



## Analysis of the factors influencing multiple uses of crime guns: An exploratory study

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### ARTICLE INFO

#### Keywords:

Gun crime  
Crime guns  
NIBIN  
Neighborhoods  
Crime

### ABSTRACT

**Purpose:** A broad body of literature has explored the topic of gun violence in the United States. The characteristics of communities, victims, and offenders have each been used to explain variation in gun crime. Less attention has been given to covariates of repeat use of crime guns. We examine the influence of neighborhood and initial incident characteristics on the odds that crime guns will be used in multiple incidents.

**Methods:** We apply binary logistic regression to a sample of 309 crime guns used in offenses in a city in the Southeastern U.S. to examine how neighborhood and initial incident characteristics influence the likelihood that a crime gun will be used in multiple incidents.

**Results:** We find that neighborhood levels of disadvantage and violence, gang involvement during the initial incident, and time in circulation following initial use in a known crime impact the odds that crime guns will be used in more than one offense.

**Conclusions:** Taken together, the findings lead to clear policy implications in terms of improved police-community relations, reconceptualization of case closures, and prioritization of crime gun seizures.

### 1. Introduction

The release of the 2020 Uniform Crime Report data led to headlines across the United States focusing on the increase in violent crime from 2019 with attention drawn to firearm use (see UCR 2021). The Pew Research Center expands on this, finding about 30% of the increase in murders are by firearm (Gramlich, 2022). Not surprisingly, this increase in firearm use / gun violence has been met with research focusing on trying to understand the increase, often through a COVID-19 framework (e.g., Brantingham, Tita, & Mohler, 2021; Kim, 2022; Kim & Phillips, 2021). COVID-19 aside, extant literature tends to focus on characteristics of communities, victims, and offenders to explain variation in either the likelihood and/or frequency of gun-related crime (e.g., Burgason, Thomas, & Berthelot, 2014; Bushman et al., 2016; Dierenfeldt, Thomas, Brown, & Walker, 2021; Lizotte, Krohn, Howell, Tobin, & Howard, 2000). However, considerably less attention has been given to crime

guns themselves and the factors that influence their use in multiple offenses.

Indeed, the literature has implied, albeit unintentionally, that each gun crime involves a unique firearm—effectively ignoring the possibility that one crime gun could be involved in multiple gun crimes. Research that has offered more direct attention to guns themselves frequently does so from a perspective of gun availability, typically through the percent of suicides by firearm (Cook, 1979; Kleck, 2015; Kleck & Paterson, 1993) or number of stolen firearms (e.g., Dierenfeldt, Brown, & Roles, 2017; Stolzenberg & D'Alessio, 2000). The current study departs from these trends through exploration of the extent to which contextual and initial incident characteristics influence the likelihood that a crime gun will be used in multiple offenses.

Drawing from structural (e.g., Shaw & McKay, 1942) and subcultural (e.g., Anderson, 1999) theoretical perspectives, this study explores how neighborhood conditions influence multiple uses of crime guns.

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<https://doi.org/10.1016/j.jcrimjus.2023.102049>

Received 15 December 2022; Received in revised form 30 January 2023; Accepted 2 February 2023

Available online 9 February 2023

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Research continues to indicate gun crimes and violence are more prevalent in disorganized neighborhoods but the impact of these factors on the likelihood that crime guns will be used in multiple incidents is less understood. We also explore the extent to which the use of crime guns in multiple incidents is influenced by characteristics of the original offense—such as gang involvement and offense severity. Finally, we shed light on the relationship between time in circulation and the likelihood of a crime gun being used in multiple offenses—an issue overlooked in the extant gun literature. Binary logistic regression techniques are applied to data obtained from the National Integrated Ballistic Information Network (NIBIN) lead logs maintained by Chattanooga Police Department, a medium sized city in the Southeastern United States, as well as sociodemographic data drawn from the American Community Survey (ACS) 5-year summary files. Our findings illustrate the importance of contextual and incident characteristics on the odds of repeated use of crime guns, as well as implications for policy and practice.

## 2. Review of the literature

Research on the use of crime guns is sparse and has instead focused on the factors that shape the frequency and likelihood of gun crime. For example, the literature has established that gun violence permeates urban communities characterized by high levels of disadvantage (e.g., Dierenfeldt et al., 2017; Kovandzic, Schaffer, & Kleck, 2013; Spano & Bolland, 2013). Such findings are consistent with the tenets of social disorganization theory, as multiple researchers have established the relationship between structural deprivation, weakened social controls, and increased violence (Maimon & Browning, 2010; Sampson & Groves, 1989; Sampson, Raudenbush, & Earls, 1997; Shaw & McKay, 1942). Building from this line of inquiry, Burgason et al. (2014) found that aggravated assaults and robberies committed in communities marked by elevated levels of disadvantage and violence were more likely to involve the use of a firearm—a finding consistent with Anderson (1999) description of the impact of street culture. These effects could be further amplified by the presence of and involvement in gangs through their subcultural influence on the nature of violence, as well as the provision of illicit guns to their members (Cook, Harris, Ludwig, & Pollack, 2015; Cook, Ludwig, Venkatesh, & Braga, 2007). The impact of these factors on the likelihood of repeat use of crime guns remains an open empirical question.

