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Testing a promising homicide reduction strategy: re-assessing the impact of the Indianapolis "pulling levers" intervention

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Abstract Since the publication of analyses suggesting the significant impact on youth homicide of the Boston "pulling levers" intervention, a series of studies of similar strategies have indicated promise in reducing homicide and gun assaults. One of these studies was an assessment of a pulling levers strategy in Indianapolis, where trend analyses indicated a significant reduction in homicide following the intervention, while six other similar Midwestern cities did not experience a significant decline in homicide. We re-assess the results of the Indianapolis study by disaggregating the offenses into gang- and non-gang homicides. Given that the pulling levers program focused on influencing gangs and networks of chronic offenders, the impact of the intervention should be more apparent for gang homicides than for non-gang homicides. Alternatively, should the impact be similar for non-gang homicides, then it is more likely that the downward trend would be caused by unmeasured external forces. Coefficient-difference tests relying on estimates obtained from autoregressive integrated moving average (ARIMA) time–series models indicate that gang homicides declined significantly more than did non-gang homicides following the Indianapolis intervention. These findings suggest 'something happened' to gang homicides that did not happen to non-gang homicides, which adds further support that the pulling levers initiative was the driving force behind the overall reduction in homicide in Indianapolis.

Keywords Autoregressive integrated moving average (ARIMA) time–series analysis · Pulling levers · Quasi-experimental design · Threats to validity

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Homicide in the United States of America reached an unprecedented peak in the late 1980s and early 1990s and then declined at an equally dramatic rate (Blumstein et al. 2000). More specifically, homicide rates declined from 9.4 per 100,000 in 1990 to roughly 5.5 per 100,000 in 2000, according to the Uniform Crime Reports (2005). Researchers contend that there were a number of reasons for the reduction in homicide over this period, such as the change in the drug market, economic expansion, efforts to decrease general access to firearms, a rise in the prison population, and the police response to gun carrying and gun crime (Blumstein and Rosenfeld 1998; Blumstein et al. 2000).

A number of law enforcement agencies responded to the peak in homicide by implementing problem-oriented policing strategies because of their promise and potential to reduce crime (Decker 2003; Huff 2002). Problem-oriented policing involves the identification of problems at the local level, the analyzing of local information, and the crafting of a response uniquely suited to each particular problem, rather than sole reliance on traditional arrest-driven practices (Goldstein 1990). One such approach that has gained popularity over the past decade has been the use of a "pulling levers" strategy, which was established in Boston as a vehicle to reduce youth homicide and gun violence (Braga et al. 2002; Kennedy et al. 1997).

Pulling levers is a violence reduction strategy that combines problem solving and focused deterrence with linkages to services and opportunity provision. The focused deterrence component involves direct communication of a deterrent message to a specific group of targeted individuals. The communication is done in a group setting and typically involves high-risk offenders who have gang or similar network connections. The pulling levers strategy employs a focused deterrence approach that uses a variety of sanctions to sway groups of chronic offenders from continuing their pattern of violent behavior. This is enhanced due to the criminal histories and extensive court involvement that is typical for most of these high-risk individuals.

The linkages to services component of the pulling levers strategies also include community-based action, social service, and opportunity provision components. This is intended to increase the legitimacy of the deterrence message as well as provide opportunities as an alternative to continued criminal activity.

The problem solving component of pulling levers typically involves police–researcher collaboration, whereby researchers identify patterns of offenders, groups, and situational contexts involved in violence. This is intended to support the focused aspect of the focused deterrence strategy.

The focused deterrence, direct communication, and problem solving components are integrated when key leaders of criminal justice agencies work together to inform chronic offenders of the sanctions they face if they continue to engage in violent crime (Kennedy 1997). Offenders are informed that there will be high inter-agency cooperation to seek the maximum penalty for violent offenses. Crackdowns on gang members and offenders that continue to engage in violence and gun crime are often used in combination with the deterrence-based meetings to increase the perceived threat of sanctions for illegal gun carrying and use.

For example, in Boston, the multi-agency task force focused their efforts on the Intervale Posse gang, which was described as the worst crack-era gang in the city (Kennedy et al. 2001: 32). The Posse gang was a well-known gang that participated in such activities as selling crack cocaine, invading homes, and attacking young

people who ventured onto their turf. The specific crackdown on the gang was preceded by a crackdown on another gang and followed by several additional crackdowns on gangs believed to be involved in gun crime (Kennedy et al. 2001). Similarly, when Minneapolis officials adopted the Boston pulling levers strategy, they increased the sanctions available to them by using federal weapons offense charges on the "Bogus Boyz", which was a crew of offenders that was believed to be responsible for a large number of violent street crimes, including the accidental killing of a young boy in a street shootout (Kennedy and Braga 1998).

The important point from the two previous illustrations is that key agency officials often use the example of a local crackdown to affirm the commitment of the focused deterrence message and the severity of the sanctions offenders face if they do not cease participating in violent activities. From a theoretical perspective, pulling levers interventions can be considered focused deterrence strategies based on the characteristics associated with offending and the criminal justice system response to offending. First, the strategy is specifically focused on the problem of gun crime. Second, this type of strategy is based on the long-established conclusion that a small number of offenders accounts for a disproportionate number of crimes (Moore 1984). Third, the strategy takes advantage of the fact that much of this chronic offending occurs within a group setting. Consequently, pulling levers relies on gangs and networks of crews or offenders to communicate the deterrence message to those most at risk for gun offending and victimization. Finally, since the strategy is both implemented and supported by a multi-agency working group, there is a variety of sanctions available that can be used against offenders. Thus, the involvement of many agency members focused on a specific problem should increase the severity and certainty of penalties, leading to alterations in perceptions about sanctions and risk. Deterrence scholars discuss how offenders are constantly revising their perceptions of the risks and rewards of criminal behavior based on new information (Horney and Marshall 1992; Nagin 1998). This is particularly relevant, given the cohesion and communication networks among gang members (McGloin 2005). The pulling levers meetings and an affirmative follow-up response are the types of new information that may cause offenders to reassess the risks of committing gun crime.

