1	91
African American (%)	78	-17	-14	-23
Female-Headed HH with Child (%)	75	-36	-13	-20
High School Grad (%)	-18	88	6	6
Median Age	1	11	84	-15
Vacant Properties (%)	80	-4	-3	26
Below Poverty Line (%)	41	-52	-62	2
Unemployed (%)	26	-72	-37	4
Homeowner-Occupied Housing (%)	-34	-11	68	13
Married Families with Child (%)	-77	25	13	29

Note: Covariates with loadings either greater than 50 or less than -50 were used to name the factors and are indicated by bolding.

Table 3-7 Differences Principal Components Analysis Loadings

Covariate	Principal Components Names					
	SES Difference	Families Difference	Structural Factors Difference	Age Difference	Home- Owner Housing Difference	Gender Difference
College Grad (%)	80	-14	-32	-19	-2	15
Ratio Ages 15 to 24 vs. 29 to 44	-51	-18	-56	-20	37	3
Male (%)	-7	12	6	4	-5	94
African American (%)	-5	-19	74	3	-6	-7
Female-Headed HH with Child (%)	-23	-86	17	-7	1	-17
High School Grad (%)	76	15	31	3	8	-9
Median Age	12	-1	-5	92	7	4
Vacant Properties (%)	13	-6	67	-24	21	26
Below Poverty Line (%)	-67	-15	4	-42	-24	3
Unemployed (%)	-72	-26	-15	-22	-16	14
Homeowner-Occupied Housing (%)	19	10	3	11	93	-5
Married Families with Child (%)	4	94	-5	-3	10	-1

Note: Bolded values are determined based on loadings less than -50 or greater than 50 and were used to create names for the principal components.

Table 3-8 Supplemental Generalized Linear Mixed Effects Models from Univariate Model

Covariate	Incidence Rate Ratios	95% Confidence Interval	p-value
Model 1: Univariate Model			
Hill District	1.92	0.90, 4.08	0.094
CBA	0.71	0.69, 0.73	<0.0001
Population (per 1,000)	1.03	0.98, 1.08	0.30
Model 2: Addition of Difference-In-Difference Estimator			
Hill District	2.05	0.96, 4.38	0.065
CBA	0.72	0.70, 0.74	<0.0001
(CBA)*(Hill District)	0.81	0.73, 0.90	0.0002
Population (per 1,000)	1.02	0.97, 1.07	0.41
Model 3: Addition of Year (Base Model)			
Year	0.96	0.95, 0.97	<0.0001
Hill District	2.05	0.96, 4.38	0.065
Arena Open	0.91	0.87, 0.96	0.0003
(CBA)*(Hill District)	0.81	0.73, 0.90	0.0002
Population (per 1,000)	1.02	0.97, 1.07	0.41

4.0 Manuscript 2: The Effect of a Casino on Violence: Gambling with a Neighborhood's Future

4.1 Abstract

Background: In 2017, a total of 460 commercial casinos and 508 tribal casinos operated in the United States; and from 2006 to 2016, the number of commercial casinos increased by 3.7%. Little evidence exists regarding the effects of casinos on neighborhood social environment. We examined the association between violence and the opening of a casino in the North Side in Pittsburgh, PA.

Methods Using a difference-in-difference study design, we generated a causal estimate of the change in violence associated with the opening of the casino in 2010. Violence data were acquired from the Pittsburgh Police for the years 2005 to 2015. Demographic, social and economic covariates were acquired from the 5-year averages of the 2005 to 2009 and 2010 to 2014 American Community Survey. A generalized linear mixed effects model was created to adjust for confounding.

Results: From 2005-2009 to 2010-2015, overall, violence declined by 29% in Pittsburgh. However, violence in the casino neighborhood was 19% higher after the casino opened than would be expected if the casino had not opened and operated. After accounting for demographic, social and economic changes, the effect of the casino on violence was significant (Incidence Rate Ratio (IRR)=1.21; 95% CI: 1.11, 1.32).

Conclusion: This study demonstrates that the development of a casino in a neighborhood may increase the level of violence in the surrounding communities.

4.2 Introduction

In 2017, 460 commercial casinos and 508 tribal casinos operated in the US, and from 2006 to 2016 commercial casinos increased by 3.7%.²⁴⁹ A number of previous studies have investigated the effect of casinos on violence^{91 123-138}; but these studies are limited by inadequate comparison groups, large geographic areas, and use of short time-series. In 2017, 382.9 per 100,000 people were a victim of violence, and for 2010 more than \$20 billion in total, or \$149,281 per victim, was spent for hospitalizations related to assault.^{15 217} Following a 48% decline in levels of violence since 1990 (729.6 per 100,000 people), recent data suggests violence increased by 1% in the past five years (in 2013: 379.1 per 100,000 individuals and in 2017: 382.9 per 100,000 individuals).²¹⁷ As violence continues to be one of the leading public health problems in the United States (US), increased importance is placed on understanding how businesses within neighborhoods contribute to violence.²¹⁹

Researchers have long noticed violence trends vary considerably by geographic area, and the social dynamics increasing the risk of violence is commonly understood to operate at moderately-sized bounded geographic areas such as neighborhoods.⁴⁹ Previous observational research consistently recognizes neighborhood-level characteristics like socio-economic status and high commercial activity are associated with violence.^{250 251} A focus on geographic or location-based factors regarding violence has led to an increase in place-based violence prevention approaches.²¹⁹ Place-based initiatives are approaches designed to improve health within geographic locations where collaboration of community members, businesses, institutions, and relevant stakeholders is encouraged.²¹⁹ Place-based initiatives affect the area to change norms and values within neighborhoods by serving as a gathering place or attracting new businesses.²⁵² Following this research, developers often propose the development of casinos to residents by

focusing on the possibility of public health improvement through stimulation of the neighborhood economy, including employment or wage growth.²⁵³ Casinos are thought to reduce violence by increasing protective neighborhood characteristics including higher employment and wages for residents, tax revenues to be used for the neighborhood, and economic growth.²⁵⁴

In August 2009, a new casino opened in the North Side, a well-defined neighborhood in Pittsburgh, Pennsylvania.⁶ The North Side is a diverse area with thriving communities but relatively high unemployment and poverty, and high rates of violence and segregation.⁷ The aim of this study was to determine whether neighborhood-level violence in the North Side increased from before to after the casino opening as compared with changes in violence over the same time period in other city neighborhoods.

4.3 Methods

We used a quasi-experimental difference-in-difference study design to analyze the impact of the casino on violence over the time period of 2005 to 2015.²²⁵ This method simulates an experimental research design by comparing the change in violence over time in the treated group compared with the control group to generate a causal estimate. To control for biases due to secular trends and confounding, it assumes that the differences between the groups would have remained constant under no treatment. Our primary outcome was yearly counts of violence defined as either aggravated assault or robbery within each neighborhood.⁶

4.3.1 Data Sources and Preparation

Data from police offense reports containing offense type, address, date and time were provided by the Pittsburgh Bureau of Police for 2005 through 2015. The police file contains information about each incident of violence including location and violence type, from which information on incidents of aggravated assault and robberies were extracted. Aggravated assault includes incidents of serious bodily injury by an attacker, and robbery indicates attempt to take object of value by force.²¹⁷ Incidents were coded for each instance of violence; if multiple individuals were involved, a single incident was recorded. Data was processed by mapping the location of incidents to 2000 census tracts through geocoding of the addresses using ArcGIS Esri's Streetmap geocoding engine and address database.²⁵⁵ Counts of violence were calculated by aggregating incidents by census tract and year.

Socio-demographic characteristics were calculated for each census tract within Pittsburgh from the US Census American Community Survey. The ACS 5-year average estimate for the years 2005 to 2009 was used for the years before the casino was built, and the 5-year average ACS estimate for the years 2010 to 2014 was assigned to after. The 2005 and 2009 census and police data were based on 2000 census tracts and the 2010 to 2014 ACS estimates were based on 2010 census tracts. The 2010 census tracts were converted to 2000 census tracts using the Longitudinal Tract Data Base (LTDB) Crosswalk files.²²⁶ The LTDB crosswalk files estimate the 2000 census values by weighting the values based on land-area and population concentration differences between the two years. Weights were calculated for census tracts changes and then used to transform the data between the 2010 and 2000 census tracts.²²⁷ A detailed description of covariate (as listed in Table 4-1) formation from the ACS variables is provided in Section 4.6.

Table 4-1 Summary of Social, Economic, and Demographic Characteristics Before and After Opening and Operation of the Casino

Covariate	North Side (N=10)		Outside North Side (N=131)	
	Before Casino Median (Q1,Q3) ^a	After Casino Median (Q1,Q3)	Before Casino Median (Q1,Q3)	After Casino Median (Q1,Q3)
Tract Population	1059 (239, 2068)	1189.3 (491.5, 1807.8)	2133 (1457, 2907)	2076.7 (1422.7, 2897.8)
Income (\$)	32,900 (28,172, 37,057)	32,009 (25,777, 37,272)	35,347 (25,580, 45,282)	38,918 (29,731, 50,388)
Ratio Ages 15 to 24 vs. 29 to 44	0.57 (0.38, 0.89)	0.33 (0.25, 0.55)	0.62 (0.43, 0.95)	0.60 (0.38, 0.84)
Median Age	39.3 (30.2, 43.0)	39.3 (31.0, 40.3)	38.3 (32.9, 43.2)	36.5 (31.0, 40.8)
Male (%)	49.4 (46.7, 54.6)	51.3 (45.6, 52.0)	47.4 (43.4, 50.5)	47.8 (44.4, 50.2)
African American (%)	30.3 (22.2, 66.2)	31.9 (26.3, 70.7)	17.6 (4.9, 51.8)	15.1 (6.2, 48.6)
Female-Headed HH with Child (%)	62.8 (49.7, 77.8)	50.0 (33.0, 77.3)	38.6 (20.0, 64.6)	40.5 (18.9, 63.9)
Married Families with Child (%)	19.3 (0, 44.0)	50.0 (16.7, 57.6)	48.3 (24.4, 75.6)	46.2 (26.7, 69.2)
High School Graduate (%)	87.6 (82.6, 91.1)	88.7 (82.7, 92.5)	88.0 (80.8, 91.6)	90.9 (86.7, 94.3)
College Graduate (%)	22.9 (16.3, 39.6)	33.0 (29.8, 46.2)	21.7 (12.5, 42.1)	27.7 (14.5, 45.5)
Below Poverty Line (%)	22.3 (18.9, 34.0)	32.3 (21.7, 38.4)	20.1 (11.2, 33.7)	20.7 (13.7, 31.3)
Unemployed (%)	11.6 (8.1, 21.8)	8.2 (7.8, 13.0)	8.1 (4.8, 13.1)	8.9 (5.6, 15.1)
Homeowner Occupied Housing (%)	38.8 (10.1, 55.7)	34.1 (29.3, 52.8)	53.9 (37.2, 71.9)	51.4 (36.0, 62.3)
Vacant Properties (%)	27.8 (20.4, 33.8)	25.6 (21.9, 28.8)	13.7 (8.1, 23.0)	13.5 (8.8, 18.7)

Note: ^a Q1, Q3: 1st Quartile, 3rd Quartile

4.3.2 Experimental Design

The City of Pittsburgh includes 141 census tracts as outlined in the 2000 census. Pittsburgh neighborhoods are culturally defined neighborhoods with stable social and geographic boundaries. The North Side, consisting of 10 census tracts, is the location of the casino and is defined as the intervention neighborhood for this analysis.⁸⁰

Construction of the casino started in December 2007 and ended in August 2009. We defined the first year of the intervention period as 2010 – the first full calendar year after the casino opened.²²⁸

4.3.3 Statistical Analysis

We calculated the median, first and third quartiles of relevant socio-demographic characteristics during each time period for the intervention and control neighborhoods. Counts of violence were plotted by year. A generalized linear mixed effects model (GLMM) was used to model counts of violence where the units of observation were census tracts (n) per year of the study (t). The outcome of each model was the count of violence, Y_{nt} , and the log link function was used to create a Poisson GLMM. The basic difference-in-difference model is represented by Equation 4-1.

$$\ln(Y_{nt}) = \beta_0 + \beta_1 northside_n + \beta_2 casinoOp_t + \beta_3 northside_n * casinoOp_t + \beta_4 year_t \\ + \beta_5 tractpop_{nt} + Z_{nt}b_n$$

Equation 4-1 Difference-in-Difference Model

In Equation 4-1, *northside* was an indicator variable set to 1 for the census tracts in the North Side and 0 for the other Pittsburgh census tracts. *CasinoOp* was a time-varying indicator variable set to 0 in the pre-casino time-period and 1 in the post-casino time period. The difference-in-difference term was defined as the interaction between the North Side indicator and the post-casino indicator. The β_3 coefficient represented the estimated population effect of the intervention on violence and e^{β_3} is the corresponding incidence rate ratio.²³⁰ The models also included time

defined by year, and census tract population, $tractpop_{nt}$, that changed with the time period. A random intercept term for each neighborhood was included and represented by b_n .

PROC GLIMMIX in the SAS System Version 9.4 (Carey, NC) for Windows was used for analyses.²³¹ Overall model fit was assessed using graphical output of Best Linear Unbiased Prediction (BLUP) plots. Random slopes for neighborhood were added and assessed, but model fit did not improve so a random intercepts model was used. Overdispersion, common in police data from the extreme differences in values between census tracts was assessed by using Pearson Statistics and (BLUP) output.²³²

Adjustment for covariates was performed by adding principal components analysis (PCA) scores calculated from 12 socio-demographic characteristics from the Census. PCA was used due to the large number of covariates and the high level of correlation among covariates.²³³ The orthogonal rotation, varimax was selected so resulting components are independent from each other and easily interpreted.²³⁴ Demographic characteristics were re-scaled as necessary to ensure proper weighting. Weights for scores, w_j , were calculated using PROC FACTOR within SAS software.²³⁵ We adjusted for these covariates in two different ways. Baseline scores were calculated based on socio-demographic characteristics before the intervention. A second set of difference weights were calculated by subtracting the pre-intervention values from the current values. Further details on the PCA process are in Section 4.6.