### 2.1. The impact of structural characteristics on crime

Neighborhood explanations of crime stem from the early work of Chicago School theorists (e.g., Burgess, 1925; Park, 1925; Park & Burgess, 1924). Shaw and McKay (1942), in particular, contributed to the reframing of crime as a product of community characteristics rather than the individual. Their theory of social disorganization suggested that crime was driven by the transmission of deviant subcultures nested within communities marked by increased levels of transience, structural deprivation, and ethnic heterogeneity. Owing to its reformulation as a theory of social control by Kornhauser (1978), as well as important contributions from Bursik and colleagues (Bursik, 1986; Bursik, 1988; Bursik & Grasmick, 1993; Bursik & Webb, 1982) and Sampson and colleagues (Sampson et al., 1997; Sampson & Graif, 2009; Sampson & Groves, 1989; Sampson, Morenoff, & Earls, 1999), the social disorganization perspective continues to inform studies of the impact of community characteristics on criminal outcomes. In their totality, these works consistently demonstrate the extent to which concentrated disadvantage and residential instability undermine the networks of informal social control responsible for inhibiting crime and deviance.

Importantly, structural indicators of socioeconomic deprivation are

strongly correlated with neighborhood racial composition. This reality is a product of the post-WWII national level shift from a manufacturing to service industry (Bursik & Grasmick, 1993; Wilson, 1980, 1987)<sup>1</sup> and increased race-based residential segregation (Massey & Denton, 1988, 1993; Peterson & Krivo, 1993). This period saw the flight of middle-class Whites and Blacks from urban centers as they migrated to newly developed suburban communities, allowing for the uproot, relocation, and concentration of successively poorer groups into the neighborhoods they had abandoned (Bursik & Grasmick, 1993). These disparities were further exacerbated through disinvestment by real estate and banking industries within communities of color (Lacker, 1995; Metzger, 2000).<sup>2</sup> What followed was a well-documented continuum of urban decline defined by the deterioration of physical and social environments (Bradford & Rubinowitz, 1975; Bursik & Webb, 1982; Skogan, 1986; Wilson, 1987). Within these structurally marginalized and socially isolated communities, violence became increasingly common (Cerda et al., 2010; Immergluck & Smith, 2006; Krivo & Peterson, 2000; McCall, Land, & Parker, 2010; Parker & McCall, 1999; Peterson & Krivo, 1993; Velez, 2009). Moreover, these conditions gave rise to cultural adaptations centered on the use of violence, often involving firearms, as a means of achieving status and respect (Anderson, 1999; Blau & Blau, 1982; Massey & Denton, 1993).

### 2.2. Codes of violence in the urban milieu

A broad body of literature has described the genesis of subcultures of violence within structurally deteriorated and socially isolated communities that lack formal control mechanisms (e.g., Anderson, 1999; Black, 1983; Nisbett & Cohen, 1996; Reed, 1982). These conditions lend themselves to the development of situational scripts that guide the behaviors of residents, promoting self-help social control in response to appropriate situational cues (Black, 1983; Copes & Hochstetler, 2003; Copes, Hochstetler, & Forsyth, 2013). The use of violence in these contexts is either encouraged or tacitly accepted as a means of achieving status and respect, as well as in defense of oneself and property (Gastil, 1971; Hackney, 1969).

Anderson (1999) noted the rise and entrenchment of such a subcultural influence in his ethnographic study of impoverished African-American Philadelphia neighborhoods. Anderson described a 'code of the streets' characterized by the rejection of mainstream norms and values that also maintained situational scripts for street-level interactions. Further, it is a subcultural orientation that promotes pre-emptive and retaliatory violence, conspicuous displays of wealth, and sexual promiscuity as mechanisms for achieving respect (Anderson, 1999). In the context of street culture, social status or 'juice' is strongly correlated with the ability to respond appropriately to verbal insults and physical threats, particularly those occurring in public settings (Anderson, 1999). Indeed, young males are expected and often encouraged to demonstrate their masculinity through acts of physical violence, often involving firearms (Anderson, 1999; Gau & Brunson, 2015; Haas, de Keijser, & Bruinsma, 2014; Jacobs & Wright, 2006; Matsueda, Drakulich, & Kubrin, 2006; Rosenfeld, Jacobs, & Wright, 2003). More than twenty years following its publication, Anderson (1999) work continues to have strong support within the literature, demonstrating its robustness as a theoretical explanation of urban violence (e.g., Burgason et al., 2020; Erickson, Hochstetler, & Dorius, 2020).

### 2.3. Street culture, gang involvement, and gun crime

Although Anderson (1999) did not specifically reference the

<sup>1</sup> See Cohen and Felson (1979) for similar arguments related to Routine Activities Theory.

<sup>2</sup> Mapping Inequality (Nelson, Winling, Marciano, Connolly, et al., 2022) provides historical shapefiles on redlining across American neighborhoods.

presence of gangs in his thesis, subsequent studies have described a number of similarities between street code adherents and gang-involved individuals (Matsuda, Melde, Taylor, Freng, & Esbensen, 2013). Both street culture and gangs tend to emerge in the presence of structural deprivation, and prey upon the frustrations and fears of young males (Anderson, 1999; Jacobs & Wright, 2006; Pyrooz, 2014). Moreover, they provide a means of status enhancement to individuals in communities where legitimate opportunities are often negligible (Cohen, 1955; Huebner, Martin, Moule, Pyrooz, & Decker, 2016; Miller & Brunson, 2000). These similarities extend to their relative influence on individual behaviors, as both gang-involved persons and street code adherents frequently exhibit higher levels of self-centeredness, quickness-to-anger, commitment to negative peers, lack of guilt, low-parental monitoring, and more time spent in unstructured environments that promote violence (Anderson, 1999; Decker, 1996; Matsuda et al., 2013; Mitchell, Fahmy, Pyrooz, & Decker, 2017). Further, street culture and gang involvement correspond with higher levels of legal cynicism, lower levels of cooperation with police, and violent offending while campaigning for respect (Anderson, 1999; Curry & Decker, 2003; Decker & Van Winkle, 1996; Hughes & Short Jr, 2005; Kirk & Papachristos, 2011; Kubrin & Weitzer, 2003; Rosenfeld et al., 2003).