In addition to the deterrence component, the pulling levers strategy also frequently includes the use of pro-social groups, such as community and church leaders, at the local level to offer offenders a variety of positive program alternatives in addition to the sanction laden message. The use of positive social groups is designed to reduce defiance (Sherman 1993) and make offenders aware that their former actions are the target of the task force, not themselves personally. In addition, Rosenfeld and Decker (1996) proposed that the reliance on community members in a strategic program sends a clear message that continued offending would not be tolerated when agents of the community are involved. Additionally, the pro-social groups attempt to link participants to legitimate services (e.g., employment, housing, mentors, drug treatment) and, thus, represent a form of social support (Cullen 1994).

While the Operation Ceasefire project originated in Boston (see Braga et al. 2001 for a discussion), the pulling levers deterrence strategy has since been replicated in other U.S. cities, including Baltimore, MD (Braga et al. 2002), Chicago, IL

(Papachristos et al. 2007), High Point, NC (Coleman 1999), Indianapolis, IN (McGarrell and Chermak 2003a, b), Los Angeles, CA (Tita et al. 2003), Lowell, MA (Braga et al. 2008), Minneapolis, MN (Kennedy and Braga 1998), and Stockton, CA (Braga 2008; Wakeling 2003). At the national level, Dalton (2002) describes how the pulling levers framework has been applied in a large number of U.S. cities and federal districts through the Strategic Alternatives to Community Safety Initiative (SACSI) and Project Safe Neighborhoods (PSN).

Assessing the pulling levers intervention

The results from research analyzing the impact of pulling levers initiatives have been impressive. Violent gang offending slowed dramatically, and youth homicide in Boston fell by two-thirds after the strategy was put into action (Kennedy 1997). Boston experienced a 63% reduction in the monthly number of homicides following the intervention (Braga et al. 2001). The intervention also produced significant reductions in shots fired, gun assaults, and youth gun assault. The 'optimal break' in the time–series was in the subsequent months after Ceasefire had been implemented (Piehl et al. 2003). The evaluation from Operation Ceasefire also suggested that the reduction in youth homicide in Boston was unique and distinct when compared with youth homicide trends in most major U.S. cities, including those in the northeast (Braga et al. 2001).

In a study designed to analyze homicide trends in the 95 largest U.S. cities during the 1990s, using growth-curve models, Rosenfeld et al. (2005) found evidence that Ceasefire was associated with a larger decline in youth homicide in Boston than in other U.S. cities[1], but suggested that the small number of youth homicide incidents limits the ability to derive strong conclusions based on their analysis.[2] Thus, both Braga et al. (2001) and Rosenfeld et al. (2005) relied on multi-site comparisons when attempting to assess the Ceasefire initiative, and both studies were suggestive of an impact.

In addition to the Boston study, five additional research evaluations from Chicago (Papachristos et al. 2007), Indianapolis (McGarrell et al. 2006), (East) Los Angeles (Tita et al. 2003), Lowell (Braga et al. 2008), and Stockton, CA (Braga 2008) utilized quasi-experimental designs. Indianapolis relied on an approach similar to Boston's where researchers found a 34% reduction in homicide following the pulling levers intervention. McGarrell et al. (2006) also analyzed homicide trends in six Midwestern cities that were similar to Indianapolis in terms of size and demographics and found that only Indianapolis experienced a significant reduction in the number of monthly homicides at the time of the intervention. Chicago and Los Angeles evaluations relied on treatment and comparison groups *within* each city. In Chicago, treatment neighborhoods experienced a statistically significant decline

[1] Also included in the assessment by Rosenfeld et al. (2005) was the New York Compstat program (see Kelling and Sousa 2001 for a discussion) and the Project Exile program in Virginia (see Raphael and Ludwig 2003 for a discussion)

[2] It should also be noted that Berk (2005) raises a number of methodological and statistical limitations in the Rosenfeld et al. (2005) manuscript.

relative to comparison neighborhoods (Papachristos et al. 2007).[3] In Los Angeles the evaluation showed that focused enforcement produced a significant short-term reduction in violent and gang crime in target areas relative to comparison areas (Tita et al. 2003). Braga et al. (2008) conducted analyses of before-and-after trends in gun violence and found a reduction in Lowell that was consistent with a unique program effect relative to other major Massachusetts cities. An evaluation of the Stockton initiative shows a statistically significant reduction in gun homicide following implementation of their pulling levers program while simultaneously showing that eight additional mid-sized cities in California (i.e., comparison sites similar to Stockton) did not experience a decline during the same period (Braga 2008). Sudden and abrupt decreases in homicide were also observed in Baltimore (Braga et al. 2002), Minneapolis (Kennedy and Braga 1998), and High Point, NC (Coleman et al. 1999). While research from these sites is also suggestive of a decline, the evaluations of these interventions were limited to single site, before-and-after assessments.

Furthermore, previous evaluations of the multiple pulling levers initiatives have focused heavily on changes in the trends of homicide and gun-related homicide. While we certainly agree that proper evaluations should focus on a change in these types of outcome measures, we also argue that another important contribution to this literature would be to draw from prior homicide research that specifically focused on the situational and contextual differences between gang and non-gang homicide. Homicides occur for a variety reasons, and many scholars argue that we cannot assume that the same factors characterize and predict these variant types of violent offenses (Fox and Zawitz 2002). Thus, our paper focuses on a more detailed examination of disaggregated homicide trends.