4.4 Results

Descriptive statistics for socio-demographic characteristics are shown in Table 4-1, and formal tests regarding the differences between neighborhoods and time periods are presented in

Section 4.6. Before the casino opened, characteristics of the North Side neighborhood differ from characteristics in the other Pittsburgh neighborhoods, most notably in terms of families with children, tract population, home ownership, and vacancies. The largest changes observed in the North Side occurred in families with children. Notable changes in other Pittsburgh neighborhoods occurred in incomes, high school graduates, college graduates, population, age, employment, home ownership, and vacancies. Graphical trends for counts of violence in Pittsburgh are shown in Figure 4-1. A clear pattern of decreasing violence over the decade studied is observed.

Table 4-2 Base and Adjusted Results of the Generalized Mixed Effects Models

Covariate	Incidence Rate Ratios	95% Confidence Interval	p-value
Model 1: Base Model			
Year	0.96	0.95, 0.97	<0.0001
North Side	1.43	0.79, 2.61	0.24
Casino Open	0.88	0.84, 0.92	<0.0001
(Casino Open)*(North Side)	1.19	1.09, 1.29	0.0001
Population (per 1,000)	1.02	0.97, 1.07	0.53
Model 2: Adjustment with Baseline Neighborhood Characteristics			
Year	0.96	0.95, 0.97	<0.0001
North Side	1.02	0.61, 1.71	0.93
Casino Open	0.88	0.84, 0.92	<0.0001
(Casino Open)*(North Side)	1.19	1.09, 1.29	<0.0001
Population (per 1,000)	1.05	1.00, 1.10	0.044
Structural Factors	1.024	1.018, 1.031	<0.0001
SES	1.001	0.989, 1.013	0.87
Housing Access	0.990	0.984, 0.996	0.0015
Gender	0.994	0.985, 1.003	0.19
Model 3: Adjustment for Differences in Neighborhood Characteristics			
Year	0.96	0.95, 0.97	<0.0001
North Side	1.42	0.78, 2.6	0.26
Casino Open	0.88	0.84, 0.92	<0.0001
(Casino Open)*(North Side)	1.21	1.11, 1.32	<0.0001
Population (per 1,000)	1.00	0.95, 1.06	0.88
SES Difference	0.994	0.991, 0.997	<0.0001
Families Difference	1.001	0.999, 1.003	0.44
Structural Factors Difference	1.002	0.999, 1.005	0.18
Age Difference	0.997	0.994, 1.000	0.026
Home-Owner Housing Difference	1.004	1.001, 1.007	0.0069
Gender Difference	1.006	1.004, 1.008	<0.0001

The Pearson statistic was 1.61 indicating possible overdispersion, but assessment of the BLUPs indicated that overdispersion did not need to be accounted for in our model. Figure 4-1

plotted mean predicted and measured counts of violence per year for both the North Side and the rest of Pittsburgh. Figure 4-1 indicated that the model demonstrated reasonable fit to the data. In the base model (Table 4-2, top panel), violence declined by 12% from 2005-2009 to 2010-2015 (IRR= 0.88; 95% CI: 0.84, 0.92; $p < 0.0001$); accounting for that temporal trend, violence throughout Pittsburgh decreased by an estimated 4% per year over the study time period (IRR= 0.96; 95% CI: 0.95, 0.97; $p < 0.0001$). In the same model, violence in the North Side was estimated to be 19% higher than would be expected if the Casino had not opened and operated (IRR= 1.19; 95% CI: 1.09, 1.29; $p = 0.0001$). When baseline neighborhood characteristics were added to the model (Table 4-2, middle panel), the estimated effect of the casino on violence did not appreciably change from the base model; this confirmed that the difference-in-difference model appropriately accounted for baseline differences between the neighborhoods. At the neighborhood-level negative structural factors was associated with higher violence rates, and housing access was associated with lower violence (Table 4-2, middle panel). In the model adjusted for changes in neighborhood characteristics over time (Table 4-2, bottom panel), violence in the North Side was 21% higher than would be expected (IRR: 1.21; 95% CI: 1.11, 1.32; $p < 0.0001$) if the casino had not opened and operated. At the neighborhood-level a decrease in SES and age, along with an increase in home ownership and male proportion (gender) were associated with a higher violence rate.

4.5 Discussion

Our difference-in-difference analyses showed that violence was 19% higher in the North Side after the casino opened than would be expected without the casino. Changes in neighborhood

characteristics did not explain the effect of a casino on violence. The current evidence regarding the effect of casinos on violence is inconsistent.^{91 123-138} Broadly, previous studies are limited by 1) large experimental geographic areas used, 2) lack of a concurrent comparison group, and 3) inadequate time to account for outliers within the overall trend. Our study improves upon previous designs^{91 123-138} by applying a difference-in-difference framework to include neighborhoods as geographic areas, a concurrent comparison group, and long pre- and post-intervention time-series.

Place-based crime interactions tend to occur on the scale of smaller geographic areas, like neighborhoods.²⁵⁶ An advantage of Pittsburgh, is neighborhoods are relatively independent geographically and are characterized by unique subcultures.⁷⁷ Since violence varies by geographic size, usage of large geographic areas inconsistently measures the effect of violence and may mask the true effect of the casino.¹⁷⁰ For instance, in a series of studies using counties, a rather large georgic area, within New Mexico and in Michigan the opening of casinos was not associated with violence.^{123 129 130}

Many previous studies are limited by identification of a control, so we took advantage of a difference-in-difference experiment to account for confounders by inclusion of a counterfactual, in our case Pittsburgh neighborhoods.²⁵⁷ While Honore et al. matched on racial characteristics to find no association¹²⁷ Stitt et al. examined the effect of casinos on violence in six communities after the introduction of casinos to six control communities matched on socioeconomic variables, and in some locations violence rates increased while in others rates decreased or no significant differences were present.¹⁹⁵ The variation in results and deviance in results from ours may be from ambiguity which characteristics are important for matching.¹²⁸ This is collaborated by a study that compared two separate city-type controls, and showed violence rates were not different when

casino-cities were compared to tourist cities, but rates were higher when compared to non-tourist cities.¹³⁷

Our results were similar to a number of studies that used a single area as a comparison group suggesting violence increased. Three studies examined the effect of the building casinos in Atlantic City starting in 1972, and result was repeated by Kim et al. in Las Vegas.^{131 134 135 138} Chang used Biloxi, Mississippi, and while assault was not associated, robbery increased.¹³⁶ Similarly, we use a single city for our analysis, and neighborhoods in Pittsburgh as a control, so city effects are controlled for and any matching is unnecessary.²⁵⁸

We include five-years of data after the casino opened, as when only a single year is used results may be from factors, such as increased policing, not present in other years.^{126 132} In studies using data from Biloxi, Mississippi, cities in Indiana, and neighborhood-level geographic areas in Philadelphia violence did not increase. These results do not corroborate ours, but these studies were based on only one year of data after the casino opened.¹²⁴⁻¹²⁶ Grinols and Mustard tested US county-level data from 1977 to 1996 to show effect on crime was low shortly after the casino opened and grew over time.¹³² These suggest the effect of a casino varies by time, and by inclusion of a long time-series we captured the mean effect over several years of data.

Despite the many strengths of the design and analytical approach, this study has some limitations. It has been shown that only 61% of robberies and 58% of aggravated assaults were reported to police.¹³ It is possible that underreporting of violent events differentially varies by neighborhood or time period. By only including a subset of crime, incidents included in the analysis could be different from those in data. There may always be unmeasured confounding within observational studies, but by using a difference-in-difference framework minimizes this confounding by using a comparison group to account for trends and biases. The effect of a casino

may vary by time,¹⁴¹ and thus a single estimate based on 5 years of data may provide an incomplete picture of the consequences of opening a casino. A certain amount of selection bias may occur as the intervention is implemented in a neighborhood with struggling communities. The effect of violence can leak outside of the geographic area into surrounding areas, and by using a GLMM in our analysis each census tract was treated as an independent unit.²²⁸

Our findings suggest placement of a casino may increase neighborhood-level violence, so distressed neighborhoods may not be boosted from the development. Future studies should examine if neighborhoods can be protected against the negative impacts of casinos by modifying features of the casinos themselves.

4.5.1 What is already known on this subject

Casinos are often sold as an initiative that can improve neighborhood health and economic factors. In 2017, a total of 460 commercial casinos and 508 tribal casinos operated in the US, and from 2006 to 2016 commercial casinos increased by 3.7%.²⁴⁹ Following a 48% decline in levels of violence since 1990, recent data suggests violence increased by 1% in the past five years.²¹⁷ Previous observational research consistently recognizes neighborhood-level characteristics like socio-economic status and high commercial activity are associated with violence.^{250 251} Few studies have examined the link between casinos and neighborhood violence, and those that do tended to have varying results.

4.5.2 What we add to the literature

This is the first study to use smaller geographic areas to test changes in neighborhood-level violence rates using a longer time period of data. This study highlights the complexity of using natural experiments by applying a difference-in-difference framework to the introduction of a casino in Pittsburgh, PA. For instance, changes within the City of Pittsburgh over the study period led to use of time-varying socio-demographic characteristics within each neighborhood.

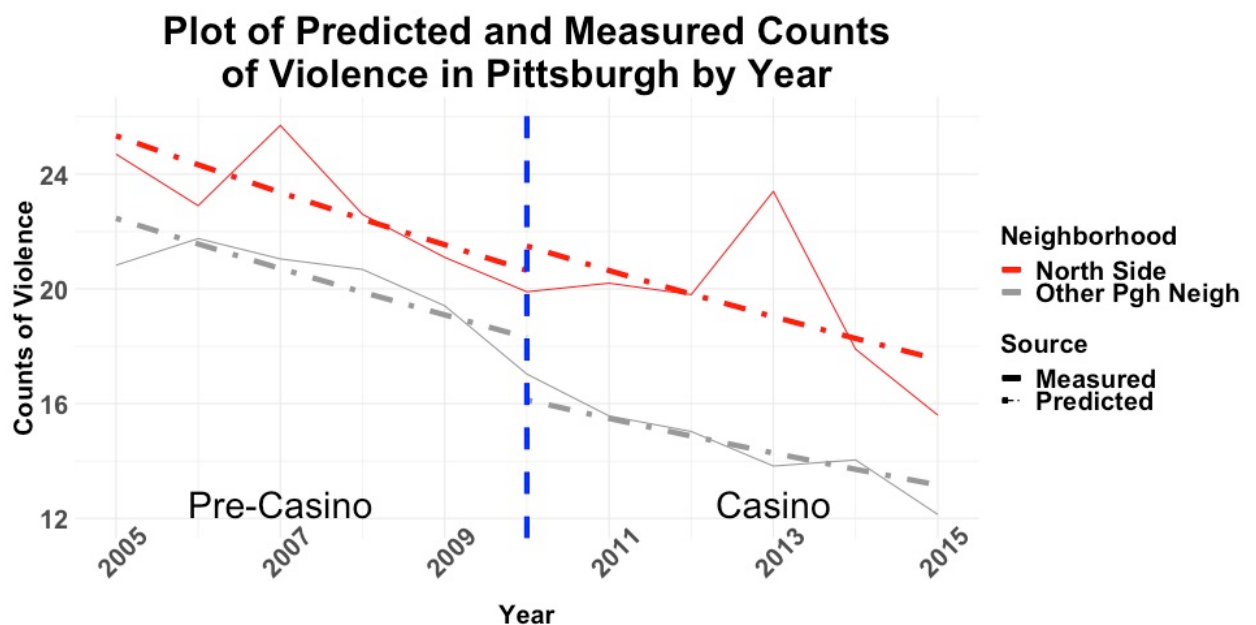


Figure 4-1 Plot of Predicted and Measured Counts of Violence in Pittsburgh Neighborhoods

Note: Thin lines indicate aggregated mean measured counts of violence, and dashed lines represent model predicted counts of violence lines.

4.6 Supplemental Information

4.6.1 Supplemental Information Regarding the Methods Section

Additional information regarding formation of the dataset and building of the model, are shown below.

4.6.1.1 Additional Information on Police Data

Violence data, acquired from the Pittsburgh Police Department, provided information about the offense, arrest (suspect), and victim for homicides, robberies, aggravated assaults, and drug and weapon violations. Relevant data elements contained within each file are represented in Table 4-3. The offense file, used to form the violence outcome, contains information about each incident of violence including location and violence type.

4.6.1.2 Definition of the North Side Neighborhood

Neighborhoods, defined by the City of Pittsburgh, are composed of the 141 census tracts for the year 2000 census. The North Side, defined as the following communities (census tracts): Allegheny Center (2204), Allegheny West (2201), California-Kirkbride (2507), Central Northside (2503, 2206), Chateau (2106), East Allegheny (2304), Manchester (2107), North Shore (2205), Troy Hill (2406), and Allegheny Center (2204), is the location of the casino so the intervention was expected to affect the neighborhood directly.^{78 80}

4.6.1.3 Notes on Formation of Socio-Demographic Characteristics

Specifics regarding formation of the twelve socio-demographic characteristics from the American Community Survey files are described as follows. Tract population was defined as the number of residents within a census tract and for each of the following variables the percentage was identified for each census tract. The racial composition of the census tract was measured as the number and percentage of individuals identifying as black or African American. Family structure was measured as the percentage of female-headed households with child and married families with child based on families with children under 18 years. Educational attainment included those who had attained at least a high school degree including individuals who were over 25 and possessed a high school diploma or higher degree, and college graduate measured individuals over 25 who completed a bachelors or higher degree. Economic measures were those defined as median income, percent below poverty line and included only those who had been evaluated for poverty status, and unemployed was evaluated in terms of those in the labor force. The housing status for the census tract included home-owner occupied housing which was defined relative to any type of housing that was occupied, and vacant properties, defined in terms of total housing units.

4.6.1.4 Additional Information on PCA Factor Analysis

As reviewed from the manuscript, Principal Components Analysis was used due to the large number of covariates and the high level of correlation among covariates.²³³ Baseline scores were calculated based on social, demographic, and economic characteristics before the opening of the casino. A second set of difference weights were calculated by differencing the post-intervention and pre-intervention time period covariates. To calculate the difference score, as

shown in Equation 4-2, the time-varying score was assigned 0 pre-intervention and weighted average of the changes in the 12 covariates post-intervention.

$$Score_{n,t} = \begin{cases} 0, & casinoOp = 0 \\ \sum_{j=1}^{12} w_j * (covar_{post} - covar_{pre})_n, & casinoOp = 1 \end{cases}$$

Equation 4-2 Time-Varying Principal Components Score

4.6.2 Supplemental Information for the Results Section

Differences between the baseline and time-changing covariates are summarized and the initial model building steps are shown.

