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Measuring hot spots policing in non-research settings

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ABSTRACT

Hot spots policing has become a robust evidence-based strategy to address the problem of crime in U.S. cities. Today, a growing number of police departments report that they use hot spots policing to some extent in their daily operations. However, to our knowledge, only one study has been conducted to determine whether police departments have implement the strategy effectively. In our study, we used crime and stop-question-and-frisk (SQF) data from the New York Police Department (NYPD) and an innovative analytical strategy to assess (1) whether the NYPD makes significant use of hot spots policing, and (2) if yes, how much hot spots policing the department performs. Our findings showed that the NYPD uses hot spots policing in about 40%–45% of its violent crime hot spots. The implications of the study are discussed.

1. Introduction

Hot spots policing has become a robust evidence-based strategy to address the problem of crime in U.S. cities. In an earlier evaluation of numerous policing strategies, Sherman et al. (1997) recognized that hot spots policing is among the few strategies that might help the police to reduce crime. Indeed, this evaluation was subsequently confirmed by the National Institute of Justice, which identified hot spots policing as a strategy supported by persuasive evidence (National Institute of Justice, 2004). Most recently, the National Academies of Sciences, Engineering, and Medicine's Committee on Proactive Policing concluded that hot spots policing strategies produce short-term crime-reduction effects without displacing crime into areas immediately surrounding targeted locations (National Academies of Sciences, Engineering, and Medicine [NASEM], 2018, p. 173). These positive evaluations regarding the effectiveness of hot spots policing are predominantly based on strong evidence drawn from a large number of experimental and quasi-experimental research. For several decades, this research consistently proposed that police can reduce crime by using hot spot policing (Braga et al., 2014; Braga et al., 2019).

These findings, along with advances in geographic information technology and data science, have prompted many police departments to use some level of hot spots policing to reduce crime and disorder in their communities (Weisburd et al., 2003; Koper, 2014). Other researchers have found similar results that show widespread use of hot spots policing among police departments across the country. For example, in a survey conducted by the National Police Research Platform in 2013, 91% (69 out of 76) of the police departments surveyed said they used hot spots policing (NASEM, 2018). The self-reported nature of these declarations, however, limits the ability to know with reasonable certainty that such police departments actually engage in hot spots policing and to what degree.

The current study represents an important contribution to literature for its use of an innovative analytical strategy that assesses the usage of hot spots policing. Although hot spots policing is quite popular, surveys of police chiefs and other department officials have

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been (to the best of our knowledge) the primary instruments that scholars have used to measure the prevalence of the policing strategy. Several research teams have used direct observation of police officers to measure hot spots policing, but these were quasi-experimental studies, which are costly in terms of data collection. Weisburd et al. (2014) used secondary data to assess whether hot spot policing affected crime in New York City and are the only researchers to have done so. The method used for the current study is similar to the one used in the Weisburd et al. study but with one significant difference. While Weisburd et al. used the concentration of SQFs as an indication of hot spots policing, we rejected the approach as inadequate, arguing that the mere concentration of SQFs does not indicate hot spots policing. Our approach to measuring the use of hot spots policing is a new analytical strategy based on crime and SQF data.

Subsequent sections of this paper include a discussion of the measurement of hot spots policing as contained in the literature followed by a discussion of the methods and analytical strategy used in the current study to measure hot spots policing based on crime and SQF data.

2. Literature review

For the last three decades, researchers and practitioners have held a firm view that crime is concentrated, not only at macro level but also at small locations, such as street intersections and blocks. The earlier research findings indicated that almost 50% of crimes clustered in micro-locations called hot spots (Pierce et al., 1988; Sherman et al., 1989). An extensive number of later studies consistently supported these findings. In a recent paper, Weisburd (2015) argued that crime concentration should be considered a "law" instead of a social sciences theory (see also, Weisburd et al., 2012; Braga et al., 2017; Weisburd, 2015; Braga et al., 2019a,b).

This new perspective regarding the distribution of crime at specific locations has caused dramatic changes in views of how to prevent crime. A prime example is hot spots policing, which now is the most well-recognized and well-supported crime control strategy. The hot spots policing strategy is based on the idea that police can reduce crime if they pay attention to what Sherman and Weisburd (1995) referred to as criminogenic locations. Extensive support for hot spots policing is plausible for at least three reasons. First, the logic of hot spots policing is consistent with well-known crime prevention theories—namely, deterrence and criminal opportunity theories. In line with the assumptions of these two theories, focusing police efforts on hot spots enhances police visibility and, in turn, leads to significant reductions in crime opportunities while increasing the level of general and specific deterrence for potential criminals (Nagin et al., 2015; Braga and Schnell, 2018; Durlauf and Nagin, 2011).