Homicide disaggregation: gang and non-gang homicide

Researchers interested in explaining the different forms of homicide have examined many components of the event, including, but not limited to: the victim–offender relationship, the age, race, and gender of the victim and/or suspect, and the unique circumstances of the event (Decker 1996; Decker and Van Winkle 1996; Fagan 1989; Kubrin 2003; Maxson and Klein 1990; Maxson et al. 1985; Parker 2001; Pridemore 2002; Riedel 1987; Wolfgang 1958). In particular, prior studies have indicated that gang homicides are more likely to include multiple suspects and involve use of firearms as the method of death than are non-gang homicides (Decker and Curry 2002; Maxson and Klein 1990, 1996; Maxson et al. 1985; Parker and Johns 2002).

Previous research has also demonstrated that gang homicides are more likely to be motivated by the drug market. The participation of gang members in illegal drug sales is well established across a variety of studies (Decker and Van Winkle 1996; Fagan 1989, Maxson et al. 1985; Vigil 1988). Blumstein and Wallman (2000) linked the temporal sequencing of the rise in homicide in the early 1990s with the emergence of street drug sales. Blumstein and Wallman concluded that this was

[3] The pulling levers element of the Chicago strategy was rooted among several other violence prevention approaches (see Papachristos et al. 2007)

particularly true for crack cocaine sales, where distributors began arming themselves with firearms as a means of safety and protection. Relevant to our study, it is apparent that the use of firearms as the method of death, the higher number of suspects, and the increased likelihood of drug-related motives are previously established correlates of gang homicide.

A relatively recent development in homicide research has been to examine the relationship between structural measures and gang homicide. Drawing from the greater ecological literature on homicides in general, Land et al. (1990) reviewed findings from 21 studies that addressed the question of whether structural covariates explained homicide trends across time and space. Land et al. (1990) reported that three effects were consistent correlates of homicide in terms of strength and statistical significance: deprivation index, population structure index, and percent divorced. Land and colleagues concluded that these factors showed a strong relationship to homicide trends and to subsequent changes in homicide. In another study designed to assess the change in U.S. city-level homicide rates during the 'homicide epidemic' in the latter decades of the 20th century, Messner et al. (2005) found that cities experienced meaningful and significant increases in homicide due to changes in structural conditions. Specifically, Messner et al. (2005) showed that cities characterized by high levels of economic deprivation tended to exhibit an earlier and immediate change in homicide rates than did other cities. Other areas of inquiry have examined the extent to which structural indicators predicted homicide subtypes (Kubrin 2003) and, more relevant to our study, have delineated gang homicides from non-gang homicides.

Recent gang homicide studies have found that structural effects, including economic deprivation, and social disorganization do not significantly delineate gang homicides from non-gang homicides.[4] In terms of structural measures, Rosenfeld et al. (1999) examined the relationship between neighborhood disadvantage, neighborhood instability, and race across sub-categories of homicide. Their models showed that neighborhood disadvantage and poverty were insignificant predictors when race was included in their models. They concluded that both gang and non-gang homicides were highly concentrated in disadvantaged neighborhoods that were situated in predominantly African American communities in St. Louis (Rosenfeld et al. 1999: 514). Pizarro and McGloin (2006) extended this body of research by examining gang and non-gang homicides in Newark, New Jersey, from January 1999 through July 2004. In their final statistical model, Pizarro and McGloin (2006) combined an incident level variable that captured escalation (see Decker 1996) with the three macro-level variables. Controlling for incident (a level 1 situational measure) and percent African American (a level 2 structural measure) appeared to wash away the delineating effects of poverty. Their social disorganization variable did not significantly differentiate between gang and non-gang homicides in any

[4] It is important to note that the first major study that examined the neighborhood–gang homicide relationship was conducted by Curry and Spergel (1988). They found that gang homicides were more likely than non-gang homicides to occur in socially disorganized areas. However, their study was limited to data in Chicago between 1978 and 1985 (i.e., prior to the gang homicide epidemic). In addition, their focal point of 'disorganization' mostly involved the percent of Hispanics living in a community (i.e., ethnic heterogeneity). More recent studies have failed to find a substantive relationship between structural measures and gang homicide when compared with non-gang homicide.

model in this study. Pizarro and McGloin's research supported the findings by Rosenfeld et al. (1999) that neighborhood disadvantage does not significantly delineate gang homicides from non-gang homicides. Thus, prior research indicates that homicide trends are highly correlated with specific structural conditions, but that many of these same structural conditions do not have delineating power between gang and non-gang homicides.

Drawing from this literature, our study is based on two major propositions: first, some scholars contend that many of the observed changes in city level homicide rates cannot be attributed to pulling levers initiatives because extraneous factors might have been the influence behind the changes in homicide in these cities. Given that Land and colleagues' (1990) review of research found that homicide trends are highly correlated with specific structural factors, one could argue that changes in these factors could have strongly influenced the observed changes in Indianapolis between 1997 and 2001. We contend that a more comprehensive analysis of disaggregated homicide trends would minimize this concern, since relatively recent gang homicide research has not found empirical support for the power of structural conditions to delineate between gang and non-gang homicide. Second, the strategic approach that was utilized in Indianapolis was specifically aimed at gangs and networks of chronic offenders. Thus, we posit that the pulling levers intervention should have its greatest impact on gang homicides. The purpose of our study was to assess whether gang homicides decreased at a greater rate than did non-gang homicides in order to test the hypothesized intervention effect and to minimize the concern that substantive external factors were the reason for the overall decline in homicide following the Indianapolis pulling levers intervention.