Importantly, guns are highly prized among both street code adherents and gang-involved individuals, as they confer symbolic status to their owners (Goldsmith, Halsey, & Bright, 2022; Katz, 1988). An individual may treat a gun as an extension of their identity, as it represents wealth, power, and the readiness to protect themselves and their belongings (Goldsmith et al., 2022; Katz, 1988). With that, a gun not only increases the odds of success when carrying out a crime, but also satisfies a perceived need for self-protection from other criminally-involved individuals (Kleck & Hogan, 1999; Sheley & Wright, 1993; Wright & Rossi, 1986). It is therefore unsurprising that communities maintaining higher levels of disadvantage, violence, and gang activity also experience higher levels of gun crime (Burgason et al., 2014; Dierenfeldt et al., 2021; Huebner et al., 2016), as well as illicit gun trafficking among street code adherents and gang-involved persons (Braga & Cook, 2016; Cook et al., 2007; Cook, Harris, et al., 2015; Cook, Parker, & Pollack, 2015; Hureau & Braga, 2018). Specifically, several studies have noted that crime guns change hands within gangs with relative frequency, allowing gang members ready and continued access and for crime guns themselves to remain in circulation for years (Braga, Brunson, Cook, Turchan, & Wade, 2021; Cook et al., 2007; Cook, Parker, & Pollack, 2015; Goldsmith et al., 2022; Hureau & Braga, 2018; Wintemute, Romero, Wright, & Grassel, 2004).

#### 2.4. The current study

The extant literature provides an understanding of the influence of structural and incident-level characteristics on the frequency and likelihood of gun crime. Focus on 'gun crime' has, however, resulted in a comparative dearth of knowledge surrounding 'crime guns.' It is, after all, unlikely that every gun crime involves a unique firearm. The current study examines if similar community patterns emerge when known crime guns are used in multiple incidents rather than a single known incident. Indeed, given the symbolic status ascribed to firearms within communities marked by disadvantage and violence, as well as by gang-involved individuals, it is possible that many crime guns are used repeatedly. This led to the current study to ask the Primary Question: How do neighborhood and incident characteristics influence the likelihood of a crime gun being used in multiple offenses? This leads to the following hypotheses:

- *H1: Neighborhood levels of disadvantage and violence will share a direct, positive association with the likelihood that a crime gun will be used in more than one offense.* This is based on prior studies of the relationships between community characteristics and the likelihood of gun

violence (e.g., Burgason et al., 2014; Cook et al., 2007; Dierenfeldt et al., 2021; Huebner et al., 2016; Thomas & Drawve, 2018).

- *H2: A crime gun will have a higher likelihood of being used in multiple offenses if the original incident was gang-involved.* This is based on prior studies of the relationship between gangs and increased levels of gun violence (Huebner et al., 2016).
- *H3: A crime gun will have a lower likelihood of being used in multiple offenses if the original incident involved a homicide or aggravated assault.* Serious and violent offenses, such as murders and aggravated assaults using firearms, are more likely to reach the attention of police (Tarling & Morris, 2010). As a consequence, the firearms used to commit such crimes may be less likely to be used again. Indeed, offenders may be eager to create distance between themselves and such crime guns in order to avoid being linked with the associated offenses. Similarly, increased attention from police may lead to quicker case closure and firearm seizures in such instances.
- *H4: The impact of gang-involvement on the likelihood that a crime gun will be used in multiple offenses will be exacerbated by higher levels of neighborhood disadvantage and violence.* The presence of gangs tends to exacerbate levels of firearm violence within communities (Huebner et al., 2016). Moreover, Matsuda et al. (2013) and Mitchell et al. (2017) suggested that there are structural and behavioral overlaps between gang adherence and individuals who identify with Anderson (1999) code of the street. Given that incidents involving gangs may be nested within areas where codes of violent are more prevalent (e.g., Matsuda et al., 2013; Mitchell et al., 2017), and guns maintain symbolic importance among such actors (Anderson, 1999; Kleck & Hogan, 1999), H4 addresses this gap.
- *H5: The impact of offense severity on the likelihood that a crime gun will be used in multiple offenses will be conditioned by neighborhood levels of disadvantage and violence.* For similar reasons, neighborhood levels of disadvantage and violence may condition the impact of offense severity on the likelihood crime guns will be used again. Carrying a firearm and involvement in violence (e.g., physical disputes, assault) have each been associated with status enhancement among street code adherents (Anderson, 1999). One might carry a firearm to overpower an adversary, essentially increasing the odds of success when carrying out acts of violence (Kleck & Hogan, 1999). However, one might also carry a firearm in order to insulate against victimization. In either case, offenders may be more likely to retain possession of crime guns and use the same weapons repeatedly in communities where street code is entrenched.