Second, hot spots policing strategies enable the police to use their limited resources efficiently because the police focus their resources on specific crime-prone locations rather than on individual offenders and victims (Sherman, 1995; Weisburd, 2008). Also, this location-specific concentration of crime remains stable for a long time (Weisburd and Telep, 2011; Weisburd et al., 2004; Weisburd et al., 2009; Sherman, 1995). Moreover, crime displacement is very rare when police target these locations to prevent crime (Weisburd and Talep, 2011; Weisburd, 2006; Taniguchi et al., 2009).

Third, a large volume of rigorously designed research has provided strong evidence regarding the effectiveness of hot spots policing in reducing crime and disorder. In a series of systematic reviews of experimental research on hot spots policing, the researchers found noteworthy reductions in crime attributable to hot spots policing strategies (Braga et al., 2014). Similarly, the results from a more recent review of 65 rigorous evaluations by Braga et al. (2019a,b) supported the effectiveness of hot spots policing in reducing crime. Police use a variety of proactive practices and crime tactics at hot spots (NASEM, 2018). An overview of the evaluation research on hot spots policing shows that problem-oriented policing has the most substantial impact on crime reduction and that the benefits of hot spots policing practices can diffuse into the locations near the areas of intervention (Braga et al., 2014, 2019).[1]

Researchers typically use experimental or quasi-experimental designs to evaluate the effectiveness of hot spots policing, primarily because it is difficult to measure the implementation of hot spots policing. A quasi-experimental research design ensures that both the impact of the process used to evaluate a program, such as hot spots policing, are assessed appropriately (see Maxfield and Babbie, 2018, p. 364). While the impact assessment is based on pretest and posttest measurements of a comparison group, the process evaluation examines whether the program was implemented in line with theoretical assumptions (Maxfield and Babbie, 2018). Both the impact assessment and the process evaluation provide estimates about the measurement of hot spots policing that are valid and reliable. An experimental research design for hot spots policing studies, on the other hand, is considered to be more rigorous because trained researchers and their associates are expected to pursue the research process meticulously and to examine whether the hot spots policing strategies are based on theoretical assumptions about this method of reducing crime.

A third type of research design, one that is neither quasi-experimental nor experimental, may prove useful for measuring the application of hot spots policing. This nonexperimental evaluation method focuses on comparing the ratio between police SQFs and crimes. We explain this measurement technique in detail in the analytical strategy section of this paper. SQFs, which also are known as Terry stops, are one of the most common police patrolling activities. According to the 1968 U.S. Supreme Court decision in *Terry v. Ohio*, the police have the power to stop, frisk, and detain individuals based upon a reasonable suspicion that a person has perpetrated a crime or is about to perpetrate a crime (Weisburd et al., 2014; Wooditch and Weisburd, 2016; Jones-Brown et al., 2010). According to the NASEM (2018), police may perform SQFs as a person-focused or a place-focused strategy. A person-focused SQF, targets the actions of specific person or persons. For example, patrol officers may engage in SQFs on key intersections or street segments just after the commission of a crime in an attempt to catch a fleeing suspect. A place-focused SQF, on the other hand, targets a specific place or places

[1] Hotspots policing is not devoid of its critics. It is argued that hotspots policing can lead to differential treatment of particular demographic groups, especially those in poverty and African-American citizens (see, for example, Sweeten (2015), Weisburd et al., (2016), (Charney et al., 2010). Here, most of the literature we reviewed consists of the studies that promote hotspot policing to illustrate why police use hotspot policing frequently.