4.6.2.1 Additional Information Regarding Descriptive Statistics

Baseline descriptive statistics for socio-demographic characteristics are presented in Table 4-4. Before the casino opened, characteristics of the North Side neighborhood differ from characteristics in the other Pittsburgh neighborhoods, most notably in terms of families with children ($p = 0.0052$), tract population ($p = 0.0073$), home ownership ($p = 0.013$), and vacancies ($p = 0.018$). To test the difference between baseline medians of demographic characteristics, pairwise tests were performed using Wilcoxon Rank Sum Tests.

Descriptive statistics representing the differences between the before intervention period from 2005 to 2009 and post-intervention period from 2010 to 2014 are shown in Table 4-5. The largest changes observed in the North Side from 2005 to 2015 occurred in families with children

with a corresponding increase from 19.3% to 50.0% ($p = 0.084$). Significant changes in neighborhoods outside of the North Side occurred in income ($p < 0.0001$), high school graduate ($p < 0.0001$), college graduate ($p < 0.0001$), tract population ($p = 0.014$), median age ($p < 0.0001$), employment status ($p = 0.010$), home-ownership ($p = 0.0001$), and vacant properties ($p = 0.0344$). Differences between the demographics before and after the opening of the casino were shown using the Signed Rank Test. The casino directly affects the 10 adjacent census tracts known as the North Side, and, in these few census tracts social, economic, and demographic characteristics vary dramatically. An example of the variation between the census tracts is illustrated by percent African American. The median of percent African American before the casino was implemented was 17.6% but the first quartile is 4.9% while the third quartile is 51.8%. The few census tracts combined with the variability in census tracts, suggest p-values presented in this table for North Side may not be meaningful at the 0.05 significance level, but are presented for completeness.

4.6.3 Additional Information on Principal Components

The number of principal components was selected to explain at least 70% of the variance and by considering breaks in the scree plot.^{240 241} For the baseline PCA factors, four factors accounting for 74% of variance were chosen. Regarding the difference PCA factors, six factors were chosen accounting for 79% of the variance. Following convention, the components were assigned descriptive names based on loadings of the components.²⁴²

The names for the four baseline factors were formed following the loadings in Table 4-6. The structural factors score identify community political resources and socio-economic conditions: college graduate, African American, female-headed household with child, vacant properties, and married families with child.²⁴³ The socio-economic score comprises both prestige-based and

resource-based measures: college graduate, high school graduate, below poverty line, and unemployed.²⁴⁴⁻²⁴⁶ Housing access includes key demographic and economic factors related to housing access: Ratio Ages 15 to 24 vs. 29 to 44, median age, below poverty line, and home-owner occupied housing.^{247 248}

Names for the difference factors are assessed using the following criteria and following the loadings are listed in Table 4-7. The socio-economic difference score includes: college graduate, ratio ages 1 to 24 vs. 29 to 44, high school graduate, below poverty line, and unemployed.²⁴⁴⁻²⁴⁶ Families difference score include female-headed families with child and married families with child. The structural factors difference score identifies political resources and socio-economic conditions which included vacant properties, ratio ages 15 to 24 vs. 29 to 44, and African American.²⁴³ Median age difference, gender difference, and home-owner housing difference scores were each dominated by a single factor.

When either the baseline or the difference scores are included within the model, the fixed effects equation of the GLMM including the principal components was modified as:

$$\ln(Y_{nt}) = \beta_0 + \beta_1 northside_n + \beta_2 casinoOp_t + \beta_3 northside_n * casinoOp_t + \beta_4 year_t + \beta_5 tractpop_{nt} + \beta_k Scores_n + Z_{nt} b_n$$

Equation 4-3 Covariate Adjusted Difference-in-Difference Model

4.6.3.1 Information on Interpretation of Time and Building of Generalized Linear Mixed Effects Model

Table 4-8 presents the univariate model, model with the addition of the difference-in-difference estimator, and the model with the addition of linear year. In the univariate model (top

panel) violence decreased by 29% over the study period (IRR: 0.71; 95% CI: 0.70, 0.73; $p < 0.0001$). Although the estimated incidence rate of violence was 55% higher (IRR: 1.55; 95% CI 0.85, 2.83; $p=0.16$) in the North Side neighborhood compared to other Pittsburgh neighborhoods, violence rates were not significantly different between the two neighborhoods. When the difference-in-difference estimator was added to the model (Table 4-8, middle panel), violence in the North Side was estimated to be 19% higher than would be expected if the Casino had not opened and operated (IRR = 1.19; 95% CI: 1.09, 1.29; $p = 0.0001$). When linear time was added to the model (Table 4-8, bottom panel), the estimated effect of the casino on violence did not appreciably change from the model in the middle panel.

Table 4-3 Elements of Police Data Files Provided by Pittsburgh Police

Data Elements	Offense File	Arrest File	Victim File
CCR#	X	X	X
Date	X	X	
Time of Day	X	X	
Day of Week	X		
Status (Arrest, Cleared, Pending)	X		
Hierarchy Code	X	X	X
Offense Code	X	X	X
UCR Code	X	X	X
Address	X	X	
Census Tract	X	X	
Police Zone	X	X	
Weapon	X		
Gang	X		
Age		X	X
Race		X	X
Sex		X	X

Table 4-4 Additional Summary of Demographic Characteristics Before Opening of the Casino

Covariate	North Side N=10	Outside North Side N=131	p-value*
	Median (Q1,Q3)	Median (Q1,Q3)^a	
Tract Population	1059 (239, 2068)	2133 (1457, 2907)	0.0073
Income (\$)	32,900 (28,172, 37,057)	35,347 (25,580, 45,282)	0.75
Ratio Ages 15 to 24 vs. 29 to 44	0.57 (0.38, 0.89)	0.62 (0.43, 0.95)	0.58
Median Age	39.3 (30.2, 43.0)	38.3 (32.9, 43.2)	0.96
Male (%)	49.4 (46.7, 54.6)	47.4 (43.4, 50.5)	0.099
African American (%)	30.3 (22.2, 66.2)	17.6 (4.9, 51.8)	0.30
Female-Headed HH with Child (%)	62.8 (49.7, 77.8)	38.6 (20.0, 64.6)	0.11
Married Families with Child (%)	19.3 (0, 44.0)	48.3 (24.4, 75.6)	0.0052
High School Grad (%)	87.6 (82.6, 91.1)	88.0 (80.8, 91.6)	>0.99
College Grad (%)	22.9 (16.3, 39.6)	21.7 (12.5, 42.1)	0.73
Below Poverty Line (%)	22.3 (18.9, 34.0)	20.1 (11.2, 33.7)	0.54
Unemployed (%)	11.6 (8.1, 21.8)	8.1 (4.8, 13.1)	0.17
Homeowner Occupied Housing (%)	38.8 (10.1, 55.7)	53.9 (37.2, 71.9)	0.013
Vacant Properties (%)	27.8 (20.4, 33.8)	13.7 (8.1, 23)	0.018

Note:

*Wilcoxon Rank Sum Test used to test for notable differences between medians.

^a Q1, Q3: 25% Quartile, 75% Quartile

Table 4-5 Supplemental Summary of Demographic Characteristics Before and After Opening of the Casino

Covariate	North Side N=10			Outside North Side N=131		
	Before Casino	After Casino	p-value*	Before Casino	After Casino	p-value
	Median (Q1,Q3) ^a	Median (Q1,Q3)		Median (Q1,Q3)	Median (Q1,Q3)	
Tract Population	1059 (239, 2068)	1189.3 (491.5, 1807.8)	0.43	2133 (1457, 2907)	2076.7 (1422.7, 2897.8)	0.014
Income (\$)	32,900 (28,172, 37,057)	32,009 (25,777, 37,272)	0.91	35,347 (25,580, 45,282)	38,918 (29,731, 50,388)	<0.0001
Ratio Ages 15 to 24 vs. 29 to 44	0.57 (0.38, 0.89)	0.33 (0.25, 0.55)	0.38	0.62 (0.43, 0.95)	0.6 (0.38, 0.84)	0.22
Median Age	39.3 (30.2, 43.0)	39.3 (31.0, 40.3)	0.92	38.3 (32.9, 43.2)	36.5 (31.0, 40.8)	<0.0001
Male (%)	49.4 (46.7, 54.6)	51.3 (45.6, 52.0)	0.49	47.4 (43.4, 50.5)	47.8 (44.4, 50.2)	0.091
African American (%)	30.3 (22.2, 66.2)	31.9 (26.3, 70.7)	0.38	17.6 (4.9, 51.8)	15.1 (6.2, 48.6)	0.95
Female-Headed HH with Child (%)	62.8 (49.7, 77.8)	50.0 (33.0, 77.3)	0.85	38.6 (20.0, 64.6)	40.5 (18.9, 63.9)	0.96
Married Families with Child (%)	19.3 (0, 44.0)	50.0 (16.7, 57.6)	0.084	48.3 (24.4, 75.6)	46.2 (26.7, 69.2)	0.29
High School Grad (%)	87.6 (82.6, 91.1)	88.7 (82.7, 92.5)	0.63	88.0 (80.8, 91.6)	90.9 (86.7, 94.3)	<0.0001
College Grad (%)	22.9 (16.3, 39.6)	33.0 (29.8, 46.2)	0.28	21.7 (12.5, 42.1)	27.7 (14.5, 45.5)	<0.0001
Below Poverty Line (%)	22.3 (18.9, 34.0)	32.3 (21.7, 38.4)	0.56	20.1 (11.2, 33.7)	20.7 (13.7, 31.3)	0.11
Unemployed (%)	11.6 (8.1, 21.8)	8.2 (7.8, 13.0)	0.49	8.1 (4.8, 13.1)	8.9 (5.6, 15.1)	0.010
Homeowner Occupied Housing (%)	38.8 (10.1, 55.7)	34.1 (29.3, 52.8)	0.70	53.9 (37.2, 71.9)	51.4 (36.0, 62.3)	0.0001
Vacant Properties (%)	27.8 (20.4, 33.8)	25.6 (21.9, 28.8)	>0.99	13.7 (8.1, 23.0)	13.5 (8.8, 18.7)	0.034

Note:

*Signed Rank Test used to test for notable differences between the before and after opening and operation of the arena in conjunction with a CBA on medians.

^a Q1, Q3: 1st Quartile, 3rd Quartile

Table 4-6 Loadings from the Principal Components Regarding Baseline Characteristics

Covariate	Principal Component Names*			
	Structural Factors	SES	Housing Access	Gender
College Grad (%)	-51	62	-35	5
Ratio Ages 15 to 24 vs. 29 to 44	-17	-47	-60	-25
Male (%)	-17	4	-1	91
African American (%)	78	-17	-14	-23
Female-Headed HH with Child (%)	75	-36	-13	-20
High School Grad (%)	-18	88	6	6
Median Age	1	11	84	-15
Vacant Properties (%)	80	-4	-3	26
Below Poverty Line (%)	41	-52	-62	2
Unemployed (%)	26	-72	-37	4
Homeowner-Occupied Housing (%)	-34	-11	68	13
Married Families with Child (%)	-77	25	13	29

Note:

* Names are based upon loadings greater than 50 or less than -50 and are marked by bolded values.

Table 4-7 Loadings and Names of the Principal Components

Covariate ^a	Principal Components Names*					
	SES Difference	Families Difference	Structural Factors Difference	Age Difference	Home- Owner Housing Difference	Gender Difference
College Grad Difference (%)	80	-14	-32	-19	-2	15
Ratio Ages 15 to 24 vs. 29 to 44 Difference	-51	-18	-56	-20	37	3
Male (%) Difference	-7	12	6	4	-5	94
African American (%) Difference	-5	-19	74	3	-6	-7
Female-Headed Families with Child (%) Difference	-23	-86	17	-7	1	-17
Change High School Grad (%) Difference	76	15	31	3	8	-9
Median Age Difference	12	-1	-5	92	7	4
Vacant Properties (%) Difference	13	-6	67	-24	21	26
Below Poverty Line (%) Difference	-67	-15	4	-42	-24	3
Unemployed (%) Difference	-72	-26	-15	-22	-16	14
Homeowner-Occupied Housing (%) Difference	19	10	3	11	93	-5
Married Families with Child (%) Difference	4	94	-5	-3	10	-1

Notes:

* Names are based upon loadings greater than 50 or less than -50 and are marked by bolded values.

^a The difference is taken by differencing the pre-intervention value from the post-intervention value.

Table 4-8 Building of Generalized Linear Mixed Effects Models

	Incidence Rate		
Covariate	Ratios	95% Confidence Interval	p-value
Model 1: Univariate Model			
North Side	1.55	0.85, 2.83	0.16
Casino Open	0.71	0.70, 0.73	<0.0001
Population (per 1,000)	1.01	0.96, 1.06	0.74
Model 2: Addition of Difference-in-Difference Estimator			
North Side	1.43	0.79, 2.61	0.24
Casino Open	0.70	0.69, 0.72	<0.0001
(Casino Open)*(North Side)	1.19	1.09, 1.29	0.0001
Population (per 1,000)	1.02	0.97, 1.07	0.53
Model 3: Addition of Linear Year (equivalent to base model in manuscript)			
Year	0.96	0.95, 0.97	<0.0001
North Side	1.43	0.79, 2.61	0.24
Casino Open	0.88	0.84, 0.92	<0.0001
(Casino Open)*(North Side)	1.19	1.09, 1.29	0.0001
Population (per 1,000)	1.02	0.97, 1.07	0.53

Note:

The results of the difference-in-difference estimator is indicated by bold.

5.0 Manuscript 3: Changes in Neighborhood Collective Efficacy and the Development of a Sports and Entertainment Arena or a Casino: Measuring the Social Fabric of a Community

5.1 Abstract

Background: Policy makers argue developments, sports and entertainment arenas (arenas) or casinos (casinos), boost economic characteristics in the surrounding neighborhood. We measure change in collective efficacy (neighborhood values and perception) and perceived neighborhood violence (disorder within a neighborhood) to track social consequences within a community. We examined the effect of the opening of a arena with the addition of a community benefits agreement (a legal-agreement for benefits) or a casino on change in perceived neighborhood violence and change in collective efficacy.