### 3. Data, measures, and methods

Data used in this study are obtained from the National Integrated Ballistic Information Network (NIBIN) lead logs maintained by the Chattanooga Police Department (CPD). Analysis is restricted to the crime guns associated with 'cleared' offenses that occurred between 6/23/2013 and 10/31/2020 ( $n = 309$ ).<sup>3</sup> The authors are aware of the limitation of using crime guns rather than gun crime as an outcome event; however, given the lack of research focusing on crime guns themselves, less is known about their usage in space. The addresses of

<sup>3</sup> This approach presents in obvious limitation in terms of generalizability. The NIBIN lead logs listed 277 crime guns associated with 'active' investigations during the same observation period. However, data for these crime guns were systematically missing or incomplete on several key measures.

the original incidents in which these firearms were used are geocoded to census tracts located within the city of Chattanooga ( $n = 29$ ).<sup>4</sup> Relevant sociodemographic data for census tracts are drawn from the 2013–2017 American Community Survey (ACS) 5-year summary file. Finally, homicide rates are calculated using address-level shooting and homicide logs provided by CPD. All research protocols were reviewed and approved by the UTC Institutional Review Board (IRB# 20–171) in connection with a Department of Justice grant awarded to the Chattanooga Police Department through the Edward Byrne Memorial Justice Assistance Grant Program (2020-DG-BX-0008).<sup>5</sup>

### 3.1. Dependent variable

For the purposes of this study, ‘multiple offenses’ is conceptualized as the known use of the same firearm in more than one criminal act against person or property in the city of Chattanooga between 6/23/2013 and 10/31/2020. Thus, the dependent variable is operationalized as a dichotomous indicator (1 = yes; 0 = no) of whether a crime gun was used in multiple violent and/or property crimes in the city of Chattanooga between 6/23/2013 and 10/31/2020 according to the cleared cases listed within the CPD NIBIN lead logs. In other words, if the known crime gun was only connected to a single incident, it was coded as zero (0), and if the known crime gun was linked to two or more incidents, it was coded as one (1). A third (33.9%) of all known crime guns in our sample had been used in multiple offenses.

### 3.2. Independent variables

Consistent with prior works, concentrated disadvantage is operationalized through multiple indicators of socioeconomic deprivation from the 2013–2017 American Community Survey (ACS) 5-year summary file. These include tract-level measurements of the percent of the population living below the federally established poverty threshold, percent of the population that is unemployed, percent of the population that is Black, percent of households headed by a single female with children, percent of the population over the age of 25 that did not earn either a high school diploma or GED, and the percent of households participating in the Supplemental Nutrition Assistance Program (SNAP). Echoing previous research conducted by Burgason et al. (2014) and Dierenfeldt et al. (2021), the 3-year average homicide rate for each census tract is calculated as a neighborhood-level measure of violence. Obliquely rotated factor analysis indicates that neighborhood measures of concentrated disadvantage and violence converge on a unidimensional construct with an Eigenvalue of 4.581 and factor loadings in excess of 0.58. Consistent with the works of Burgason et al. (2014) and Dierenfeldt et al. (2021), these measures are retained as a summary index of neighborhood disadvantage and violence constructed as the average of standardized values ( $\alpha = 0.905$ ).

Similarly, ethnic heterogeneity is operationalized as the percent of the population that is either Hispanic or foreign-born as documented in

the 5-year ACS summary files. Again, factor analysis with an oblique rotation reveals that these measures converge on a single dimension with an Eigenvalue of 1.809 and factors loadings of 0.951. These measures are retained as a summary index of ethnic heterogeneity constructed as the average of standardized values ( $\alpha = 0.893$ ).

The literature has clearly demonstrated the importance of residential stability and community investment in the development and maintenance of informal networks of informal social control (e.g., Kasarda & Janowitz, 1974; Kornhauser, 1978; Sampson et al., 1997; Sampson & Groves, 1989). Consistent with prior studies, residential stability is operationalized as the percent of residents who lived in the same home for at least 1 year. Given that community investment is conceptualized as the infusion of lending capital into residential neighborhoods, this measure is operationalized as the percent of homes that are owner occupied.<sup>6</sup>

Neighborhood-level controls gathered from the 2013–2017 ACS 5-year summary files include age structure, income inequality, and total population. Age structure is conceptualized as the proportion of the population that are in their peak offending years, operationalized here as the percent of the population between the ages of 15 and 24. Income inequality is conceptualized as uneven distribution of income within a population, typified by the concentration of income within a small subset of residents. This measure is operationalized through the use of the Gini Index of income inequality, whereby a value of 0 indicates perfect equality and a value of 1 represents perfect inequality. Last, total population is operationalized as the total census tract population converted to its natural logarithm.

Multiple incident-level variables are drawn from the CPD NIBIN lead logs. Each is gathered from the original incident linked to each crime gun and geocoded to its corresponding census tract. Suspect identification operationalized as a dichotomous indicator (1 = yes; 0 = no) of whether or not the suspect(s) in the original incident linked to a specific crime gun was identified. Gang involvement is conceptualized as a criminal incident in which the suspect or the victim was a known gang member.<sup>7</sup> This concept is operationalized as a dichotomous measure with (1) indicating that either the suspect or victim associated with the original incident linked to a crime gun was gang-involved and (0) indicating that they were not gang-involved. Offense severity is operationalized through a dichotomous indicator measuring whether the original incident involved homicide or aggravated assault (1 = yes; 0 = no). Similarly, multi-victim incidents are operationalized via a dichotomous indicator of whether the original incident involved more than one victim (1 = yes; 0 = no). Finally, time in circulation is conceptualized as the amount of time between when a catalogued firearm was used in its first known criminal offense and when it was seized by police.<sup>8</sup> This measure is operationalized as the number of days between the

<sup>6</sup> Measures of home ownership and residential stability are frequently retained in summary indexes. In the present study, however, this measure lacked internal consistency ( $\alpha = 0.352$ ).

<sup>7</sup> The CPD Crime Gun Intelligence Center uses a triangulated approach to establishing gang involvement. The unit maintains an actively updated gang validation list that is then compared to the Tennessee Department of Corrections crime portal, which maintains its own validated gang list. This information is then compared to social media sites for mentions of shooting victims/suspects and their affiliations. Finally, this information is compared to statements provided by shooting witnesses/victims/suspects.