(NASEM, 2018) to prevent and reduce crime. Research indicates that the most significant number of SQFs take place in concentrated areas (Weisburd and Eck, 2004; Weisburd et al., 2014). Whether SQFs are effective in reducing crime is the subject of debate. The research offers two competing perspectives. First, some researchers, who used macro locations (e.g., precincts and census tracts) as the unit of analysis, tended to find that the crime reduction effects of SQFs are either negligible (Rosenfeld and Fornango, 2014) or small (Rosenfeld and Fornango, 2017) for the general population. Other researchers, who used micro-locations as the unit of analysis, found that SQFs have a more substantial impact on crime prevention. Indeed, there is a strong consensus among researchers that proactive SQFs targeting micro-criminogenic locations should be considered a category of hot spots policing. The research has recognized that this type of SQF produces noteworthy reductions in crime without any significant crime displacement to nearby areas (Weisburd and Eck, 2004; Weisburd et al., 2014; Weisburd et al., 2016; MacDonald et al., 2016). Overall, researchers have associated the effectiveness of SQFs with hot spots policing because the correlation between the spatial concentration of crimes and SQFs is high (Weisburd et al., 2014). Weisburd et al. (2014), using the NYPD's SQFs and crime incident data, which overlap at the same locations, investigated whether this high correlation existed. Before conducting the analysis, the researchers eliminated crime incidents that resulted in arrests because the SQFs might have been the cause of these crime incidents. Therefore, each arrest eliminated one crime incident for each street segment or intersection. Second, the researchers used a rank-order correlation method rather than a correlation based on the raw data because both datasets are highly skewed. The results of the analysis showed a high correlation between SQFs and crime incidents, proving that the police mostly focus on crime hot spots while performing SQFs.

In our research, we developed another measure to determine to what extent police SQFs reflect hot spots policing. As explained below, we take the ratio of SQFs to crime incidents that fall into the same street segments or intersections.

3. Methods

3.1. Data

Two publicly available datasets from the NYPD were used for the current study: (1) SQF incidents[2] and (2) crimes reported to the police.[3] Both datasets have been used for scholarly research in the past, particularly by researchers who conduct spatial analysis (e.g., Weisburd et al., 2014). In addition to these two datasets, two shapefiles (i.e., vector-data representations of the location, shape, and attributes of geographic features) were downloaded: (1) NYC Street Centerline[4] and (2) NYPD Sectors.[5] The NYPD sectors shapefile included precinct numbers.

3.2. Data preparation

The SQF and crime data used in the study covered the years 2006 through 2018.[6] The XY coordinates in each record were used to geocode the data. The precinct numbers in the shapefile attributes tables also were used during the geocoding process which involved the assignment of street elements[7] to precincts and then the assignment of all crimes and SQFs to street elements. Because both datasets contained a large volume of cases (about 6.4 million cases in the crime dataset and about 4.2 million cases in the SQF dataset), an R software program was used to assign street elements to the crimes and SQFs.[8]

A buffer of 10 m was created around the street centerlines (i.e., street segments), while a buffer of 17 m was created around crime sites and SQF incidents.[9] Next, the buffered street centerlines were intersected with the buffered crime and SQF incidents (a thousand incidents at a time). If a crime or SQF incident intersected with only one street line, that crime or SQF incident was assigned a street segment. If a crime or SQF incident intersected with more than one street line, that crime or SQF incident was attached to an intersection.

It should be noted that because the data for the study covers a span of more than 10 years, police practices regarding the classification of crimes and SQFs may have changed over that period. The probable effects that such changes may have on the analyses are concerning. To understand the extent of such effects, an Excel file that lists all state criminal laws (last updated on August 25, 2020) with their effective dates and/or repeal dates was downloaded from the New York State Division of Justice Services website (https://

[2] *NYC OpenData: The Stop, Question and Frisk Data*. https://data.cityofnewyork.us/Public-Safety/The-Stop-Question-and-Frisk-Data/ftxv-d5ix.

[3] *NYC OpenData: NYPD Complaint Data Historic*. https://data.cityofnewyork.us/Public-Safety/NYPD-Complaint-Data-Historic/qgea-i56i.

[4] *NYC OpenData: NYC Street Centerline* (a road-bed representation of New York City streets containing address ranges and other information such as traffic directions, road types, segment types). https://data.cityofnewyork.us/City-Government/NYC-Street-Centerline-CSCL-/exjm-f27b.

[5] *NYC OpenData: NYPD Sectors* (geographic boundaries of NYPD sectors). https://data.cityofnewyork.us/Public-Safety/NYPD-Sectors/eizi-ujye.

[6] About 0.3% of the crimes had dates earlier than 2006.

[7] Street elements are street segments and intersections. For the study, a street segment was defined as two sides of a street between two intersections or an intersection and a cul-de-sac.

[8] R codes are available from the first author upon request.