Methods: Change in collective efficacy and perceived neighborhood violence in two neighborhoods where either the casino or arena opened were compared to four quasi-matched neighborhoods within the City of Pittsburgh. In 2011, neighborhood residents were surveyed regarding demographics, employment, neighborhood factors, social milieu, and development impact. Each outcome was calculated using survey questions respect to perceived change from five years previously. Reduced models containing basic socio-demographic characteristics and expanded full covariate set models were fit using ANCOVA.

Results: Neither collective efficacy ($p = 0.25$) nor perceived neighborhood violence ($p = 0.66$) did not change from the opening and operation of an arena in conjunction with the CBA.

While perceived neighborhood violence did not change ($p = 0.35$) from the opening and operation of a casino, collective efficacy was reduced ($\beta: -0.69; p = 0.020$).

Conclusion: This study demonstrates that the development of a casino, did not affect perceived neighborhood violence but could reduce levels of collective efficacy in communities most likely to be affected. Collective efficacy or perceived neighborhood violence were not changed by the addition of a CBA or arena.

5.2 Introduction

In recent years, construction of arenas and casinos have grown in the US. Over half of the 234 new arenas built from 1950 to 2010 (\$59 billion was spent in 2006 dollars) were built in the last twenty years.²¹⁶ Similarly, casino construction grew by 3.7% from 2006 to 2016, and by 2017 460 commercial casinos were open.²⁵⁹⁻²⁶¹ However, it is difficult to assess how these developments may affect the social consequences on residents within the neighborhoods where the arenas and casinos are built. A few previous studies have investigated if opening and operating casinos changes perceived neighborhood violence,^{122 157 158 193 194} and the effect is mixed. A second measure, collective efficacy can be thought of as “social cohesion among neighbors combined with their willingness to convene on behalf of the common good”⁸ while perceived neighborhood violence measures the amount of violence that participants observe within a community.⁷⁷

A focus on geographic or location-based disparities has led to an increase in place-based approaches to improve public health.²¹⁹ Rates of perceived neighborhood violence vary greatly by perceived moderately bounded geographic areas known as neighborhoods.^{139 184-189} Others have noticed variability in collective efficacy can differentiate why some neighborhoods have high violence and others have low violence, even as neighborhoods have otherwise similar economic and health characteristics.¹⁹⁷

Previous cross-sectional research has found that features of the environment, such as alcohol outlets, lower collective efficacy, while environmental features, like parks, increase collective efficacy.²¹¹ Similarly, perceived neighborhood violence can be affected by various social factors in an area including public drunkenness and drug addicts and the physical features of vacant lots or public housing.^{183 190 191} While previous studies have shown specific buildings or

reputations of elements in neighborhoods increase or decrease perceived neighborhood violence or fear of crime,^{181 262 263} no previous studies have specifically examined how perceived neighborhood violence changes from an arena or casino opening.

In 2011 within the City of Pittsburgh, an arena opened in the Hill District and in 2010 a casino opened in the North Side. The Hill District is a relatively well-organized neighborhood with strong community groups who have a long history of improving neighborhood life.^{3 4} However, the neighborhood experiences high rates of poverty, unemployment and limited access to services.⁷⁷ Accompanying the arena was a community benefits agreement (CBA), a legally negotiated agreement between the community and developers to provide benefits.^{5 78} In contrast, the North Side is a diverse area with some thriving communities but also high unemployment and poverty, few units of affordable housing, and high rates of violence and segregation. The aim of this study was to determine whether collective efficacy and perceived neighborhood violence changed in the intervention neighborhoods when compared to four neighborhoods over the same time period.

5.3 Methods

We conducted a cross-sectional survey to examine the effect of a casino and arena (which included a CBA) on change in collective efficacy and change in perceived neighborhood violence. Based on set geographic and cultural boundaries, the casino was expected to impact all residents of the North Side while the arena/CBA was expected to impact residents of the Hill District. In addition, the CBA was signed between neighborhood groups within the Hill District and developers including the City of Pittsburgh.^{5 78} A map of the intervention neighborhoods location

is available in Section 5.6, Supplemental Information. The casino opening in August 2009 and the arena opening in August 2010. The perceived change measures compare the current perception at the time of the survey (2011) to five years beforehand (2006) which is before each of the interventions.

5.3.1 Experimental Design

To conduct the survey, we used the Allegheny County BRFSS infrastructure which is a cooperative endeavor of the Allegheny County Health Department in conjunction with the Graduate School of Public Health (GSPH), University of Pittsburgh and a number of participating organizations and agencies in Allegheny County, PA. The Computer Assisted Telephone Interviewing (CATI) Center in the Department of Behavioral & Community Health Sciences at GSPH, University of Pittsburgh assembled the CDC questionnaires ²⁶⁴, programmed the CATI system, selected the sample and conducted the survey.

Participant selection was taken from a list generated using the disproportionate stratified sample design applied to the universe of all telephones in Allegheny County, PA. These telephones were divided into four strata based on the estimated probability that the telephone number is attached to a housing unit. A large fraction of the sample was chosen from strata containing phones that are most likely to be in residential buildings. An adult age 18 and over was selected as a respondent from a list of adults residing in the household generated from responses given by the person who answers the telephone.

The survey included a sample of respondents within the two intervention neighborhoods, as well as in four comparison neighborhoods - for the two intervention neighborhoods we surveyed two geographically similar neighborhoods, one demographically similar neighborhood and one

demographically disparate neighborhood. The four control neighborhoods were selected from neighborhoods within Pittsburgh, PA and matched on minority composition (in particular, % black), violence level, SES, or location in relation to the intervention neighborhood. Additional information is available within Section 5.6.

As individuals were surveyed regarding perceived change within a single neighborhood, only participants who were residents of the same neighborhood since 2006 were included. Length of residence was evaluated using a self-identified measure indicating living within the neighborhood for at least five years. Residence in one of six neighborhoods was verified using self-reported neighborhood and identification of a close intersection.

5.3.2 Survey Design and Study Population

The cross-sectional survey was conducted by telephone from July to December 2011 and lasted an average duration of 25 minutes. The 131 questions of the survey related to basic demographics, household economic status, income, health coverage, injuries, residential mobility, social milieu (informal social control, social cohesion, and trust), crime and violence, and perceptions of the impact of the casino or arena. Initial selection of participants was taken from a list containing land-line phones of the six neighborhoods (2 intervention and 4 control) within Pittsburgh, PA. Residents were called until enrollment was reached using previously calculated estimates based on power calculations was achieved. Inclusion criteria of: 18 years old or over, phone number matching number at residence, address within a neighborhood, land-line phone dialed, and private residence. All participants who met the inclusion criteria were consented at time of interview. Additional details regarding the survey is available elsewhere.⁷⁷

5.3.3 Measures

As conceived by Sampson et al. for cross-sectional collective efficacy, change in collective efficacy was defined as perceived change since 2006 in terms of change in informal social control and change in social cohesion.⁸ Informal social control measures the “reactions of individuals and groups that bring about conformity to norms and laws, [including] career and community pressure, bystander intervention in a crime and collective responses such as citizen patrol groups”, and social cohesion was defined as the evaluation of shared values within a community.²⁶⁵ A three-point score, was computed based on the selection of three ordered answers, *worse* to *better*, for each question. Answers of *Don’t know* or *Not sure* were recoded to a neutral response of *About the same* or *Neither more or less likely*. A Change in Collective Efficacy score was created for each participant by aggregating responses to the ten survey questions as listed in Section 5.6. The score was classified as “missing” if an answer to one or more of the questions was missing or was recoded as *Refused*.

Change in Perceived Neighborhood Violence measures the change in the perception of the commonality of neighborhood-level violence compared with 5-years previously (2006).⁷⁷ Many previous studies measured individual-level and neighborhood-level perceptions of cross-sectional perceived violence levels, fear of crime, or an aggregation of both measures;^{172 181 266 267} but no previous study has specifically assessed perceived change. We created our measure based on previously developed cross-sectional measures regarding perception of violence.²⁶⁸⁻²⁷¹ A score was created from an individual’s selection of a Likert-scale response: *Strongly Agree* to *Strongly Disagree*. Answers for responses of *Don’t know* or *Not sure* were recoded to *Neither agree nor disagree*. *Refused* or *No response* answers were counted as “missing”. Further discussion of these measures is included in Section 5.6.

5.3.4 Covariates

The survey assesses key demographic and injury/violence characteristics including: age, education, employment, gender, injury in the past 12 months, marital status, race, victim of crime, and witness to a crime in the neighborhood. Variables known to be associated with each outcome, for instance, variables representing neighborhood characteristics used to quasi-match neighborhoods, were considered for inclusion in the analysis. Further detailed information regarding the formation of the covariates is available within Section 5.6.

5.3.5 Statistical Analysis

Means and standard deviations or counts and percentages were calculated for social, economic, and demographic characteristics of the intervention and control neighborhoods. Tests for pairwise differences between neighborhoods were conducted using chi-square tests or Fischer's exact tests for categorical variables and t-tests for continuous variables.

Data was assessed for missing values. Within the sample surveyed, the low level of missing data were considered to be missing completely at random. Each outcome was modeled as continuous variable with a normal distribution measured using a Likert scale and an ANCOVA model was used. The outcome of each model, Y_i , represents change in collective efficacy or perceived neighborhood violence and varies within each individual, i . The response variable, the arena or casino, is denoted, dev_i . Since the study population was based on a list of random numbers, sampling weights were not used in our model.

Models were fit with a covariate set based on relevant characteristics. As shown in Equation 5-1, the covariates in the adjusted model included: age, employment, marital status

(*marital*), race, gender, education, injury, victimization of crime (*victim*), and witnessed a crime in neighborhood (*witness*).

$$Y_i = \beta_0 + \beta_1 * dev_i + \beta_2 * age_i + \beta_3 * employment_i + \beta_4 * marital_i + \beta_5 * race_i + \beta_6 * gender_i + \beta_7 * education_i + \beta_8 * injury_i + \beta_9 * victim_i + \beta_{10} * witness_i$$

Equation 5-1 Adjusted Model

Models were fit separately for each outcome using PROC GLM in the SAS System Version 9.4 (Carey, NC) for Windows.²³¹

5.4 Results

A flow chart illustrating participant selection is presented in Figure 5-1. A total of 13,182 individuals were called and after non-responses and exclusions, 1273 individuals consented. The overall response rate of 9.7% is similar to studies using social indicators. A total of 971 participants lived in the neighborhood for at least five years.

A summary of the social, economic, and demographic characteristics by neighborhood is shown in Table 5-1. Participants tended to be better educated in the control neighborhoods than in the intervention neighborhoods (North Side $p = 0.012$; and, Hill District $p < 0.001$), and younger in the Hill District (aged 62.7, $p = 0.031$) and North Side (aged 63.5, $p = 0.047$) than the control neighborhoods (aged 65.9).

Figure 5-2 and 5-3 display the distribution of change in perceived neighborhood violence and change in collective efficacy. The change in perceived neighborhood violence and the change

in collective efficacy were missing in 2.6% and 2.4% of the sample, respectively. Individuals in the Hill District tended to perceive neighborhood violence as increasing (29.3%) and collective efficacy as decreasing (42.2%) to a greater degree than in either the North Side (perceived neighborhood violence: 20.9%, collective efficacy: 33.2%) or the comparison neighborhoods (perceived neighborhood violence: 16.9%, collective efficacy: 25.6%).

Table 5-2 summarizes the univariable and adjusted ANCOVA models for each outcome change in perceived neighborhood violence and change in collective efficacy. The effect of the arena or casino on perceived neighborhood violence was not significant when accounting for demographic characteristics (arena $p = 0.66$, casino $p = 0.35$). The estimated effects of the demographic characteristics in the adjusted model are presented in Table 5-3. Individuals who witnessed a crime reported perceived neighborhood violence increased by -0.92 ($p < 0.001$) in the arena/CBA model and 0.78 ($p < 0.001$) in the casino model. African Americans perceived violence worsened by 0.55 ($p < 0.001$) and 0.35 ($p < 0.001$) in the arena and casino models respectively.

The effect of the arena and CBA on collective efficacy was not significant when demographic characteristics were included in the adjusted model ($p = 0.25$). Residents in the North Side, where the casino is located, reported greater drops in collective efficacy of -0.69 ($p = 0.020$) in the full model. African Americans had worsened collective efficacy in both models.

5.5 Discussion

Although perceived neighborhood violence in the North Side was not impacted by the opening of a casino, collective efficacy was reduced. In the Hill District, collective efficacy and

perceived neighborhood violence within the neighborhoods did not change markedly with the opening and operation of arena in conjunction with implementation of the CBA.

We built upon previous work that demonstrated features of the environment effect levels of collective efficacy,²¹¹ but we examine how an arena with a CBA or a casino change collective efficacy. In a study of business improvement districts (a geographic area where local businesses are taxed for neighborhood improvement services, BIDs) conducted by MacDonald et al., collective efficacy became an important factor when understanding the effect BIDs on violence with less collective efficacy associated with an increase in violence.²¹² Similarly, we showed a development was associated with a decrease in reported collective efficacy, but both of these studies only examined cross-sectional collective efficacy.

While studies have begun to understand the effect of cross-sectional collective efficacy regarding environmental features, the mechanisms behind changing collective efficacy is poorly understood. Hipp showed in communities that perceived an increase in violence over the previous time period, collective efficacy correspondingly decreased.²¹⁰ In a study of collective efficacy and violence rates over 3 time points, collective efficacy was not related to violence either simultaneously or after a 2 or 5 year lag, but an indirect relationship was suggested through the pathway of disadvantage.²⁷² In two studies examining change in collective efficacy, both Schmidt et al. and Sampson et al. measured collective efficacy over multiple-time points to suggest with an absence of changes to the physical environment, collective efficacy stayed constant.^{206 207} However, none of these studies examined the effect of interventions aimed at changing the environment on changing collective efficacy. In the few studies that examined interventions and changing collective efficacy,^{208 209} only Carlson et al. showed adults reported collective efficacy

of children increased in an intervention aimed at children disseminating HIV/AIDS information to adults.²⁰⁹ However, our study did not include children.