Analytic framework

This study attempted to improve upon prior pulling levers evaluation research by examining the impact that the Indianapolis pulling levers strategy had on gang homicides relative to non-gang homicides. The Indianapolis study was designed and implemented by a multi-agency task force known as the Indianapolis Violence Reduction Partnership (IVRP). The data used to address this research question included all homicides that occurred in Indianapolis between January 1997 and June 2001. We hypothesize that gang homicides in Indianapolis should have experienced the greatest overall reduction following the IVRP pulling levers intervention, since it was this form of homicide that was the specific focus of the IVRP working group.

As stated above, prior research found that Indianapolis had experienced a decline in overall homicide following the IVRP intervention and that six similar Midwestern cities had not experienced a similar decline during this same time period (McGarrell et al. 2006). Yet, the Indianapolis results were based on an overall decline in homicides. A stricter test of the pulling levers hypothesis is that the greatest impact of the intervention should be on gang rather than non-gang homicides. The prediction that the pulling levers meetings in Indianapolis would have a specific effect on gang homicide is based on the fact that the IVRP strategy focused on specific gangs and communicated this message in a series of face-to-face meetings with groups of chronic offenders drawn from identified gangs and neighborhood

crews. The meetings sought to change the perception of the likelihood of sanctions for illegal gun possession and use as well as create a perception of group accountability for gun violence. Some support for this assertion that the meetings might have had an impact on perceptions came from a multi-stage (i.e., before–after design) survey of arrestees. Chermak and McGarrell (2004) showed that offenders in Indianapolis believed they were significantly more likely to go to prison for the commission of homicide in Wave 2 (after the pulling levers intervention) than in Wave 1 (before the pulling levers intervention).[5] Thus, there is some evidence that offenders were aware of the increased sanctions for violent crime.

We also examined key demographic and situational measures of the gang homicide categorization as a way to cross-validate the official classification of gang homicide (i.e., offenses where at least one actor was part of a group of known, chronic offenders). More specifically, prior gang research shows that there are key demographic correlates of the actors that have been consistent predictors of gang homicides when compared with non-gang homicides, which include the age, race, and gender distribution of the actors involved. This body of research shows that participants in gang homicides tend to be younger, non-white, and male (Decker and Curry 2002; Maxson et al. 1985; Pizarro and McGloin 2006; Spergel 1983). In terms of the situational features of the events, gang homicides often include multiple suspects, involve the use of firearms, and are more likely to be drug related than are non-gang homicides (Blumstein and Wallman 2000; Decker and Van Winkle 1996; Maxson and Klein 1990; Maxson et al. 1985; Fagan 1989; Vigil 1988). Thus, we include this information as it pertains to the gang homicide classification.

Data source

The problem-solving component in the IVRP pulling levers initiative was implemented through a police–research collaboration involving a team of researchers from Indiana University and a local research organization, the Hudson Institute. The researchers had conducted a detailed problem analysis that indicated that over half of the city's homicides involved gangs or groups of known chronic offenders. Beginning in January 1997 through the end of June 2001, the researchers coded information about homicides (n=563) during bi-monthly incident meetings.[6] These sessions were case-by-case reviews of homicide incidents by teams of detectives, street-level officers, prosecutors, probation and parole officers, and other criminal justice actors. The incident reviews took advantage of the detailed knowledge of cases possessed by criminal justice officials as well as their knowledge of the social

[5] While this finding supports the 'awareness' of offenders in the IVRP, Chermak (2007) found in a later evaluation that implemented an experimental design in Indianapolis that offenders' in the two treatment groups (law enforcement and community probationers) as well as the control group had similar recidivism patterns.

[6] The research team observed the incident reviews and coded a variety of dimensions of the incidents. Some details, such as whether the incident was gang motivated or drug motivated, could not be reliably coded due to a lack of information. However, two-person independent coding revealed congruence of over 90% on whether the incident was gang-involved, drug-involved, the type of weapon, and for other variables described herein.

networks in which many offenders and victims were involved and the areas where street violence frequently occurred (McGarrell and Chermak 2003a, b). Of particular importance was the fact that the incident review findings revealed patterns of violence in Indianapolis that were not available in official data sources. Specifically, they revealed the high degree of gang-involved incidents that shaped the overall pulling levers strategy. As the incident reviews continued, they also provided real-time information about the actors involved as well as the networks engaged in homicides and shootings. This information was used to select groups called in to pulling levers notification meetings.[7]

We used time–series analysis as the primary analytic strategy to assess the impact that the IVRP pulling levers intervention had on gang homicides compared with non-gang homicides. Bushway and McDowall (2006) referred to the interrupted time–series design as a preferred analytic strategy to test whether specific types of crime alter at specific points in time. Specifically, autoregressive integrated moving average (ARIMA) models are used to assess the impact of the pulling levers change on both gang and non-gang homicides (McCleary and Hay 1980). In order to evaluate whether the intervention reduced gang homicides significantly more than non-gang homicides, we used coefficient comparison tests (Clogg et al. 1995; Paternoster et al. 1998), which have been used in prior research to test differences in coefficients derived from ARIMA time–series models in a similar fashion (Simpson et al. 2006).

Description of variables

The unit of analysis in this study was the month, while the outcome measure was the event, measured as a gang homicide or a non-gang homicide. In terms of the coding of these offenses, the research team in Indianapolis only coded an offense as a gang homicide if there was confirmatory evidence presented at the review. Specifically, an incident was defined as a gang homicide if an actor was a confirmed gang member within the police department's formally defined definition of a gang, if at least two review participants independently provided information indicating prior gang involvement, or if at least two participants could describe the known group of offenders by a combination of name, territory, and known associates (McGarrell and Chermak 2003a: 64). In this case, a gang homicide referred to any homicide that involved either a victim or suspect who was a gang member or was part of a known periphery gang network (i.e., known associates). It did not indicate that the specific homicide was gang-motivated but rather gang-involved. In essence, this was a more 'loose' classification, which is often referred to as the "Los Angeles" definition of gang affiliated homicides (Maxson and Klein 1990).