[9] The buffer distances were selected for practical reasons. More than 10 million points (i.e., the geocoded locations of crimes and SQF incidents) had to be attached to street segments. It was not efficient to do this task in the traditional way (e.g., using the ArcGIS software's near function or a similar function from some other GIS software). Thus, buffers were created around both the street centerlines and the incidents. Afterward, the buffered features were intersected. Various buffer distances were tried, but the 10-m buffer around the street centerlines and the 17-m buffer around the incident locations yielded the highest number of incidents being attached to the street segments. Thus, we chose to use these distances for the final results.

www.criminaljustice.ny.gov/crimnet/clf/rel-db/rel-db.htm). Within the study period (i.e., 2006 through 2018), a total of 250 laws related to five types of crime—assault, murder, homicide, manslaughter, and robbery—either became effective or were repealed. For example, Penal Law 125.26 Aggravated Murder was repealed on June 6, 2006. These changes in the law, some of them likely being minimal and others more significant, probably affected police practices; however, no changes in police practices were found in the secondary data sources used for the current study.

Nonetheless, an attempt was made to assess the extent to which the changes in state laws may have affected police practices during the study period. To do so, a monthly time-series of the total number of crimes for each of the following crime types was created: (1) murder and non-negligent manslaughter, (2) felony assault, (3) assault 3 and related offenses, and (4) robbery. Next, each time series was decomposed into the following categories: trend, seasonal, and random components. The random components were then examined (see Figures A1-A4). The following assumption was made: If, in any month, the random component was two or more standard deviations from the mean, then an abrupt shift from routine police practices had occurred. An attempt was not made to determine whether the changes in criminal laws had caused the changes in police practices. The random component was two or more standard deviations from the mean in only a few cases. Out of 144 months, murder and non-negligent manslaughter deviated from the mean in four of those months, felony assaults deviated from the mean in five of the months, assault 3 and related offenses deviated from the mean in seven of the months, and robberies deviated from the mean in six of the months. Except for murder and non-negligent manslaughter, such deviation is expected by chance alone, assuming the *p*-value for significance is 0.05. A similar exercise was conducted separately for each borough of New York, and the results were similar. Thus, although it is not possible to say definitively that the changes in criminal law did or did not influence police practices in any of the cases in the study dataset, the available data indicate that the changes in criminal law did not have a widespread influence on police practices during the study period.

Regarding the changes in police practices for SQFs, no information could be found to indicate that the practices had or had not changed. Scholars who used New York City SQF data for their own research faced the same problem. For example, Weisburd et al. (2016, p. 4) stated the following while referring to the New York Civil Liberties Union's website: "[E]very time a police officer stops a person in NYC, the officer is supposed to fill out a form to record the details of the stop" (New York Civil Liberties Union, 2012; para. 16). Weisburd et al. went on to note the following:

> Officers fill out the forms by hand, and then the forms are entered manually into a database. We are told by the NYPD that SQFs are consistently reported from 2003, but we do not have any data to evaluate this assertion. (Weisburt et al. p. 4)

Thus, the reliability of SQF data is an issue, and it should be considered while interpreting the results of this study.

3.3. Analytical strategy

Although the theory of crime concentration at hot spots is quite clear, different perspectives exist about the conceptualization of hot spots, particularly about their size. Research has identified various microgeographic units as hot spots, such as addresses (Eck and Weisburd, 2015), blocks (Taylor Gottfredson and Brower, 1984), or clusters of blocks (Block and Block, 1995). Likewise, hot spots policing is a form of proactive policing that focuses police resources on crime-concentrated areas to deal with crime and crime-related problems (NASEM, 2018). Of course, a significant police resource is the amount of police time spent on activities. One might argue, therefore, that spending more police time at hot spots rather than at other locations is an indicator of hot spots policing. Nevertheless, this idea is flawed in that police naturally spend more time at crime-prone locations regardless of whether they are practicing hot spots policing or not. For example, random patrolling activities would be disproportionately higher at hot spots locations than locations that have fewer crimes. Theoretically, police might spend time and perform crime-control activities in a particular place for two main reasons: (1) a crime incident draws their attention, and (2) they perform proactive policing at their discretion. Many crimes and related problems simply pull the police to hot spots. From a rational perspective, these types of responses—because they are reactive—should not be considered hot spots policing. Thus, hot spots policing activities are those activities above and beyond reactive police responses. The question is: How does one measure the amount of time that is above and beyond reactive responses? It is a challenging question to answer because it is difficult to determine not only *whether* the police are performing hot spots policing but also at what *level* (or dosage) of hot spots policing is being conducted.