<sup>8</sup> The NIBIN Program produces digital images of the markings transferred to a bullet or cartridge found as evidence at a crime scene or used in functionality tests of seized firearms. These images are uploaded to the NIBIN database, and in turn, used for comparisons with other ballistic images that have been entered into the database. If images are matched, the evidence is further investigated by trained NIBIN analysts for confirmation. Confirmed matches are reported to investigators of the department in which the firearm has been associated with (National Institute of Justice, n.d.). This process determines if a firearm has been used in more than one offense.

<sup>4</sup> There are 56 census tracts located in Chattanooga. That all 309 crime guns were used in offenses located in only 29 of these census tracts is indicative of the extent to which gun violence is concentrated in the city of Chattanooga. Indeed, the 309 crime guns examined here are associated with 1095 gun crimes within the 29 census tracts included in the analyses that follow. Tracts were used over block groups given the distribution of crime guns across block groups reduced aggregate counts to a point that regression was untenable (i.e. nesting).

<sup>5</sup> This project was supported by Grant No. 2020-DG-BX-0008 awarded by the Bureau of Justice Assistance. The Bureau of Justice Assistance is a component of the Department of Justice's Office of Justice Programs, which also includes the Bureau of Justice Statistics, the National Institute of Justice, the Office of Juvenile Justice and Delinquency Prevention, the Office for Victims of Crime, and the SMART Office. Points of view or opinions in this document are those of the author and do not necessarily represent the official position or policies of the U. S. Department of Justice.

date a firearm was used in its first known crime and the date it was seized by CPD.<sup>9</sup> To address issues of skew and kurtosis, this measure is converted to its natural logarithm.

### 3.3. Analytic approach

This study adopts a multiple regression technique to explore the factors that influence the likelihood of a crime gun being used in multiple incidents. Considering the dependent variable is dichotomous in nature, binary logistic regression is selected as the appropriate statistical technique.<sup>10</sup> This approach utilizes a maximum likelihood method that involves calculating the natural log of odds that an event will occur. Simply put, this method is used to determine the probability of Y predicting X (0,1), with 1 being the desired outcome. Binary logistic regression is useful in that it does not require unbounded variables, does not assume linearity between the dependent and independent variables, and does not require normal distribution of the dependent variable.

## 4. Results

Descriptive statistics for all variables included in the analysis are displayed in Table 1. Fig. 1 is provided as a visualization of the tracts in Chattanooga with percent poverty displayed along with the 29 study tracts. Table 2 displays the results of the three binary logistic regression models used to test the effects of incident and neighborhood level variables on the likelihood of a known crime gun being used in multiple offenses. Model fit statistics showed that Model 1 improved from the constant-only model when predictor variables were added (-2 Log Likelihood = 328.722,  $\chi^2 = 67.358, p \leq .001$ ). Model 1 correctly clas-

**Table 1**  
Descriptive statistics (n = 309).

Variable	M / %	SD	Min	Max
Total Population	3884.7	1357	1194	6564
Total Population (Ln)	8.198	0.377	7.09	8.79
CDV Index	0.293	0.765	-1.15	1.61
Homicide Rate <sup>a</sup>	33.398	29.588	0	123.07
% Poverty	31.23	14.416	5.28	64.18
% Unemployed	7.452	4.145	0.1	15.34
% Black	62.836	25.374	4.67	94.41
% FHH	53.072	25.222	0	89.34
% Low Ed	20.522	9.823	4.47	42.23
% Snap	32.114	14.759	4.02	64.44
Ethnic Heterogeneity	-0.243	0.838	-0.96	2.3
% Hispanic	5.382	7.387	0	27.97
% Foreign Born	4.093	3.845	0.39	16.92
GINI Index	0.466	0.059	0.349	0.656
Residential Stability	85.156	6.92	60.69	95.74
Community Investment	44.972	15.753	1.17	68.22
Age Structure	12.933	3.395	5.9	22.83
Time in Circulation	163.776	297.004	0	2400
Days in Circulation (Ln)	3.01	2.502	0	7.78
Violent Incident	0.514	-	0	1
Suspect Identification	0.375	-	0	1
Gang Involvement	0.634	-	0	1
Multiple Victims	0.113	-	0	1
Multiple Offenses	0.339	-	0	1

Note: <sup>a</sup> Rate per 100,000.

<sup>9</sup> The reader should interpret this variable with caution, as the 'first criminal offense' refers to the first criminal offense that was known to police and reported in NIBIN. It is possible that a firearm was used in prior offenses unknown to law enforcement and the NIBIN Program.

<sup>10</sup> Hierarchical generalized linear models (HGLM) were first attempted. However, reliability estimates failed to meet the minimum threshold of 0.200, indicating that multi-level modeling was inappropriate.

sified 71.8% of cases. The findings are discussed in relation to each hypothesis.

**H1.** Neighborhood levels of disadvantage and violence will share a direct, positive association with the likelihood that a crime gun will be used in more than one offense.

Among the independent variables, three variables share statistically significant relationships with the outcome measure. First, the disadvantage and violence index shares a negative and statistically significant relationship with the dependent variable (OR = 0.604,  $p \leq .05$ ). In other words, there is a reduction in the odds that known crime guns will be used in multiple offenses if they were originally used in neighborhoods where codes of violence are more likely to be entrenched—a finding counter to the expectations expressed in Hypothesis 1.

**H2.** A crime gun will have a higher likelihood of being used in multiple offenses if the original incident was gang-involved.

In support of Hypothesis 2, there is an increase in the odds that known crime guns will be used in multiple offenses firearms if the original incident involved a suspect or victim who was a known gang member (OR = 3.075,  $p \leq .001$ ). Finally, time in circulation is associated with a positive and statistically significant increase in the odds that a known crime gun will be used in multiple offenses (OR = 1.410,  $p \leq .001$ ). Simply stated, the longer a firearm remains in the community following its known use in a crime, the more likely it is to be used in another offense.