In terms of the incident, Table 1 displays the distribution of gang homicides that occurred in Indianapolis between 1 January 1997 and 30 June 2001. Gang homicides included those homicides where either the victim or the suspect was involved with a known group of gang offenders (i.e., gang affiliated homicide). Slight majorities of

[7] Chermak (2007) later found that, in subsequent years, it became difficult for the IVRP task force to maintain the tight connection between the incident reviews and the groups targeted for pulling levers.

Table 1 Total number of homicides in Indianapolis classified by type

Homicide Type	Number	Percent
Non-gang	271	48.1
Gang	292	51.9
Total	563	100

the total number of offenses were classified as gang homicides (51.9%) compared with non-gang homicides (48.1%).[8]

The dichotomous intervention measure (0=pre-intervention, 1=post-intervention) used in our analyses was based on the joint federal–local investigation known as the Brightwood Investigation (for more detail see McGarrell and Chermak 2003a, b; McGarrell et al. 2006) that occurred on 5 April 1999. The investigation was a multi-agency initiative focused on a high crime hotspot (known as Brightwood) that led to the arrest of 16 individuals, the seizure of 78 firearms, 12 kg of powered cocaine, 500 g of crack, and over US$150,000 in cash. In terms of the pulling levers initiative, the arrests and prosecution of the Brightwood gang were exploited by members of the task force as an example of the "zero tolerance policy of violence" in Indianapolis (McGarrell et al. 2006: 220).

Specifically, a series of pulling levers meetings held before the Brightwood crackdown had informed gang members that violence would yield focused enforcement against the gang.[9] In addition, task force members used the investigation as a vehicle to engage key community leaders who could reach gang members regarding the increased law enforcement attention to gun crime. Thus, community leaders and police personnel worked together to inform gang members that they were not going to continue to tolerate gangs terrorizing neighborhoods. The message was also combined with a communication of social support, encouraging offenders to take advantage of pro-social opportunities to make changes to their lifestyle and behavior.

Key demographic and situational correlates that have been previously established indicators of gang homicide are indicated in the subsequent tables. In terms of the demographic measures, these include the actor's age, race, and gender (Bowker et al. 1980; Curry and Spergel 1988; Decker 2003; Decker and Curry 2002; Maxson et al. 1985; Spergel 1983). The key situational measures include detailed information about the homicide incident. Information was coded as to whether the incident was gun-related or drug-motivated and whether there were multiple suspects, which are all strong correlates of gang homicide (Blumstein and Wallman 2000; Decker and Van Winkle 1996; Fagan 1989, Maxson et al. 1985; Vigil 1988).

[8] In order to assess the face validity of the gang/non-gang homicide classification in Indianapolis, we compared gang homicide rates in other cities. Since this study relied on the Los Angeles definition of gang homicide, it was important to compare the proportion of gang homicides observed in Indianapolis with that in Los Angeles. Nearly 45% of all homicides in Los Angeles were gang related between 1994 and 1995 (Maxson 1999). In Newark, NJ, homicides were gang related in 40% of the cases between 1999 and 2004 (Pizarro and McGloin 2006). Thus, the proportion of gang related homicides in Indianapolis (51.9%) was consistent with that in prior gang research.

[9] Between October 1998 and May 1999 a total of 17 pulling levers meetings were held. Eight occurred prior to the Brightwood arrests and nine subsequently thereafter. Approximately 320 individuals attended these meetings (McGarrell and Chermak 2003a).

Table 2 displays the percent of non-white[10] actors involved in the different homicide subtypes. Gang homicide offenders and victims were considerably younger than non-gang homicide actors. In gang homicides the victim was non-white 84.8% of the time, compared with non-gang homicides, where 63.1% of the cases involved a non-white victim. In gang homicides the suspects were non-white 89.9% of the time, while suspects in non-gang homicides were non-white 63.2% of the time.[11] In addition, 88.9% of gang homicide victims were male. Comparatively, in 69.2% of the non-gang homicides, the victim was male. Finally, suspects were male in gang homicides 95.9% of the time, while the suspects were male in 83.2% of the cases in non-gang homicides. Thus, the classification of these gang homicides was consistent with that in prior research.

Effect of the IVRP intervention

One way to examine whether homicide patterns changed following the IVRP intervention is to compare the percentage change across homicide types (i.e., gang and non-gang homicides) between pre- and post-intervention. Table 3 displays the number of gang and non-gang homicides in Indianapolis. Gang homicides declined by 45.5% following the pulling levers intervention, compared with non-gang homicides that declined by 15.6%. In addition, we include the distributional change in homicide types by including key situational measures that have been linked with gang homicide through prior research. As Table 3 indicates, homicides that were firearm-related, drug-motivated, and involved multiple suspects all declined following the IVRP intervention.[12]

Results

As an initial step, we displayed the monthly homicide trends in the Indianapolis data between January 1997 and June 2001. Each month was operationalized as running

[10] The original race categories were white, African American, Hispanic, and other. The use of non-white as a dummy variable serves both theoretical and empirical purposes. First, prior gang research has shown that African American communities (Kubrin and Wadsworth 2003) and Hispanic communities (Curry and Spergel 1988) are at greater risk for gang activity. Second, Hispanics made up a very small percentage of both victims and suspects in Indianapolis homicides. Specifically, where the race of the actor was known, Hispanics made up fewer than 2.9% (29 of the 1,027 known victims and suspects combined) of the cases. Thus, for theoretical and empirical clarity, Hispanics and African American actors were collapsed into a non-white category.