Casinos and arenas are believed to harm neighborhoods by interfering with the neighborhood's social fabric through increased traffic, pollution, changing land values, and disruption in the neighborhood.¹⁰⁰⁻¹⁰² Existing studies on casinos used related social measures like quality of life or opinion of the casino's impact on the community, and the results were mixed¹²² but these measures do not necessarily correspond to collective efficacy. By suggesting a casino decreased collective efficacy of neighborhoods, our results suggest a development may meet the developer's goals, but can adversely affect a community.⁷⁵

Studies on CBAs and developments are either case-series or case studies, but the success of CBAs are highly sensitive to neighborhood characteristics such as strength of community groups.¹¹⁰⁻¹²¹ For the Hill District CBA, over 100 community organizations, unions, and others banded together to sign the CBA as one ensuring strong community representation.⁷¹ These legally-enforced, benefits, with Pittsburgh officials both in the negotiation and as a signatory, included a specific needs.⁵ Carbone and McMillin suggest neither component of collective efficacy is associated with collective action,²⁷³ which may lead to the result of the arena and CBA not associated with a change in collective efficacy.

Neither the casino nor the arena was related to a neighborhood's change in perceived neighborhood violence. Previously published results show many residents in the arena neighborhood reported perceived neighborhood violence worsened even though violence levels decreased over the study period.⁷⁷ Similarly to change in collective efficacy, higher cross-sectional perceived neighborhood violence is associated with lower values of economic indicators and worse health outcomes¹⁷⁴⁻¹⁷⁶, but changes in perceived neighborhood violence was not associated

with changing health outcomes.²⁷⁴ Designs of buildings can affect perceived neighborhood violence so it is thought perceived neighborhood violence can be decreased by changing design of buildings.^{182 183} Neither adding the arena with a CBA or a casino were environmental features that changed perceived neighborhood violence within a neighborhood.

In contrast to previous studies, we showed perceived neighborhood violence did not change from the addition of a casino. Cross-sectional surveys comparing communities perceived impact of casinos and perception of crime indicated that perception of change in crime varied dramatically between communities.^{122 193 194} In contrast, a cross-sectional study by Long et al. showed all communities reported perceived crime increasing after the casino opened.¹⁵⁸ In the sole longitudinal study, Carmichael et al. conducted three surveys in four years in a casino community and suggested residents perceived impact of casino violence worsened in every follow-up survey.¹⁵⁷ We surveyed participants approximately two years after the opening of the casino, so a longer follow-up time may give residents time to form a stronger opinion.

There are several notable strengths in our study design. Since the impact of a casino or arena could be different in struggling communities with high unemployment as there is stronger support for a casino when the economic impact on the area was positive¹⁵⁶ or a person works at casino,¹⁹⁴ we concentrated on complete neighborhoods. Moreover since individuals who live close to a casino have stronger opinions than those who live farther away and using a large geographic area could dilute the effect of the casino and arena,^{194 275 276} we focused on one community instead of comparing the effect across multiple communities as in previous studies.¹⁹⁶ Analysis of individual community also facilitated the use of good matching algorithms; when multiple communities are used, little is known on characteristics important for matching.¹²⁸ In a study examining social and environmental mechanisms behind changing collective efficacy, Hipp

suggested one year time period allows residents time to “update” their neighborhood perceptions based on environmental changes.²¹⁰ Since the survey was conducted approximately one year after the arena construction and two years after the opening of the casino, we incorporated Hipp’s suggestion.

This study has some limitations. We measure only the short term effect of the casino, and some previous work on the economic effect of arenas suggests the possibility of a “honeymoon” effect that can last five to ten years after the opening of the stadium during which the effect of the casino on social and environmental factors is elevated.^{238 239} A similar effect may occur for collective efficacy and perceived neighborhood violence. A certain amount of selection bias may occur as the interventions are implemented in neighborhoods with struggling communities. More importantly, the individuals who agreed to participate in the survey were a select sample of the residents in the communities. Females were more likely to participate and may report higher perceived violence than males. The average age is greater than 60, and older participants perceive greater neighborhood violence for same level of violence than younger individuals.²⁷⁷

5.5.1 Conclusions

Our findings suggest change in perceived neighborhood violence was not affected by the opening and operation of the arena in conjunction with the CBA or casino. Change in collective efficacy was not impacted by the neighborhood addition of an arena or implementation of a CBA but was decreased by the opening and operation casino. Future work should concentrate on tracking changing collective efficacy in casino communities and the effect on changing public health outcomes.

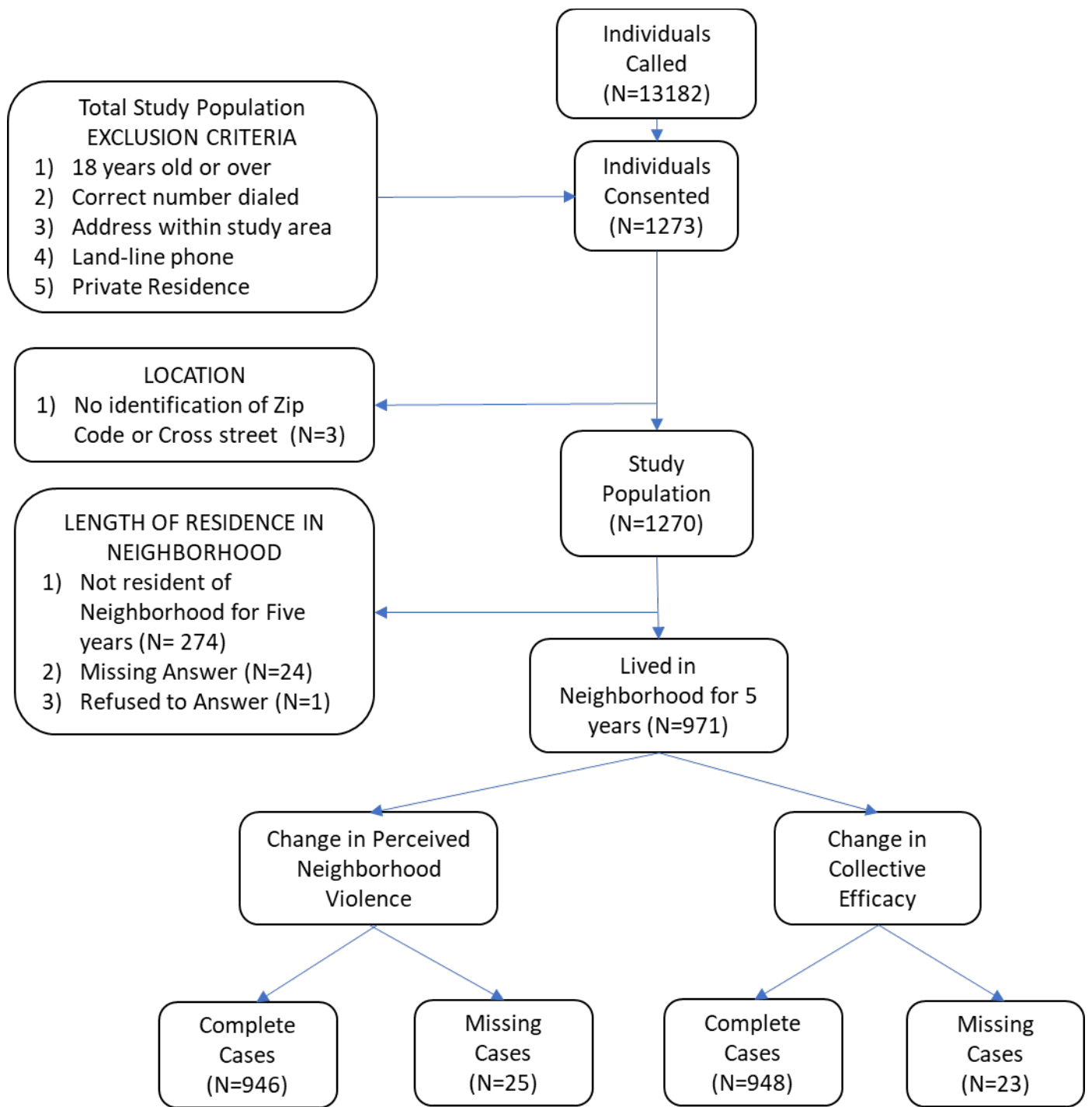


Figure 5-1 Study Population Flow Chart, July to December 2011

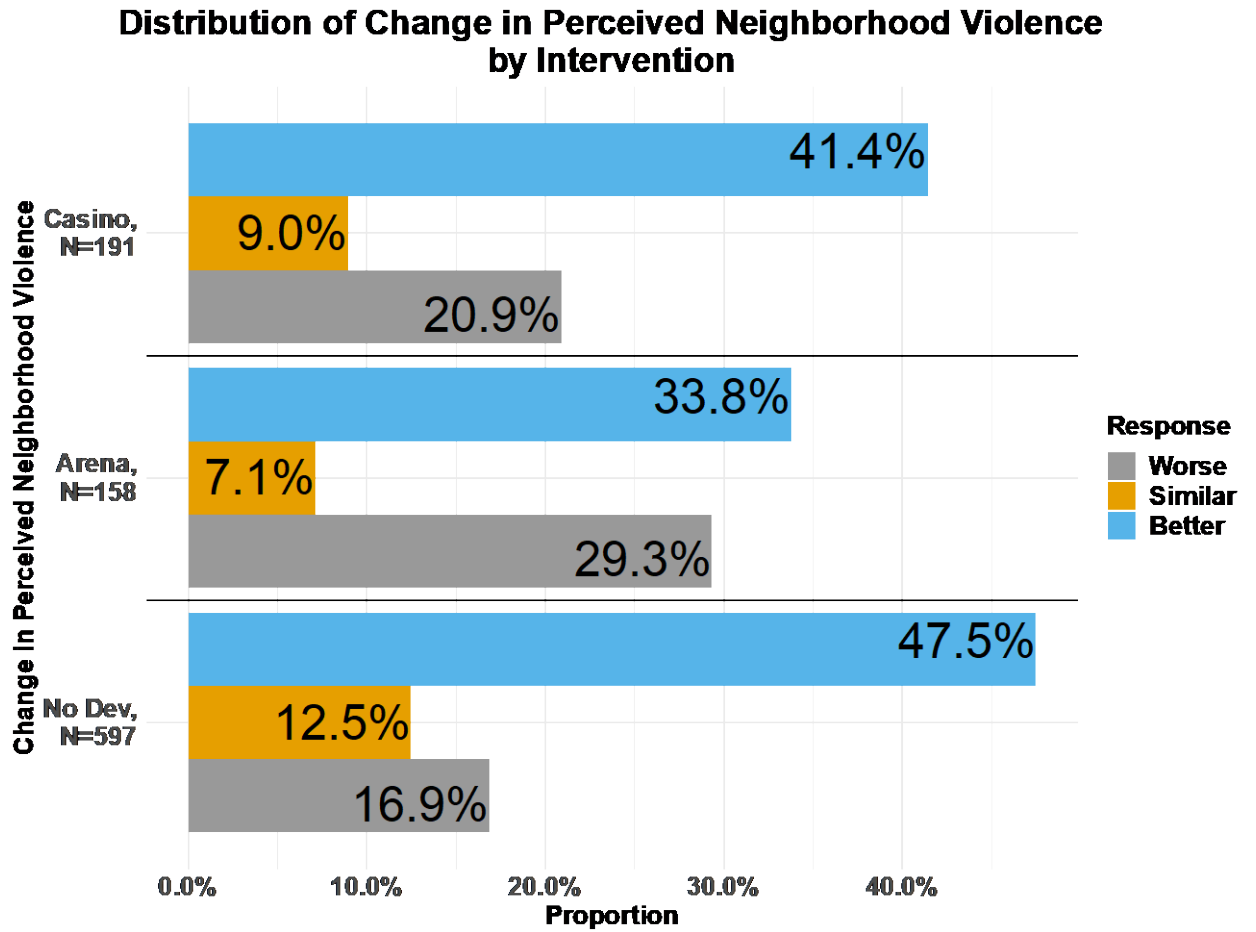


Figure 5-2 Change in Perceived Neighborhood Violence Distribution by Development

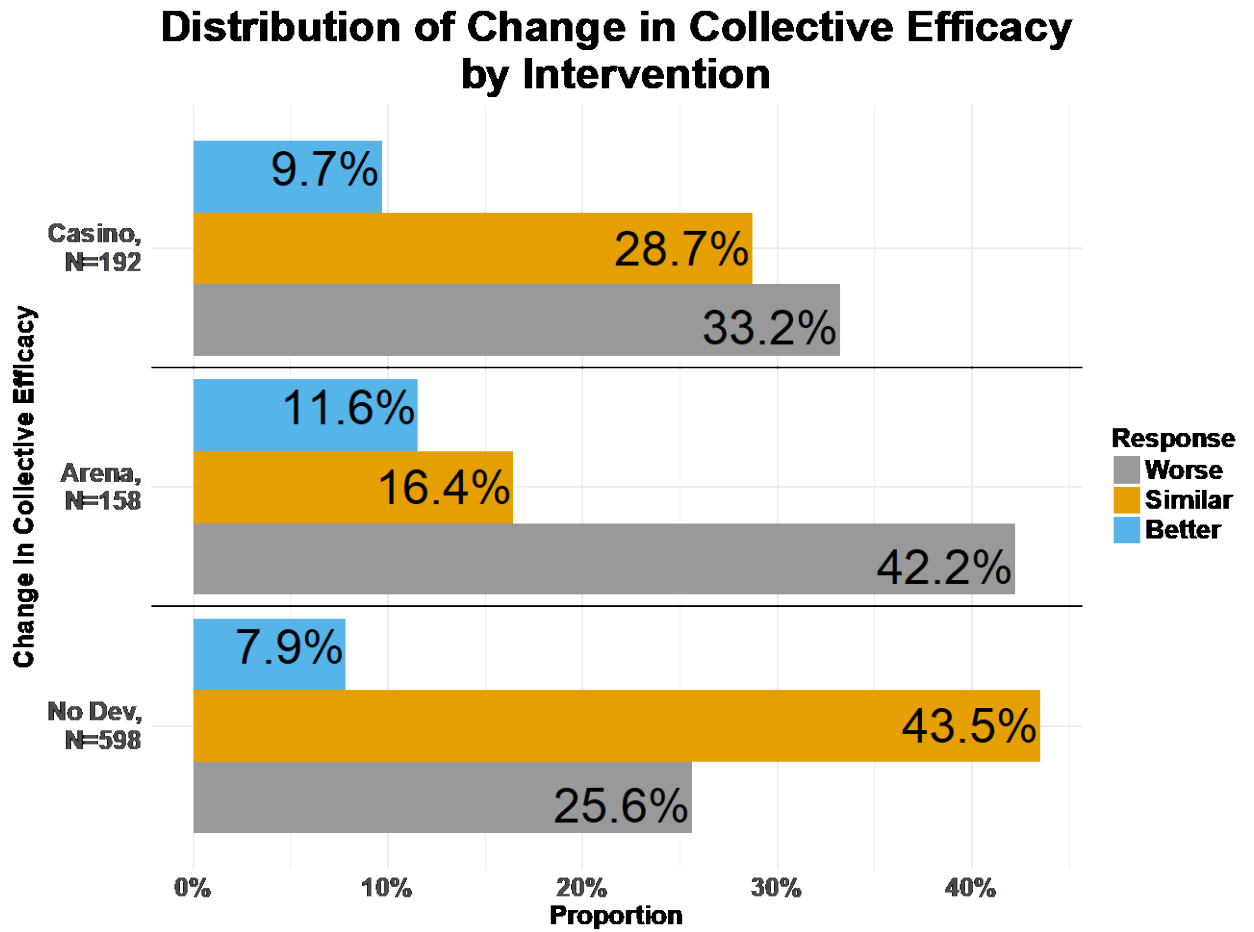


Figure 5-3 Change in Collective Efficacy Distribution by Development

Table 5-1 Summary of Social and Demographic Characteristics within the Six Neighborhoods