**H3.** A crime gun will have a lower likelihood of being used in multiple offenses if the original incident involved a homicide or aggravated assault.

As seen in Table 2, all remaining variables, including severity of the original offense, fail to exhibit statistically significant relationships with the outcome measure. This prompts rejection of Hypothesis 3, as known crime guns used in a homicide or aggravated assault are no more or less likely to be used to additional offenses.

**H4.** The impact of gang-involvement on the likelihood that a crime gun will be used in multiple offenses will be exacerbated by higher levels of neighborhood disadvantage and violence.

Counter to this expectation, however, the interaction between the disadvantage and violence index and the binary indicator of whether the original incident was gang involved fails to achieve statistical significance (Model 2). This finding suggests that conditions that promote the entrenchment of codes of violence do not moderate the impact of gang involvement on the odds that known crime guns will be used in multiple offenses—prompting rejection of Hypothesis 4.

**H5.** The impact of offense severity on the likelihood that a crime gun will be used in multiple offenses will be conditioned by neighborhood levels of disadvantage and violence.

Consistent with this approach, Model 3 includes an interaction term between the community disadvantage and violence index and the binary indicator of whether the original incident involved a homicide or aggravated assault. Consistent with Hypothesis 5, the interaction is positive and statistically significant (OR = 2.873,  $p < .01$ ), indicating that the impact of offense severity on the likelihood that a known crime gun will be used in multiple offenses is exacerbated in neighborhoods maintaining comparatively higher levels of disadvantage and violence—conditions that encourage the rise and entrenchment of street culture.

## 5. Discussion and conclusions

The purpose of this study was to explore the influence of neighborhood and initial incident characteristics on the odds that known crime guns will be used in multiple offenses. Existing literature pertaining to

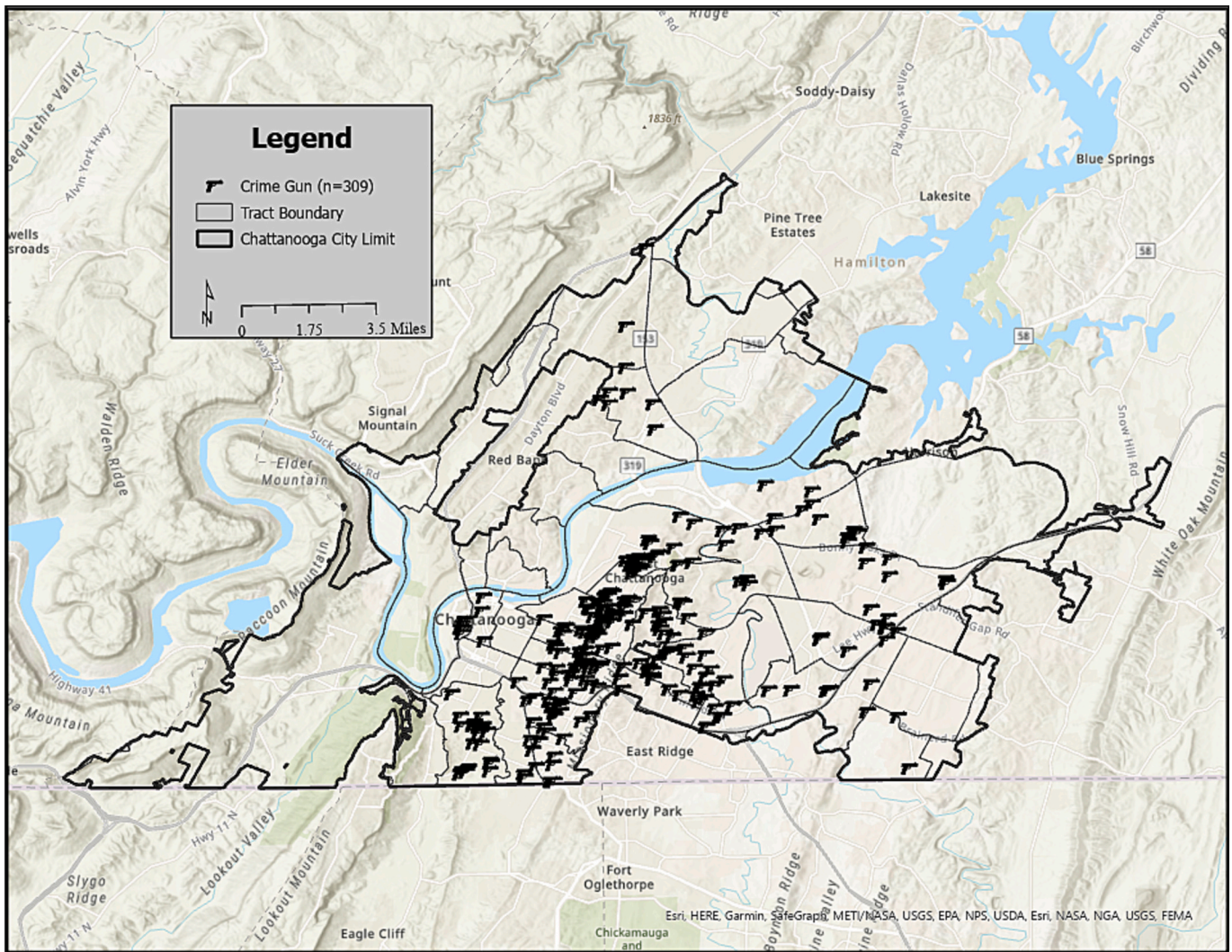


Fig. 1. Spatial distribution of crime guns across chattanooga census tracts.