[11] The joint distribution of inclusion concerning the victim's demographic information was 95.2% (536/563). Comparatively, 36% (203/563) of the suspects' demographic data were coded as missing due to a high number of unknown suspects. Where there were multiple suspects per homicide incident (122 incidents in total, or roughly 17.9%), the average age, proportion of non-white, and proportion of male individuals per incident were used where the demographic information of the suspect was known.

[12] There were 563 total homicides between January 1997 and June 2001. Some homicides were not included in the distribution of the situational measures due to missing or incomplete data on the incident. These incomplete data varied by measure. Thus, missing data were excluded from the situational distribution seen in Table 3. There were complete data for 98.2% (553/563) of the firearm-related offenses, 86.8% of the drug-motivated offenses (489/563), and 98.5% (555/563) of the homicides that involved multiple suspects.

Table 2 Key demographic measures by homicide type (*SD* standard deviation)

Parameter	Gang Homicide				Non-gang Homicide			
Age	Number	Mean	Median	SD	Number	Mean	Median	SD
Victims	289	28.2	25	11.4	247	34.4	30	18.4
Suspects	170	24.3	22	19	190	29.9	26	13.2
Non-white	Number		Percent		Number		Percent	
Victims	289		84.8		247		63.1	
Suspects	170		89.9		190		63.2	
Male	Number		Percent		Number		Percent	
Victims	289		88.9		247		69.2	
Suspects	170		95.9		190		83.2	

from its first through its last day. Figure 1 shows the trend in both gang and non-gang homicide in Indianapolis across the entire distribution. Analogous to the assumption of a normally distributed dependent variable when a least-squares regression model is used (Berk 2003), a major statistical assumption in an ARIMA time–series analysis is variance and mean stationarity (i.e., stability) across the trends being modeled (McCleary and Hay 1980). As shown in Fig. 1, both the numbers of gang and non-gang homicides appear to drift downward at a time that corresponds to the intervention date of April 1999. The augmented Dickey–Fuller unit root test indicated the presence of a unit root, which means that a drift (or trend) existed in the original series. To address the concern that both types of homicide were potentially 'regressing toward the mean' at the time of the intervention, we transformed the series, using the natural logarithm of each month's value in the subsequent ARIMA models as a way to control for variance instability over the time–series (McCleary and Hay 1980). This reduced the series into a white-noise process (see Fig. 2 in Appendix A), which is an assumption of ARIMA modeling.[13]

Examination of the autocorrelation function (ACF) and partial autocorrelation function (PACF) indicated that neither standard nor seasonal trends existed in either model. More specifically, the ACF and PACF revealed that there were no significant correlations at key lags, as indicated by the Box–Ljung Q-statistic for each model's series of residuals. This indicates that neither autoregressive nor moving average components needed to be included in the models. Thus, estimation of the impact of the IVRP intervention only contains the transfer function, since all of the assumptions of the ARIMA models were met.

Given that ARIMA time–series approaches have been criticized by some criminologists as "more art than science" (Kleck 1997), we were diligent in meeting the assumptions of the tests, as noted above. This criticism is in light of the Box–Jenkins ARIMA approach that requires an iterative process: identification, estimation, and diagnosis. We closely examined the intervention date and found the 'optimal break' (Piehl et al. 2003) indeed occurred in the series of homicides in April 1999. Results obtained from a maximum likelihood mean reduction estimate showed that the greatest decline in the homicide series occurred in April 1999,

[13] The augmented Dickey–Fuller unit root test indicated that the transformed series were stationary, meaning that the variance in the series was sufficiently stable over time to meet the assumptions of the subsequent ARIMA models (McCleary and Hay 1980).

Table 3 Change in homicide in Indianapolis following the IVRP intervention

Homicide Type	Before the IVRP Intervention	After the IVRP Intervention	Total number	Percentage Change
Number of non-gang homicides	147	124	271	−15.6
Number of gang homicides	189	103	292	−45.5
Situational measures				
Percent firearm-related	77.4	67.4	553	−10.0
Percent drug-motivated	57.8	53.2	489	−4.6
Percent with two or more suspects	19.5	8.5	555	−11.0

lending further support to the notion that the intervention date had both substantive and statistical credibility (see McGarrell et al. 2006: 233).

More specific to our study, we followed Cochran and colleagues' (1994) assertion that the functional form of the intervention should also be explored empirically with the disaggregated homicide types as well. Thus, we estimated both zero-order (abrupt, permanent) transfer functions as well as first-order (pulse, gradual) transfer functions for the series of gang and non-gang homicides. The results were consistent with our theoretical expectation, that the permanent transfer function was the more appropriate model, as well as with prior research that both gang and non-gang homicides were more likely to follow an abrupt, immediate decline following the IVRP intervention date of April 1999. Both sets of rate-change parameters (δ) were statistically significant in the zero-order and first-order models, indicating that the functional form of the distribution fit both sets of models. When this is the case, the Akaike information criterion (AIC) is often used for model comparison purposes (McQuarrie and Tsai 1998). Results indicated that the more parsimonious model was the zero-order model than the first-order model for both gang homicides (105.8< 106.1) and non-gang homicides (71.72<80.45).

Table 4 presents the impact assessment of the IVRP pulling levers initiative for gang and non-gang homicides. Both gang homicides and non-gang homicides declined between pre- and post-IVRP intervention. Gang homicides experienced a statistically significant decline ($P<0.01$) of 38.1% following the IVRP intervention.