Covariate	Codes	Intervention					Control Neighborhoods N=574 (62.8%)
		Arena/CBA N=152 (16.6%)		Casino N=188 (20.6%)			
		Count (Percent)	p-value ¹	Count (Percent)	p-value ¹	Count (Percent)	
Age*		62.7 (15.9)	0.031*	63.5 (13.9)	0.047*	65.9 (15.9)	
Employment	Employed	47 (30.9)		67 (35.6)		195 (34.0)	
	Unemployed	11 (7.3)	0.065	10 (5.3)	0.31	18 (3.1)	
	Other	93 (61.6)		110 (58.8)		360 (62.8)	
Marital Status	Married	30 (19.7)	<0.001	68 (36.2)	0.089	248 (43.2)	
	Not Married	122 (80.3)		120 (63.8)		326 (56.8)	
	White	9 (5.9)		119 (63.3)		381 (66.4)	
Race	Black	141 (92.8)	<0.001	61 (32.4)	0.52	177 (30.8)	
	Other	2 (1.3)		8 (4.3)		16 (2.8)	
	Male	27 (17.8)	0.0021	64 (34.0)	0.34	174 (30.3)	
Gender	Female	125 (82.2)		124 (66.0)		400 (69.7)	
	Less than High School	11 (7.2)		10 (5.3)		21 (3.7)	
	High School	56 (36.8)	<0.001	64 (34.0)	0.012	139 (24.2)	
Education	More than High School	85 (55.9)		114 (60.6)		414 (72.1)	
	No	136 (89.5)	0.15	161 (85.6)	0.79	487 (84.8)	
	Yes	16 (10.5)		27 (14.4)		87 (15.2)	
Injury	No	151 (99.3)	>0.99 ^a	184 (97.9)	0.27 ^a	568 (99.0)	
	Yes	1 (0.7)		4 (2.1)		6 (1.0)	
	Victim of Crime	138 (90.8)	0.005	176 (93.6)	0.11	553 (96.3)	
Witnessed Crime	No	14 (9.2)		12 (6.4)		21 (3.7)	
	Yes						

Note:

* Mean and standard deviations are presented, and a T-test used.

^a Fischer's exact test used to from a cell count less than five.

¹ Chi-Square test.

Table 5-2 Summary of Univariable and Adjusted Model Results for Change in Perceived Neighborhood Violence and Change in Collective Efficacy

Outcome	Intervention	Model Type			
		Univariable		Adjusted Model ^a	
		Estimate (SE) ^b	p-value	Estimate (SE)	p-value
Change Perceived Neighborhood Violence	Arena/CBA	-0.42 (0.10)	<0.001	0.05 (0.11)	0.66
	Casino	-0.17 (0.09)	0.057	-0.08 (0.09)	0.35
Change in Collective Efficacy	Arena/CBA	-1.61 (0.32)	<0.001	-0.43 (0.37)	0.25
	Casino	-0.90 (0.29)	0.002	-0.69 (0.30)	0.020

Note:

Bolding of intervention indicates a notable difference between the development and control neighborhoods.

^aAdjusted Covariate Set: Age, Employment, Marital Status, Race, Gender, Education, Injury, Victim of Crime, Witnessed a Crime in Neighborhood.

^b SE indicates Standard Error.

Table 5-3 Adjusted Model Results for Change in Perceived Neighborhood Violence and Change in Collective Efficacy

Covariate	Codes	Perceived Neighborhood Violence				Collective Efficacy			
		Casino		Arena/CBA		Casino		Arena/CBA	
		Estimate (SE) ^a	p-value	Estimate (SE)	p-value	Estimate (SE)	p-value	Estimate (SE)	p-value
Development		-0.08 (0.09)	0.35	0.05 (0.11)	0.66	-0.69 (0.30)	0.020	-0.43 (0.37)	0.25
Age (per 10 years)		0.066 (0.03)	0.026	0.027 (0.03)	0.36	0.019 (0.10)	0.85	0.093 (0.101)	0.36
Employment (ref: Employed)	Unemployed	-0.20 (0.10)	0.11	-0.14 (0.10)	0.35	-0.20 (0.32)	0.028	-0.55 (0.33)	0.042
	Other	-0.05 (0.21)		-0.11 (0.20)		-1.87 (0.69)		-1.50 (0.69)	
Marital Status	Not Married	-0.05 (0.08)	0.52	-0.06 (0.08)	0.43	-0.49 (0.27)	0.066	-0.33 (0.28)	0.25
Race (ref: White)	Black	-0.35 (0.08)	<0.001	-0.55 (0.09)	<0.001	-0.88 (0.28)	0.002	-1.34 (0.32)	<0.001
	Other	-0.15 (0.22)		-0.19 (0.25)		1.07 (0.73)		0.16 (0.84)	
Gender	Female	-0.06 (0.08)	0.44	-0.07 (0.09)	0.43	-0.13 (0.28)	0.64	-0.22 (0.30)	0.46
Education (ref: Less than High School)	High School	0.38 (0.19)	<0.001	0.35 (0.19)	<0.001	0.61 (0.65)	0.005	-0.80 (0.65)	0.068
	More than High School	-0.13 (0.20)		-0.07 (0.20)		-0.35 (0.67)		-1.33 (0.67)	
Injury		0.09 (0.11)	0.37	-0.07 (0.11)	0.50	0.07 (0.36)	0.85	0.01 (0.37)	0.97
Victim of Crime		-0.19 (0.33)	0.56	-0.54 (0.39)	0.17	0.09 (1.11)	0.94	-0.62 (1.33)	0.64
Witnessed Crime		-0.78 (0.19)	<0.001	-0.92 (0.18)	<0.001	-0.55 (0.63)	0.38	-0.62 (0.62)	0.32

Note:

^a SE indicates Standard Error.

5.6 Supplemental Information

5.6.1 Additional Information on Neighborhood Locations and Quasi-Matching

The Hill District, the site of the arena in conjunction with the Community Benefits Agreement, and North Side, casino development area, locations are mapped within the City of Pittsburgh neighborhoods in Figure 5-4. In addition to the two intervention neighborhoods, the four control neighborhoods, Spring Garden, Homewood, North Oakland, and Squirrel Hill are shown. Homewood was selected based upon minority composition, violent crime levels, and SES similar to the Hill District. Control neighborhoods, Spring Garden and North Oakland, were chosen based on adjacency to the intervention areas of the North Side and the Hill District, respectively. Squirrel Hill was selected based on discordant characteristics from the intervention neighborhoods. Table 5-4 lists additional demographic information used to quasi-match the four control neighborhoods selected from neighborhoods within Pittsburgh, PA. These neighborhoods were chosen based on population-level similarities used to the intervention neighborhoods: minority composition (% black), violence level, SES, and location in relation to intervention neighborhood.

5.6.2 Details Regarding Change in Perceived Neighborhood Violence and Change in Collective Efficacy

Ten survey questions were used to form change in collective efficacy and one question was taken to create change in perceived neighborhood violence, and each question is listed in Table 5-5. Each measure was formed by aggregation of the relevant questions to create an individual score.

5.6.3 Further Information Regarding Covariates

Survey questions to form social, demographic, and economic characteristics for each participant were listed in Table 5-6. Economic measures included employment status and included those employed if *employed for wages/salary* or *self-employed*; unemployed if *out of work for more than 1 year* or *out of work for less than 1 year*; and, classified as other for *A student, A Homemaker, Retired, or Unable to work*. Demographic characteristics included age (“What is your age?”) and a single identification of race formed in terms of self-identification of African American, white, or other. Social characteristics comprise of marital status defined as married (*Married*) or Not Married (*Divorced, Widowed, Separated, Never Married, and A member of an unmarried couple*) and educational attainment. Educational attainment of less than High School included the categories *Never attended school or only attended kindergarten, Grades 1 through 8 (Elementary), Grades 9 through 11 (some high school)*; high school was defined as *Grade 12 or GED (High school graduate)*; and, greater than high school comprised of *College 1 year to 3 years (Some college or technical school)* and *College 4 years or more (College graduate)*. Injury and

violence measures included victim of injury or crime and witnessing of crime composed of *yes* and *no* questions.

5.6.4 Full Information on Response Rate

Information regarding response rate for participants by neighborhood and overall are displayed in Table 5-7. Formation of the study population was taken from records with complete, partial, and early terminations or 1273 participants. Overall response rates by neighborhood varied from a low of 7.6% in Spring Garden to a high of 14.5% in North Oakland.

Map of Pittsburgh Neighborhoods

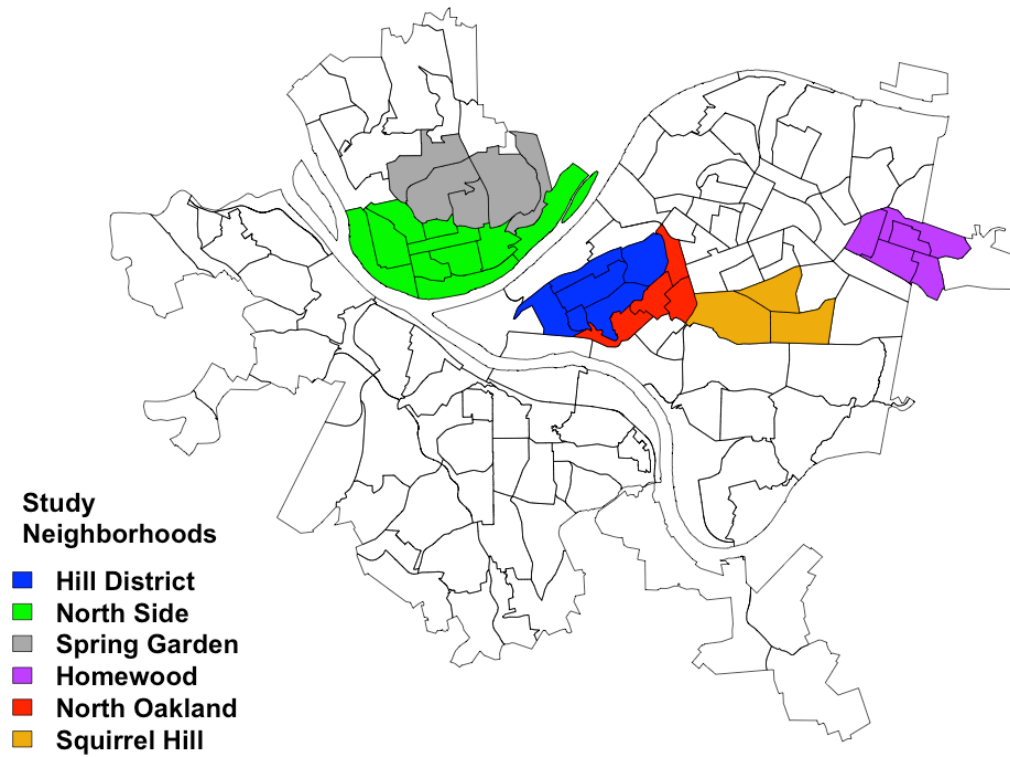


Figure 5-4 Map of Pittsburgh Neighborhoods with Locations of Interventions

Table 5-4 Summary of Quasi-Matching Characteristics

Neighborhood	Intervention/ Control	Minority Composition (% African American)^a	Violent Crime (per 1,000 people)^b	Socio- Economic Status	Relation to Development
North Side	Casino	40.5%	16.6	Various	Intervention
Hill District	Arena/CBA	76.9%	15.6	Unhealthy	Intervention
Homewood	Control	93.2%	25.6	Unhealthy	N/A
North Oakland	Control	9.4%	4.1	Healthy	Adjacent to Hill District
Squirrel Hill	Control	4.3%	0.97	Healthy	N/A
Spring Garden	Control	47.9%	21.6	Unhealthy	Adjacent to North Side

Notes:

^a 2007 to 2012 5-year American Community Survey estimate

^b Violent Crime, aggravated assault and robbery, from 2009 City of Pittsburgh Police offense reports in terms of residents within each census tract from the 2007 to 2012 5-year American Community Survey estimate

Table 5-5 Change in Collective Efficacy and Change in Perceived Neighborhood Violence Survey Questions

Survey Measure	Possible Responses*
Outcome Measure: Change in Collective Efficacy	
Change in Social Cohesion	
Were people in your neighborhood more or less willing to help their neighbors five years ago?	More willing About the Same Less Willing
Was this neighborhood more or less close-knit five years ago?	More close-knit About the Same Less close-knit
Were people in this neighborhood more or less trustworthy five years ago?	More trustworthy About the Same Less trustworthy
Were people in this neighborhood more or less trustworthy five years ago?	Better About the same Worse
Did people in this neighborhood get along with each other better or worse five years ago?	Better About the Same Worse
Five years ago, did the people in this neighborhood have values more similar to each other or less similar to each other than they are now?	More similar About the Same Less similar
Change in Informal Social Control	
Children were skipping school and hanging out on a street corner?	More likely Neither more or less likely Less likely
Children were spray-painting graffiti on a local building?	More likely Neither more or less likely Less likely
Children showed disrespect to an adult?	More likely Neither more or less likely Less likely
A fight broke out in front of their house?	More likely Neither more or less likely Less likely

Table 5-5 Continued

The fire station closest to their home was threatened with budget cuts?	More likely
	Neither more or less likely
	Less likely
Outcome Measure: Change in Perceived Neighborhood Violence	
Compared to 2006, there is more violent crime in my neighborhood now?	Strongly Agree
	Agree
	Neither Agree or Disagree
	Disagree
	Strongly Disagree

Note:

* Responses “Refused” or “Don’t know/not sure” were asked for these questions.