**Table 2**  
Binary logistic regression of firearm use in multiple incidents (n = 309).

Variable	Model 1 Exp(b)	Model 2 Exp(b)	Model 3 Exp(b)
Total Population (Ln)	0.607(0.511)	0.615(0.512)	0.610(0.515)
CDV Index	0.604*(0.252)	0.722(0.383)	0.335*** (0.334)
Ethnic Heterogeneity	1.032(0.181)	1.029(0.181)	1.021(0.183)
Residential Stability	1.036(0.025)	1.036(0.025)	1.035(0.025)
Community Investment	0.981(0.012)	0.981(0.012)	0.979(0.012)
Age Structure	0.976(0.044)	0.973(0.045)	0.976(0.045)
Income Inequality	0.900(2.410)	0.960(2.414)	0.525(2.467)
Suspect Identification	1.056(0.319)	1.051(0.319)	1.031(0.324)
Gang Involvement	3.075*** (0.329)	3.032*** (0.329)	3.263*** (0.339)
Violent Incident	0.773(0.299)	0.776(0.299)	0.774(0.304)
Multi-Victim Crime	1.285(0.427)	1.262(0.428)	1.385(0.431)
Time in Circulation (Ln)	1.41***(0.063)	1.411*** (0.063)	1.414*** (0.065)
CDV x Gang Involvement		0.777(0.407)	
CDV x Violent Incident			2.873**(0.376)
Constant	0.891(-0.115)	0.801(-0.222)	1.537(0.430)
-2 log likelihood	328.722		
Chi-square	67.358 (df = 8)		
Nagelkerke R <sup>2</sup>	0.271		

Note: \*p ≤ .05 \*\*p ≤ .01 \*\*\*p ≤ .001.

the issue of gun crime has examined the impact of characteristics of the community and incident characteristics on both the likelihood and frequency of gun-related crimes (e.g., Burgason et al., 2014; Dierenfeldt et al., 2021), but have yet to consider the impact of these factors on the (re)use of crime guns themselves. This study thus represents a novel contribution to the literature, but one with important implications for future research and practice. In this vein, several of our findings merit further discussion.

Consistent with studies of the impact of structural (e.g., Dierenfeldt et al., 2017; Kubrin & Weitzer, 2003; Sampson et al., 1997) and sub-cultural (e.g., Anderson, 1999; Kirk & Papachristos, 2011) conditions on crime, it was anticipated that higher levels of disadvantage and violence within neighborhoods would correspond with an increase in the odds that known crime guns would be used in multiple offenses. Counter to this expectation, however, known crime guns used in these contexts maintained comparatively lower odds of being used in additional crimes. This finding was surprising given the symbolic status ascribed to firearms by gang members and street-oriented individuals (e.g., Goldsmith et al., 2022; Katz, 1988)—groups that tend to be concentrated within neighborhoods exhibiting elevated levels of disadvantage and violence. Simply put, this symbolic status would suggest a desire to preserve a firearm once it has been obtained, possibly leading to its use in multiple offenses.

There are, however, several possible explanations for this finding. First, although codes of violence might be more prevalent in

communities marked by higher levels of disadvantage and violence, neither is a direct measure of street culture. Our finding may, therefore, be an artifact of reliance on proxy measures that could be overcome through the use of standardized attitudinal scales like those adopted by Kwak, Dierenfeldt, and McNeeley (2019), which serve as direct measures of the prevalence of street culture. Alternatively, the negative influence of disadvantage and violence may be explained by the likely increased presence of police in such contexts. Although CPD was unable to provide information on patrol deployments during the observation period, it is possible that increased police presence in high crime neighborhoods corresponds with either quicker case clearances and crime gun seizures or expedited efforts by offenders to discard crime guns after their initial use. Indeed, the works of Kennedy, Piehl, and Braga (1996) and Wintemute et al. (2004) suggest that offenders prefer guns that are 'new in the box' in order to avoid being apprehended with a firearm that has already been used in a crime. Third, we must acknowledge that this finding may be product of our sample. All known crime guns were nested within 29 census tracts, which effectively limited the sample to the most violent areas of the city. As a robustness check, supplementary analyses substituted a disadvantage and violence index comprised of *all* census tracts in the city. In doing so, the impact of disadvantage and violence on the odds that crime guns would be used in multiple offenses was reduced to statistical non-significance.

In contrast, firearms that were used in gang-involved crimes were comparatively more likely to be used in multiple offenses. As described by Cook et al. (2007), gangs frequently provide firearms to their members for the purposes of protection and perpetration of violence. Considered in conjunction with our findings, the guns used in gang-involved crimes may be retained and recirculated within the group or by the individual following their initial use, allowing for their continued use (e.g., Cook, Harris, et al., 2015; Hureau & Braga, 2018). Participation in gang crime and subcultural violence increases the likelihood increases the victimization, especially of a retaliatory nature (Jacobs & Wright, 2006; Kubrin & Weitzer, 2003). Those involved in such activities likely anticipate or precipitate their own victimization, and retention of crime guns may simply provide ready access to a firearm when it is needed (Anderson, 1999; Baron, Kennedy, & Forde, 2001; Berg, Stewart, Schreck, & Simons, 2012; Brezina, Agnew, Cullen, & Wright, 2004; Huebner et al., 2016; Wright & Rossi, 1986). Moreover, gang-involved crimes are often unreported and frequently lack cooperative witnesses, which would be expected to hinder investigation, case closure, and gun crime seizure by police (Curry & Decker, 2003). This, in turn, would allow for the continued use of crime guns following the initial offense. That neighborhood context did not moderate this effect provides a layer of support for this assertion, demonstrating the robustness of the relation between gang involvement and the odds that crime guns will be used in multiple offenses.