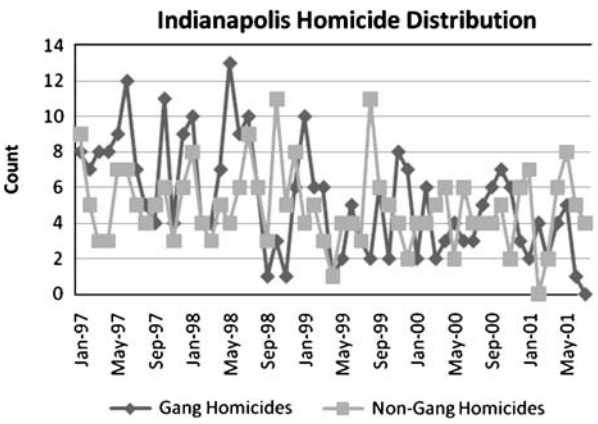

Fig. 1 Distribution of homicides in Indianapolis

Table 4 Time–series analyses for disaggregated homicide by type in Indianapolis (*s.e.* standard error)

Homicide Type	Pre-intervention Mean	Post- intervention Mean	ARIMA Model			Intervention Coefficient (s.e.)	*P*	AIC
			P	d	Q			
Gang-homicides (Ln)	1.73	1.25	0	0	0	−0.481 (0.172)	<0.01	105.8
Non-gang homicides (Ln)	1.56	1.47	0	0	0	−0.09 (0.126)	0.443	71.72

Comparatively, non-gang homicides declined by 8.6%, but the decline was not statistically significant (p=0.443).[14] This means that we rejected the null hypothesis that the decline in gang homicides following the IVRP intervention was due to chance, while we could not rule out that the decline in non-gang homicides was due to chance. All the assumptions of ARIMA modeling were met with these models; specifically, that none of the Box–Ljung Q-residual statistics was statistically significant after inclusion of the transfer function in either model.

While the above analysis indicated that the reduction in homicides was more evident in gang homicides than in non-gang homicides, in terms of magnitude and statistical significance, this comparison alone was limited, due, largely, to the fact that the statistical tests and subsequent coefficients were independent of one another (Clogg et al. 1995: 1263). Thus, we relied on an equality of regression coefficients test (Clogg et al. 1995; Paternoster et al. 1998), where the null hypothesis states that the difference between the gang and non-gang homicide coefficients is zero. This approach was also consistent with previous research comparing ARIMA estimates between models (see Simpson et al. 2006). Given that both estimates in the above model were negative, meaning a reduction had occurred in both gang and non-gang homicides following the 'intervention component' modeled in the series, our hypothesis was directional (i.e., the reduction in gang homicides was greater than the reduction in non-gang homicides). Consistent with a directional hypothesis, we employed the one-tailed distribution (z-critical=1.65) with an alpha level=0.05 (Greene 1993).[15] Table 5 displays the results, which indicated that the decline in gang homicides was significantly greater than the decline in non-gang homicides following the IVRP intervention.

Discussion

In terms of our findings, prior research indicates that overall homicide in Indianapolis experienced a statistically significant decline of 34.1% following the

[14] In order to calculate the percentage change, we used the multiplicative inverse of the natural logarithm, which means we used exponentiation on the raw coefficients and subtracted 1.0. Thus, gang homicides declined by 38.1% (0.681−1.0=−0.381) and non-gang homicides declined by 8.6% (0.913−1.0=−0.086) following the IVRP intervention.

[15] Again, the use of a one-tailed distribution when assessing the differences between ARIMA coefficients had been performed in prior research (Simpson et al. 2006).

Table 5 Coefficient difference test comparing gang homicides with non-gang homicides (*β1* gang homicide coefficient, *β2* non-gang homicide coefficient)

Difference Test	Change in Coefficients (Δ)	Absolute Sum of Errors (Σ)	z Value	*P*
β1–β2	−0.391	0.213	−1.835	<0.05

IVRP pulling levers initiative (McGarrell et al. 2006). Our results examining the change in disaggregated homicides indicated that gang homicides experienced a statistically significant decline of 38.1% following the IVRP. Comparatively, non-gang homicides experienced a decline of 8.6%, but the decline was not statistically significant. In addition, the difference coefficient test indicated that the decline was significantly greater in gang homicides than in non-gang homicides following the IVRP intervention.

One issue of concern in examining the results is whether the classification of gang homicide changed over time. This is magnified by the fact that the gang classification was driven by the participants in the IVRP meetings and then coded by the research team. The threat is that, over time, IVRP participants would be less likely to classify homicide participants as gang involved. Although this threat could not be eliminated, countervailing pressures were evident. Specifically, when the results of the initial incident review revealed the high level of gang involvement in homicides, the chief and the command staff began to place a high level of emphasis on gang activity. This was observed in the police department's Compstat meetings, in increased training of patrol on gang awareness, and in pressures on patrol to fill out gang contact sheets. Given this level of attention, the organizational pressures were to classify incidents increasingly as gang-involved during the intervention period. The fact that the number and proportion of gang homicides declined despite these pressures is suggestive of programmatic impact.

Additionally, as a way to triangulate the measurement validity of our gang homicide outcome measure, we also included bivariate trend analyses of measures that prior research has shown to be consistent with gang homicide. Homicides that were firearm-related, drug-motivated, and involved multiple suspects declined over this same before–after intervention period. Thus, all the analyses presented here were very consistent and painted a similar picture. The disaggregation of homicide into offense types showed that gang homicide declined significantly more than non-gang homicide did following the IVRP pulling levers intervention.

Another limitation to our study is that we did not have specific measures of city-wide structural factors and their rate of change over this period in Indianapolis, including measures of deprivation, social disorganization, and population density. Yet, while their relationship with homicide in general is well established, prior research also suggests that these factors exert a similar effect on gang and non-gang homicides. Thus, based on prior research, we concluded that it was unlikely that a significant change in these factors in the spring of 1999 would have generated this impact on gang homicide but not on non-gang homicide. Further, it is highly improbable that such structural factors would produce such an abrupt decline in one type of homicide. However, we do acknowledge that improvement in the structural conditions could have had a direct effect, with those individuals

more likely to have been influenced by gang behavior (i.e., poor, young, inner-city racial minorities) in Indianapolis. Further research in this area is certainly warranted.