**Table 5-6 Subset of Survey Forming Social, Demographic, and Economic Characteristics and Establishment
of Residence Length**

Covariate	Question	Answers*
Length of Residence in Neighborhood		
N/A	Since 2006, have you moved into your current neighborhood from a different neighborhood?	Yes No
Individual Social, Demographic, and Economic Factors		
Age	What is your Age?	
Race	Which one or more of the following would you say is your race?	White
		Black or African American
	Asian	
	Native Hawaiian	
	American Indian	
	Instructions: If more than one response to question [above], continue [below].	
	Which one of these groups would you say best represents your race?	White
		Black or African American
		Asian
		Native Hawaiian or Other Pacific Islander
American Indian or Alaska Native		
Employment	Are you currently...?	Employed for wages/salary
		Self-employed
		Out of work for MORE than 1 year
		Out of work for LESS than 1 year
		A Homemaker
		A student
		Retired
		Unable to work
Marital Status	Are you...?	Married
		Divorced
		Widowed
		Separated
		Never Married

Table 5-6 Continued

		A member of an unmarried couple
		Never attended school or only attended kindergarten
		Grades 1 through 8 (Elementary)
		Grades 9 through 11 (Some high school)
Education	What is the highest grade or year of school you have completed?	Grade 12 or GED (High school graduate)
		College 1 year to 3 years (Some college or technical school)
		College 4 years or more (College graduate)
Injury	In the past 12 months, how many times did you have an injury for which you received medical care from a doctor or other health professional?	Yes
		No
Victim of Crime	In the past six months, have you been the victim of a violent crime?	Yes
		No
Witnessed Crime	In the past six months, have you witnessed a violent crime in your neighborhood? This includes homicide, rape or sexual assault, robbery, and aggravated assault.	Yes
		No

Note:

* Responses “Refused” or “Don’t know/not sure” were asked for these questions.

Table 5-7 Overall and Neighborhood Specific Response Rates

Record Type	Neighborhood													
	Overall		Hill District (Arena/CBA)		North Side (Casino)		Homewood		Squirrel Hill		Spring Garden		North Oakland	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Complete Responses	1209	-	208	17.2	208	17.2	172	14.2	207	17.1	208	17.2	206	17.0
Partial Responses	42	-	7	16.7	12	28.6	6	14.3	4	9.5	6	14.3	7	16.7
Complete and Partial Responses	1251	-	215	17.2	220	17.6	178	14.2	211	16.9	214	17.1	213	17.0
Complete, Partial, and Early Terminations	1273	-	226	17.8	268	21.1	179	14.1	209	16.4	173	13.6	218	17.1
Total Records	13182	-	2390	18.1	3032	23.0	1760	13.4	2218	16.8	2283	17.3	1499	11.4
Response Rate		9.7		9.5		8.8		10.2		9.4		7.6		14.5

6.0 Discussion

This dissertation provides evidence that large-economic developments, the opening and operation of a casino and arena in conjunction with a community benefits agreement, is associated with changes in the neighborhood social environment. In the North Side, a casino was associated with an increase of violence by 21% than would otherwise be expected and reduced reported collective efficacy, but had no effect on levels of perceived neighborhood violence. In the Hill District, the development of an arena in conjunction with a community benefits agreement reduced violence by 23% than would otherwise be expected, but neighborhood collective efficacy or perceived neighborhood violence were not affected. For both neighborhood developments, social and economic changes within a community did little to explain the effect of either the arena/CBA or casino on violence.

6.1 Development Type

While both neighborhoods in this thesis were affected by large-economic developments, the effect on social factors varied based on development type; the CBA/arena reduced violence while violence increased and collective efficacy reduced from the casino. Previous research has similarly noted large-economic developments differentially disrupt communities, but how is little understood.²⁵² For instance, we showed the effect of the opening of a casino is similar to deteriorated buildings which both increase neighborhood violence.^{222 223} Features of the environment affect reported collective efficacy by changing experiences,²¹¹ we expand to

demonstrate two developments features have time-varying effects on collective efficacy and perceived neighborhood violence.

Sparse literature exists regarding the social effect of the opening and operation of casinos arenas in conjunction with a CBA. Specific research regarding the effect of the introduction of arenas are limited, without a community benefits agreement, concentrating on economic indicators,^{95 145 147} but no study has examined the effect on violence, collective efficacy, or perceived neighborhood violence. In contrast, studies have examined the effect of a casino on violence, but the results are mixed.^{91 123-136} While no studies have examined casinos or arenas on change in collective efficacy, in previous studies that have examined casinos and perceived neighborhood violence, the results were mixed^{122 157 158 193 194}

6.2 Large-Economic Developments and Violence

While our findings are similar to some previous studies regarding casinos and violence, current evidence is may be mixed due to variations in methodological choices.^{91 123-136} These limitations are 1) usage of large experimental geographic areas including states and cities, 2) questionable comparison groups, and even if appropriate missing a concurrent comparison times, and 3) inadequate follow-up time to account for outliers within the overall trend. Important to our approach was improvement upon previous studies regarding large-economic developments, including those uncovered in the casino literature by using a difference-in-difference framework to refine these approaches by using neighborhoods, a concurrent comparison group, and lengthy time-series before and after the intervention.

No previous studies have examined the effect of arenas with or without a CBA on violence, but prior reviews have consistently concluded arenas overall have no overall effect on the economic indicators, employment and income.^{95 145 147} Similarly to the large-economic development literature, the results on economic indicators varied by type of arenas, suggesting factors such as amount of arena use is important.^{148 151 152 154 155} While concentration of negative economic indicators are statistically significantly related to levels of violence through predictor or as a mediator, the effect of an arena on economic indicators is not necessarily predictive of the effect on violence.^{10 29-34 37 67 278} Previous studies concerning CBA's are limited to narrative reviews or characteristics of differences between locations of CBAs.¹¹⁰⁻¹²¹ To our knowledge, our study is the first study to specifically assess the effect of an arena and CBA on violence or social factors.

6.3 Previous Difference-in-Difference Studies

Only two previous studies used a difference-in-difference approach, but was only used for a casino and economic indicators. Both studies concluded economic indicators were positively affected by the casino. Geisler looked at the introduction of casinos in riverboat states, Illinois, Indiana, Iowa, Louisiana, Mississippi, Missouri, and the effect on employment and income at the county-level. Using difference-in-differences approach found that income rose (+\$917, 3.9%) and unemployment drops (-0.51%), in casino counties but the effect leaked outside of the casino counties neighboring counties experienced a smaller increase in income.²²⁸ By using Pittsburgh neighborhoods as geographic areas, we took advantage of the cultural independence of neighborhoods to control for leakage of the effect outside of the area. Wolfe et al. used a

difference-in-difference framework with annual data from 1988 to 2003, and matched tribes with and without casinos. The authors found that the difference-in-difference estimator was significantly associated with an increase in income ($b=1.75$, $SE=0.62$, $p\text{-value} < 0.01$).²⁷⁹ However, we improve upon these approaches by using smaller geographic areas. Both of these studies used economic indicators only and did not include violence outcomes in their studies.

6.4 Small Geographic Areas

While the current study concentrates on a place-based approach by employing census tracts as neighborhoods, many previous studies tended to concentrate on counties or cities. Usage of large geographic groups leads to a result different from ours as crime is not distributed uniformly across geographically or temporally but “var[ies] substantially at different levels of spatial and temporal resolution”.¹³⁹ When smaller census tracts were used, as in our studies each large-economic development was associated with a change in violence. An advantage of Pittsburgh when conducting the natural experiment is neighborhoods are relatively independent geographically and culturally, suggesting each geographic area can be thought as a different unit and census tracts can easily be used. A place-based theoretical approach, such as routine activities theory, suggests usage of smaller geographic areas on the scale of census tracts to measure interaction between actors of violence.²⁵⁶

A common approach analyzed the effects of developments using all counties (a large geographic area) within a single state, and in contrast to our results, the effect of a casino was determined to be non-significantly related to violence in three of the four studies. Mays et al. examined violence rates within New Mexican counties from 1991 to 1999 by comparing 6 casino

introduction counties to all other counties in New Mexico. The introduction of casinos did not change violence within intervention counties.¹²³ In a study tracking opening of casinos in Michigan counties, Gazel et al. suggested the presence or opening of a casino did not change violence.¹³⁰ Falls and Thomson used data from 1994 to 2010 for all 84 Michigan counties, and introduction of a casino did not increase rates of robbery in casino counties.¹²⁹ This approach is also limited through comparison groups inclusive of both urban and rural counties. A comparison group with both county types may be inappropriate as violence trends are different between urban and rural areas casinos tend to be larger and more lucrative in rural than in urban areas.^{133 218} In addition, our results may differ as in our approach only urban counties were included in the comparison group.

Many policing policies, like hot-spots policing, are commonly based counts of violence; similarly, we designed our study to use counts.²⁸⁰ Hot-spots policing is an approach identifying clusters of violence within a neighborhood, so increased police resources are often sent to the “hot-spots”.^{281 282} Since the present sports and entertainment arena attracts individuals into the area, the population at risk for violence is commonly thought to include the visitors to the area.⁹¹ In the single study showing casinos associated with violence using a state-wide approach, Reece examined violence after gambling legalization during 1993 in Indiana’s counties from 1994-2004. After visitors were taken into account, in communities where casinos opened robbery decreased in the first two years after the casinos and assault statistically significantly reduced after 2 years.⁹¹ These results contradict ours, but visitors are included in the rates of violence. In studies that compared both including and excluding visitors in the violence rates, the relationship between casinos and violence would either disappear or change signs based on presence of daily visitors in population at risk.^{91 134-136} We used counts as many policing policies including “hot-

sports” policing are based counts of violence and not rates.²⁸⁰ Others point out the population at risk is ill defined as violence occurs in a public place, offering a hypothesis for the inconsistent results.²⁸³

Important to our place-based approach is specification of the geographic area, as violence varies dramatically between smaller geographic areas. By performing the analysis at the city or larger areas the effect of the arena can be misattributed to other events.^{37 139 170} A few previous studies concentrating on arenas and economic indicators acknowledged in larger spatial areas economic outcomes can be drowned out by larger economic forces.^{154 155} Agha used smaller metropolitan areas and van Holm used census tracts to showed income increased.^{155 284} By using census tracts within Pittsburgh to show violence increased, we controlled for spatial variation common to violence.

In studies that argued against using smaller spatial areas, Baade et al argued the effects commonly “leak” out of smaller areas, but Baade and Propheter et al. suggested using too large of cities the small effect of the arena was unlikely to be related to a statistically significant effect on local economy as the economy is too large.^{149 150 154} In a series of three studies by Baade et al. income and employment was uniformly found to be not associated with arenas even as the approach was refined.¹⁴⁸ Saito et al. showed some arenas increased income, but only 6 of the 10 metros reached statistical significance.¹⁵¹ Propheter examined 24 cities and arenas were not associated with change in income but the effect varied by time period.¹⁵⁴ By partnering the development with a CBA, positive effects are hoped to stay within the neighborhood.⁵ In the legally binding CBA for the Hill District, the addition of a grocery store, a master plan for the neighborhood, and promoting of hiring within the neighborhood was expected to offset the

addition of the arena by increasing residential engagement and controlling for “leakage” out of the neighborhood.⁸

The effect by geographic area size extends to the effect on social indicators. For instance, the impact of a casino or arena could be different in struggling communities with high unemployment as there is stronger support for a casino when the economic impact on the area was positive¹⁵⁶ or a person works at casino,¹⁹⁴ so we concentrate on neighborhoods. In addition, individuals who live close to a casino have stronger opinions than those who live farther away, so using a large geographic area could dilute the effect of the casino and arena.^{194 275 276} Previous designs are improved on by examining smaller areas, Pittsburgh neighborhoods,¹⁶³ and using this approach we showed casinos decreased collective efficacy.

6.5 Comparison Groups

In our study, we improved upon a second limitation of previous approaches by electing to include only the city of Pittsburgh as our study population and consequently as the comparison group. Our results correspond to subset of studies when the comparison group corresponded to a single geographic region. In contrast to our approach, many previous studies lack a concurrent comparison group or use questionable comparison groups. In a group of studies which picked comparison groups based on matching characteristics, results either non-significant or were inconsistent within the study. Honore et al. compared two counties where casinos opened in the Mississippi region to control counties without casinos matched on social and racial/ethnic backgrounds. Data was taken from 1993/1995 to 2004 with the baseline year at the time-point when a single casino opened, and casinos were not associated with changes in rates of violent

crime or changes in unemployment.¹²⁷ In this study, a pre-intervention time-series was absent limiting the necessary pre-intervention time trend. Stitt et al. examined the effect of casinos on violent crime in six communities after the introduction of casinos to six control communities matched on socioeconomic variables, and four years before the opening of the casino were compared to four years after opening. In some locations violence rates increased while in others rates decreased or no significant differences were present.¹⁹⁵ As above, all of these studies suffer from usage of large geographic areas, counties or cities, and the variation in results could be from the multiple communities and controls due to unclarity which characteristics are important for matching.¹²⁸ To set our control, we take advantage of a difference-in-difference experiment which accounts for un-measured confounders by inclusion of a counterfactual.^{225 257} Here, the counterfactual is taken from other neighborhoods in Pittsburgh. By using a single city as our comparison group, city effects are controlled for and picking matching characteristics is avoided.

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When the comparison group was centered around a single geographic area, while methodological limitations exist, all studies showed results corresponded to our result. Albanese looked at index crime in Atlantic City from 1978 to 1982 after the introduction of the first casino in 1978 and subsequent building a total of 9 casinos by 1982, and found a strong correlation the increase in index crime and casino's in Atlantic city (0.96).¹³⁴ Hakim and Buck examined data from 1972 to 1984 from Atlantic City and surrounding communities in New Jersey. In all communities, the violent crime-rate increased after the introduction of the casinos when economic and social factors were taken into account.¹³¹ Curran and Scarpitti again examined Atlantic City and similarly found that overall index crime increased after the introduction of the casinos.¹³⁵ Chang examined the effect of the opening of casinos in Biloxi, Mississippi using police data from

1986 to 1994. In 1992 the first Casino opened, and by the end of 1994 ten casinos were in operation. While assault was not associated with the introduction of casinos, robbery statistically significantly increased after the introduction of the casinos.¹³⁶ While studies concentrating on a single city correspond to our results, a weakness of these studies is usage of large geographic areas and many do not have a long pre-intervention time period to capture overall trends.