Unlike gang involvement, the severity of the original offense maintained no statistically significant influence on the odds that a crime gun would be used in multiple offenses. This finding was somewhat surprising given that murders and aggravated assaults involving firearms are much more likely to come to the attention of police (Tarling & Morris, 2010). Although this might suggest that offense severity is simply not as impactful as the literature would suggest, ad hoc review of the NIBIN lead log entries, and discussion with CPD, prompts us to offer an alternative explanation: functionality tests. In the days and weeks leading up to their respective homicides and aggravated assaults, many of the crime guns included in our sample were first linked with more mundane 'shots fired' (no victim) or property damage incidents. That is, the initial incidents associated with many of the known crime guns in this study may have been test fires performed in preparation for more serious crimes (e.g., homicides/aggravated assaults). Although beyond the scope of the present research, the potential richness of such an inquiry should not escape future studies. Interestingly, the use of a cross-product interaction indicated that the impact of offense severity on the likelihood that a crime gun would be used in multiple offenses is

exacerbated in neighborhoods maintaining comparatively higher levels of disadvantage and violence. As has been noted, levels of cooperation with police are reduced in communities maintaining higher levels of disadvantage and violence—the conditions that promote the entrenchment of street culture (Anderson, 1999; Huebner et al., 2016; Kwak et al., 2019; Matsuda et al., 2013). Thus, while such offenses may be more likely to come to the attention of police (Tarling & Morris, 2010), lack of cooperation may inhibit the seizure of offenders and/or their crime guns—allowing for their continued use.

Perhaps the most novel contribution of this study revolves around the relationship between time in circulation and the odds of a known crime gun being used in more than one offense. As expected, the longer a firearm remained in the community following its use in a crime, the more likely it was to be used in another offense. This finding illustrates the importance of quickly seizing crime guns following their initial use. Although an arrest of a suspect may be made, the crime gun itself may circulate through other criminogenic individuals and create more violence in the community. This finding suggests that law enforcement agencies may benefit from reconceptualizing how they define case clearance and, in turn, begin emphasizing gun seizures to the same extent that they do arrests.

Despite this study's contribution to the literature, there are several limitations worth noting. To reiterate, the NIBIN log itself is only a subset of gun violence given that it contains only information on known gun crimes. In addition to the obvious drawbacks of cross-sectional research, our study suffers issues of important omitted variable bias and sample bias. In terms of the former, this study was unable to include suspect or victim characteristics (e.g., sex, race, age) due to incomplete records provided by the partnering police department. Although demographic identifiers were likely maintained in agency datasets outside of the NIBIN lead logs, this limitation does illustrate the importance of thorough, consolidated record keeping within law enforcement agencies. The same can be said for patrol deployment information, an important consideration in terms of potential for formal social control. Understandably, criminal justice agencies collect, format, and maintain data for their own purposes rather than those of researchers. More frequent collaboration between practitioners and academics may, however, yield solutions to these issues.

Further, this study lacked direct measures of street culture and legal cynicism, each of which might be expected to influence our findings. Relatedly, these phenomena likely create an issue of sample bias. Given that street culture is associated with higher levels of legal cynicism (Anderson, 1999), it is possible that a multitude of firearm-related incidents were not reported to CPD—particularly those involving victims of color. Indeed, crime reporting has been found to be lower in disadvantaged, high crime communities as a product of both fear of retaliation and lack of confidence in police (Anderson, 1999; Kubrin & Weitzer, 2003). Moreover, these effects are amplified among youthful victims and offenders, particularly when no injuries are sustained (Hart & Rennison, 2003; Kwak et al., 2019).

Finally, the current study adopted a traditional communities and crime approach, excluding the wide body of literature on crime and place. Given the exploratory nature of the study (i.e., focus on crime guns rather than gun violence), we see the merging of theoretical perspectives in future studies. That is, the place in neighborhoods (Tillyer, Wilcox, & Walter, 2021) framework provides a well-organized approach to account for more common environmental criminology concepts such as crime generators and attractors (Brantingham & Brantingham, 1995) and risky facilities (Eck, Clarke, & Guerette, 2007) while simultaneously controlling for the larger community context in which these places are situated. Joining these spatial frameworks would provide a better understanding of the spatial characteristics and movement of crime guns in space.

These limitations notwithstanding, this study maintains important implications for policy and practice. First, it appears necessary for academics and practitioners alike to reconsider conceptualization of case

closure. Currently, law enforcement personnel and researchers could consider a case 'closed' once a suspect has been identified and arrested, charged, and/or convicted. However, the increase in gun-related homicides over the last decade (Center for Disease Control, 2022), along with the findings presented in this study, suggest that this approach may be a misstep. Simply put, future research and practice should prioritize offenders and gun seizures simultaneously when investigating gun violence in the community. Indeed, of the 309 crime guns included in our sample, 105 were used in multiple offenses and the average crime gun remained in circulation for more than 5 months. Worthy as this goal might be, it will almost certainly rely on the cooperation of witnesses and victims. The literature has, however, consistently described the difficulties in addressing violence in more cynical communities, as perceived police ineffectiveness (Goudriaan, Lynch, & Nieuwebeerta, 2004) and fear of crime (Sargeant & Kochel, 2018) have been associated with lower levels of reporting. Thus, alternative mechanisms for reporting may be needed—particularly those that provide reporting parties anonymity (e.g., tip-lines, reporting apps). Moreover, agencies should focus on familiarizing themselves with the communities they police, as the public may be more likely to report if they feel that officers are integrated and legitimate, as opposed to an occupying force, within their community (Tyler, 2017). Stronger police-community relations would also lessen the perceived need for self-help social control that characterizes many urban areas.

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