Previous research has used experimental designs or systematic social observations to understand how much time police spend at hot spots (e.g., Sherman and Weisburd 1995). Both approaches, however, are expensive and may not be achievable without a carefully designed research design. An efficient approach would be to count the pieces of police work (e.g., traffic stops, SQFs) and observe whether the pieces concentrate at hot spots; however, as mentioned earlier, the mere concentration of police work at crime hot spots does not necessarily mean that the police are practicing hot spots policing. The concentration of police work could result instead from a variety of factors (e.g., frequent crime incidents) that pull the police to hot spots.

In this study, SQFs were used to determine whether this policing activity was concentrated in violent-crime hot spots in New York City. Next, the expected and observed proportions of SQFs that occurred in violent-crime hot spots were compared. If the observed proportion of SQFs in a hot spot exceeded the expected proportion (which would indicate that the police are going above and beyond what they are expected to do), then the police were performing hot spots policing. Otherwise, the concentration of SQF activities at hot

spots was considered to have been the result of responding to crime-related problems rather than practicing hot spots policing. For ease of analysis, proportions (rather than raw numbers) were used to compare the expected and observed instances of hot spots policing. To be more specific, within a certain place, the expected proportion of SQFs equals the proportion of crimes.[10] Therefore, the expected proportion of SQFs in a place was measured by calculating the proportion of crime occurring in the same place. To illustrate the point more clearly, consider this example: Say that 4% of all crimes in a jurisdiction (e.g., precinct) occur in a hot spot. One would then expect that 4% of the jurisdiction's SQFs took place in that hot spot because of the pulling forces mentioned previously (e.g., more crime, more disorder). If the police in that jurisdiction were performing hot spots policing, then the proportion of SQFs in that hot spot should be significantly higher than 4%.

The unit of analysis of this study is a hot spot. The term *hot spot* is defined here as a cluster of street elements in the form of (1) a street segment and the adjacent intersection or intersections (see Fig. 1a) or (2) an intersection and all adjacent street segments (see Fig. 1b). Previous research emphasizes that the visibility of police has a deterrent effect on potential criminals and advises the use of places as hot spots (Sherman &Weisburd, 1995; Sherman et al., 2014). Sherman, Gartin, and Buerger (1989) define a place as "a fixed physical environment that can be seen completely and simultaneously, at least on its surface, by one's naked eye" (p. 31). For the current study, the size of each hot spot was intended to be larger than the size of a specific place; however, the identification of hot spots in the current study still complied with the suggestions made by Sherman et al. (2014). For example, a police car parked in a street segment is usually visible to both the segment and the adjacent intersection(s). Likewise, a police car parked at an intersection is mostly visible to both the intersection and all adjacent street segments.

For the current study, the proportion of SQFs to the proportion of crimes was compared based on the assumption that the proportion of crimes equals the expected proportion of SQFs at hot spots. The following steps were completed for this calculation:

Step 1. Using data from time 1, the five highest violent-crime[11] hot spots in each precinct of New York City were identified. Five was an arbitrary number chosen for ease of analysis and not harm to the analysis process. It is plausible to assume that each precinct command is likely to focus on the top crime-density areas for hot spots policing activities, regardless of whether this is the top three, four, five, or more hot spots. Also, considering that New York City has 77 precincts, a relatively smaller number of hot spots would have been available for analysis if fewer hot spots had been selected.

Then, for each hot spot…

Step 2. The proportion of crimes (i.e., P_{crime}) that occurred at that hot spot in time 2 was calculated with the following equation:

$$P_{crime} = \frac{C_{hot}}{C_{precinct}} \tag{1}$$

where: C_{hot} is the number of crimes in the hot spot, and $C_{precinct}$ is the number of crimes in the precinct.

Step 3. The proportion of SQFs (i.e., P_{SQF}) that occurred in that hot spot in time 2 was calculated with the following equation:

$$P_{SQF} = \frac{SQF_{hot}}{SQF_{precinct}} \tag{2}$$

where: SQF_{hot} is the number of SQFs in the hot spot, and $SQF_{precinct}$ is the number of SQFs in the precinct.

Step 4. The standard error and the 95% confidence interval of P_{crime} was estimated. The standard error of P_{crime} was calculated with the following equation:

$$se_{P_{crime}} = \sqrt{\frac{p_{crime} * (1 - p_{crime})}{N_{precinct}}} \tag{3}$$

where: $se_{P_{crime}}$ is the standard error of P_{crime}, and $N_{precinct}$ is the total number of crimes in the precinct.