We used neighborhoods in Pittsburgh without the construction of new arenas as our comparison group. Coates and Humphreys showed the effect of an arena varied by if the comparison group includes only areas with sports-teams vs. areas without sports teams.¹⁵³ In an initial study, Coates and Humphreys showed some arenas decreased income, while others showed no effect.¹⁵² In a subsequent study expanded for more sports and years Coates showed arenas reduced income, wage, and salary.¹⁵³ We showed the effect of an arena and CBA on violence did not appreciably change by inclusion of baseline or difference neighborhood characteristics that included economic indicators.

Similar choices were made for the survey as we are concentrating on one community versus comparing the effect across multiple communities as in previous studies concentrating on social factors.¹⁹⁶ When multiple communities are used, little is known on characteristics important for matching.¹²⁸ We matched neighborhoods within a single city to find collective efficacy, but not perceived neighborhood violence were significantly related to the introduction of the large-economic developments.

6.6 Short Time-Series

Our results regarding large-economic developments correspond to results when a longer time series of data is used. A third improvement from previous studies, is usage of longer time-series data. Many previous studies suffered from inadequate time post-intervention for by using shorter longitudinal data, results can be based on outlier years common in violence data.^{140 171 228} In the only study using neighborhood-level geographic areas, Johnson et al. examined the introduction of a casino in 2010 by using violent crime data from 2004 to 2011 for a neighborhood in Philadelphia. Violent street felonies, such as aggravated assault, did not increase by the opening of the casino in the neighborhood.¹²⁶ In a study that compared violent crime rates 1 year before a casino to 1 year after, Giacomassi and Stitt examined legalized gambling in Biloxi, Mississippi. Reports of aggravated assault or robbery increased across the change but change was not significant.¹²⁵ Wilson compared two cities in Indiana with the opening of a casino by including violence data from 1992/1993 to 1997 for each city, but only a year of data after the intervention was included. Violent crime was not significantly associated with the introduction of a casino in one city, but in the other city only aggravated assault statistically significantly increased (p-value: $0.02 > p > 0.01$).¹²⁴

In a study with longer follow-up, Grinols and Mustard tested US county-level data from 1977 to 1996 to track the expansion of casinos outside of Nevada. Overall, the effect on crime was low shortly after the casino opened and grew over time. For aggravated assault, the increase was only statistically significant after the third year of the casino opening. On the other hand, rates of robbery in casino counties increased as soon as the casino opened, but stabilized at a higher rate three years later.¹³² Like Grinols and Mustard who use a long time-series after a casino opened, we used five years of post-intervention data to show casinos increased violence. In addition to

controlling follow-up time, we restricted pre-intervention time-frame to restrict presence of large social or economic trends within a specific time period. For instance, the crack cocaine epidemic caused a large increase in violence in the 1980s and 1990s, and by starting our data in 2005 we restricted the effect of the crack cocaine epidemic.²⁸⁵ Methodological differences between our study and previous studies help to explain differences between results.

The same trends are found when economic indicators are used as previous authors have commented the study length is important, and only by using a long time-series can any effect be found.^{149 151-153} Previous studies applying longitudinal study approaches almost consistently showed casinos were associated with an increase in positive economic indicators. Rephann et al used county data from 68 US counties from 1988 to 1994 to show a larger growth in earnings than in employment..²⁸⁶ Cotti found using US data, and taking into account local economic trends, casinos were associated with increased employment increased employment and income.¹⁷⁰ Humphreys tracked data from 1991 to 2005 in the seven provinces which contain casinos. Employment increased in areas where casinos opened, but only over five years after the opening of a casino.¹⁶¹ Using Mid Atlantic states (DE, MD, NJ, NY, PA), Economopoulos showed initial employment increases in private, total, and retail employment, the longer the casino is in area the more employment decreases (“erodes”).¹⁷¹

In a series of studies by Walker et al., the causal impact of casino gambling profits and per capita income was evaluated. The first study showed a relationship when using quarterly data.¹⁶³ When using annual data for 15 years, the authors found that there was no evidence for Granger-causation in either direction with regards to casino profits and per capita income.¹⁶² To account for growth in the casino industry, the most recent study extended the data used to 2010 and added one additional state, and personal income increased in these states independent of the number of

“lag” years included in model.²⁵⁴ Using Native American tribes, Evans and Topoleski examined the employment effects of new casinos by comparing tribes that opened casinos to those that did not from 1983 to 1999. Four years after casino opened, employment for tribes with casinos increased by 26% compared to those without casinos.²⁸⁷ Hicks forecast income and compared this to actual income in Indiana counties from 1990 to 2008. Hicks found that there was a small income growth in counties with casinos, but in adjacent counties income declined.²⁸⁸ In line with our results, studies concerning casinos and economics consistently showed a positive effect on economic indicators. However, as in previous studies concerning casinos and violence these studies showed methodological weaknesses of large spatial areas, lack of concurrent comparison groups, and short time-series data. All of these studies use large geographic areas, like state-level data, the small effect of a casino is drowned out by larger economic forces.³⁷ By using smaller economic areas, in our study we are able to capture the effect of a casino on the local economy.

Following previous work on arenas and economic indicators, results similarly vary by time period used and depend on economic indicators. In a study (Propheter) of 24 metropolitan statistical areas with single-team arenas, the effect on income depended on time-period. Overall, arenas were not associated with change in income from 1979 to 2009, but in arenas built from 2001 to 2009 were associated with a small decrease in income.¹⁵⁴ By examining 37 metropolitan areas from 1969 to 1994, Coates et al. showed an arena decreased income.¹⁵² In a subsequent study, the authors included additional years, 1969 to 2011, added the sports hockey and soccer, additional economic variables, and all US metropolitan statistical areas. The effect varied, but if income was related, income decreased. Importantly, the effect varied based on if the comparison group was host or non-host cities to sports teams and by type of stadium.¹⁵³ In a study that examined the effect of arenas that tended to be in smaller metropolitan areas, the authors used 238

metropolitan areas between 1985 and 2006. In contrast to previous studies, the authors showed income increased, and the effect varied by time as the effect was stronger during the first five years.¹⁵⁵ We used the first five years after the arena and casino opened and showed a strong effect on violence.

The effect on social factors similarly was affected by time, so we used a time period to allow for updating of opinions. In a study examining mechanisms for which people change collective efficacy, Hipp suggested one year allows for residents to “update” their perception of collective efficacy based on neighborhood changes.²¹⁰ To provide the necessary lag time, the survey was conducted approximately one year after the arena construction and two years after the opening of the casino. Results of the survey correspond to a subset of studies as results of previous studies vary by temporal time included in the survey. Cross-sectional surveys comparing communities perceived impact of casinos and perception of crime found that perception of change in crime varied dramatically between communities.^{122 193 194} In contrast, a cross-sectional study by Long et al. showed all communities reported perceived crime increasing after the casino opened.¹⁵⁸ In the only longitudinal study, Carmichael et al. conducted three surveys in four years in a casino community and suggested residents perceived impact of casino violence worsened in every follow-up survey.¹⁵⁷ We did not find perceived neighborhood violence did not change, by the casino, but this may be due to size of geographic area used.

6.7 Social Fabric of Neighborhoods

Casinos and arenas are believed to harm neighborhoods by interfering with the neighborhood’s social fabric through increased traffic, pollution, changing land values, and

disruption in the neighborhood.¹⁰⁰⁻¹⁰² Previous studies regarding the effect of CBAs on local communities, are case-series or case studies, which outline the general effect of a CBA to suggest CBAs have varying effectiveness regarding neighborhood effects.¹¹⁰⁻¹¹⁸ Historically, CBAs were negotiated de novo or individually for each development, and in a review conducted by Wolf-Powers of 27 CBAs negotiated de novo concluded “local politics of organized labor; the accountability of the community benefits coalition to affected community residents; and most importantly, the role of local government in negotiation and implementation” play a key role in successful implementation of a CBA.¹¹¹ More recently, specific frameworks city-wide have emerged for implementation of new CBAs as more recently use of CBAs continues to grow.¹¹³ CBAs are thought to provide benefits to the community by introducing legal agreements between developers and community leaders that enumerates benefits such as grocery stores and jobs.^{5 113} Our results provide empirical support to the conclusion that CBA’s combined with a developments can provide positive benefits to a community by reducing violence. Carbone and McMillin suggest neither component of collective efficacy is associated with collective action,²⁷³ which might suggest why the arena and CBA did not change collective efficacy.

In a study of Business Improvement districts (a geographic area where local businesses are taxed for neighborhood improvement services) conducted by MacDonald et al., collective efficacy became an important adjustment in understanding the effect on BIDs and violence.²¹² Similarly, we showed a development decreased collective efficacy, but both of these studies only examined cross-sectional collective efficacy.

While studies have begun to understand the effect of cross-sectional collective efficacy, the mechanisms behind changing collective efficacy is poorly understood. Hipp showed in communities that perceived an increase in violence over the previous time period, collective

efficacy correspondingly decreased.²¹⁰ In a study of collective efficacy and violence rates over 3 time points, collective efficacy was not related to violence either simultaneously or after a 2 or 5 year lag, but an indirect relationship was suggested through the pathway of disadvantage.²⁷² In two studies examining change in collective efficacy, both Schmidt et al. and Sampson et al. measured collective efficacy over multiple-time points to suggest with an absence of changes to the physical environment, collective efficacy stayed constant.^{206 207} However, none of these studies examined the effect of interventions aimed at changing the environment on changing collective efficacy. In the few studies that examined interventions and changing collective efficacy,^{208 209} only Carlson et al. showed adults felt increased collective efficacy towards children in an intervention aimed at children disseminating HIV/AIDS information to adults.²⁰⁹ However, our study did not include children. By suggesting a casino decreased collective efficacy, our results suggest a development may meet the developer's goals, but can adversely affect a community.⁷⁵

6.8 Limitations in Designs

By using only police data where only a sub-set of violent incidents are reported, results may vary based on reporting of crime. In a study of reporting limitations, 60.9% of robberies were reported to police and 58.4% of aggravated assaults were reported to police.¹³ There is little overlap between police and hospital trauma data, except in the most serious cases of homicide fatalities. Seven-of-ten assault injury incidents that come to the attention of police or medical care providers involve contacts with only one of these systems.²⁸⁹ By only including a subset of crime, incidents included could be different from those in police data. Grinols suggest the effect of a

casino varies by time, and during the modeling process time trends were only accounted for by a covariate with the model so the effect of the intervention by time was not determined.¹⁴¹ Geisler and Nichols suggest the effect of multiple casinos is different from a single casino.²²⁸ Only a single casino within a city was used, so the effect may be different in another city or if multiple casinos were built. The effect of violence can leak outside of the geographic area into surrounding areas, and by using a GLMM in our analysis each census tract was treated as an independent unit.

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We are only studying short-term benefits, other studies have suggested longer-term benefits of an arena are different based on a theorized “novelty-factor” wearing off.^{150 152} We are only measuring the “honeymoon” effect of the arena. A “honeymoon” effect is regarded to last five to ten years after the opening of the stadium.^{238 239} Previous research suggests that there is a “honeymoon effect” where the initial effect of a stadium is stronger which lasts 10 years.²⁹¹ More recent research suggests that the honeymoon effect is shorter than the time used in previous studies and Agha used five years to adjust for this effect.^{155 238 239} A similar effect may occur for collective efficacy and perceived neighborhood violence. A certain amount of selection bias may occur as the intervention is implemented in a neighborhood with struggling communities. Females were more likely to participate and may report higher perceived violence than males. The average age is greater than 60, and older participants perceive greater neighborhood violence for same level of violence than younger individuals.²⁷⁷

6.9 Public Health Significance

As violence continues to be one of the leading public health problems in the United States, recent research suggests recent trends of violence are increasing by 3.7% from 2013 to 2017.²¹⁸ Policy makers argue the addition of arenas or casinos increase neighborhood economics and health, however, understanding the effect of the addition of an arena or casino to a neighborhood is little understood.^{74 143}

Construction of new sports and entertainment arenas or casinos are both increasing in recent years; new importance is placed for understanding the effect on local communities. New sports and entertainment arenas cost \$59 billion (adjusted for 2006 dollars) from 1950 to 2010, and construction is accelerating with over half of these facilities built since 1990.²¹⁶ Similarly, casino construction grew by 3.7% from 2006 to 2016, and by 2017 460 commercial casinos were open.²⁵⁹⁻²⁶¹ However, mechanisms behind these developments affecting the public health of neighborhood residents is little understood.

Comprehensive place-based development strategies offer new methods to change public health within communities, but little understanding exists regarding the effect of these developments within communities. By examining the effect of a casino and an arena along with a CBA, this work suggests social and violence characteristics within a neighborhood are changed depending on type of development and engagement within the community. A casino harms a community and should not be considered by policy makers to improve distressed neighborhoods, in contrast this research suggests casinos should be considered to be removed from distressed neighborhoods to provide public health benefits to these neighborhoods. An arena in conjunction with a CBA improved public health characteristics within neighborhoods.

6.10 Conclusions

A negotiated CBA in conjunction with an arena is associated with a decrease in mean counts of violence when compared to other Pittsburgh neighborhoods, but the effect is not mediated by SES. Efforts to involve community groups ensure opportunities for residents of distressed communities to participate in public forums and provide control over development in area. Findings suggest an arena combined with a CBA can improve a community, combining developments with local community groups can reduce violence, but future work should determine if the effect of a CBA generalizes to other types of developments.

Our findings suggest a casino increases violence in a neighborhood, and should not be considered as a policy to improve distressed neighborhoods. This increase could strain already distressed police departments with increased crime and negatively affect health and safety of local residents. Future studies should examine if neighborhoods can be protected against the negative impacts of casinos by modification of the casinos themselves.

While change in perceived neighborhood violence was not changed by the arena or casino. Change in collective efficacy was not impacted by the arena, but was decreased by the casino. In addition to harming the violence characteristics within the neighborhood, the casino interrupts the social fabric within the neighborhood suggesting disruption in protective factors from violence.

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