Berk (2005), Levitt (2004), and Wellford et al. (2005) contend that the reduction in homicide that is often associated with the implementation of pulling levers strategies could also have been influenced by other factors, such as increases in the number of police, the rising prison population, the legalization of abortion, and the reduction in the crack-cocaine epidemic. Indeed, the research that examined the distinctions between gang homicides and non-gang homicides had not controlled for structural factors such as these. Perhaps, most importantly, it is unlikely that these factors, with the possible exception of a sudden increase in police levels, which did not occur in Indianapolis during this period, would produce a sudden and abrupt impact on gang homicide as opposed to non-gang homicide. Perhaps, the greatest threat is that the Brightwood crackdown produced an impact on homicide through the associated incapacitative effect of the 16 individuals who were arrested and prosecuted. Although the incapacitation of high rate violent offenders could reasonably be expected to have had an impact, particularly in the Brightwood neighborhood where the group controlled drug selling activity, several factors make us question this rival explanation. First, the impact on gang homicide was city-wide and not driven by the effect within the Brightwood neighborhood. Second, the Brightwood group was one of a large number of groups believed to be involved in drug distribution. Although the multiple arrests may have prevented their involvement in street violence during the evaluation period, their arrests would also seem to have created the potential for violence, given the void in control over drug trafficking in the Brightwood neighborhood. Third, the 16 targets did not all have violent backgrounds, at least based on official records. Finally, this type of crackdown occurs fairly regularly in a city like Indianapolis but without routinely producing a city-wide decline in gang homicide of this magnitude. What was different in this instance was that the crackdown was combined with a direct communication strategy aimed at high-risk groups of known chronic offenders believed to be involved in, or at risk of being involved in, gun violence. However, we, too, acknowledge that these and other factors could have had both a direct and indirect effect on the reduction of gang homicides relative to non-gang homicide.

We agree with Berk (2005), Sherman and Weisburd (1995), and Wellford et al. (2005) that it is impossible to know just how much of a decline in crime can be attributed to a strategic intervention (such as the mixed deterrence/social support model that was implemented in Indianapolis) without an experimental design. Certainly, it will be challenging to implement a pulling levers experiment. The most promising opportunity may be to use a randomly selected gang target area in which to implement the treatment and then to contrast this with comparison areas. As discussed in detail in a scholarly exposé between Berk (2005) and Rosenfeld et al. (2005), it is impossible to rule out the extent to which external forces played a part in the decline of homicide at the macro-level absent an experimental design.

These limitations aside, the results from this study show that the driving force behind the decline in overall homicide in Indianapolis (see McGarrell et al. 2006) was the specific decline in gang homicide. Our analyses indicated that gang

homicides experienced a statistically significant decline, while non-gang homicides did not. In addition, the rate of decline of gang homicides was greater than that of non-gang homicides. Thus, whatever the process behind the decline in homicides in Indianapolis was, it affected gang homicides significantly more than it did non-gang homicides. The fact that the IVRP strategy specifically focused on targeting and reducing gang homicides lends support to the idea that pulling levers had a substantive effect on the reduction in the number of gang-involved fatalities that occurred in Indianapolis.

These findings contribute to the relatively small yet growing pool of research that shows problem-oriented policing and pulling levers strategies can have a substantial effect on the reduction of homicide. At a minimum, these results support the continued implementation and testing of the pulling levers model to address the tragic level of gang violence in the U.S.A. The initial evaluations of the Boston (Kennedy et al. 1996) and Minneapolis (Kennedy and Braga 1998) pulling levers interventions were based on simple before-and-after comparisons. These were later supplemented by a quasi-experimental evaluation in Boston (Braga et al. 2001) and similar quasi-experiments in Chicago (Papachristos et al. 2007), Indianapolis (McGarrell et al. 2006), (East) Los Angeles (Tita et al. 2003), Lowell (Braga et al. 2008) and Stockton (Braga 2008). Given the consistency of these findings, clearly it is time for rigorous experimental trials of the pulling levers strategy. The advantages of randomized experiments are well known and have led many researchers to advocate their use when assessing the impact of social interventions (Berk and Sherman 1988; Judd and Kenny 1981; Riecken and Boruch 1978; Sherman and Weisburd 1995). Although pulling levers initiatives are challenging to implement, and until a research team implements an experimental design in this area, we simply cannot know the true extent to which such initiatives change city-wide homicide patterns. We hope the results presented here add weight to the notion that such a design is warranted and long overdue.

Appendix A

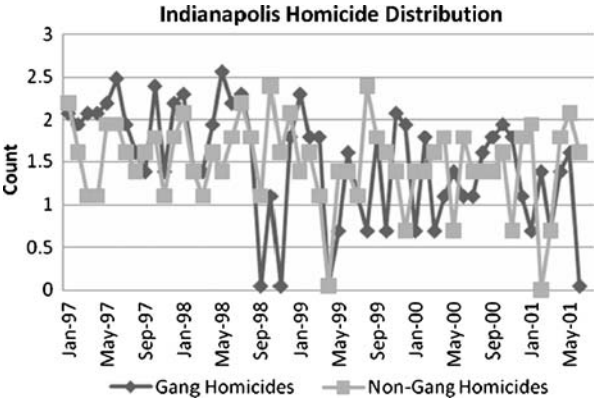

Fig. 2 Natural logarithm of the transformed series of gang and non-gang homicides in Indianapolis

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