Step 5. P_{SQF} was compared to P_{crime} see if P_{SQF} falls within the 95% confidence interval of P_{crime}. If P_{SQF} is larger than P_{crime} and outside of the confidence interval, then P_{SQF} is significantly larger than P_{crime}, and the precinct has performed hot spots policing.

The following example illustrates the five-step process used for the analysis of 2007 data (i.e., the first row of Table 3):
Steps 1 and 2. All violent crimes that occurred in 2006 ($N = 168{,}858$) were selected, and the hottest five hot spots in each precinct

[10] The numbers/proportions of SQFs and crimes are expected to be correlated, and they are indeed highly correlated. Weisburd et al. (2014) found strong correlations (Spearman's rho ranging from 0.59 to 0.69) between numbers of SQFs and crimes at crime hot spots in New York City. The current study found similar correlations—not only for hot spots but also for all street elements in the dataset (see Table 2).

[11] The violent crimes in the dataset included the following: assault 3 and related offenses, felony assault, homicide, murder and non-negligent manslaughter, and robbery.

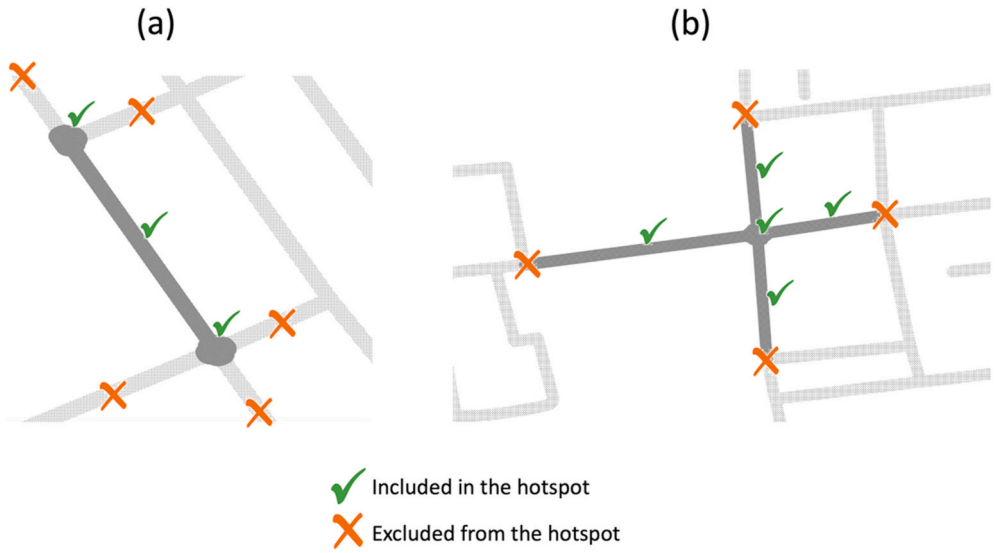

Fig. 1. Hotspots samples.

were identified (N hot spots = 375).

Step 3 and 4. All crimes and SQFs that occurred in 2007 (N = 514,719) were selected and, for each precinct, the proportion of crimes and SQFs that occurred in these five hot spots was calculated.

Step 5. For each hot spot, the proportion of SQFs was compared to the proportion of crimes.

The results of the analysis provided the number of hot spots in which (1) the proportion of SQFs was smaller than the proportion of crimes, (2) the proportion of SQFs was not significantly different from the proportion of crimes, and (3) the proportion of SQFs was significantly larger than the proportion of crimes.

The process was repeated for each year of data.[12]

4. Results

Table 1 shows the descriptive statistics about the distribution of crimes and SQFs over the street segments and intersections. According to the original data that we downloaded from the NYPD website, the total number of SQFs ranged from 11,008 (in 2018) to 685,724 (in 2011), while the total number of crimes ranged from 445,217 (in 2018) to 535,094 (in 2007). It was possible to assign most of the SQFs (90%–95%) and crime incidents (96%–98%) to street elements. The number of crimes and SQF incidents that could not be assigned to street elements because they were too far from street centerlines or did not intersect a street element is small and negligible.

Table 1 also indicates that the type of street element, whether it is an intersection or a street segment, is related to the level of crime and SQF concentration. The majority of crimes are concentrated at street segments, while the majority of SQFs are concentrated at intersections. Thirty-four percent to 46% of the SQFs occurred on street segments, while the remainder occurred at intersections with

[12] Crime hot spots typically do not stay the same for long periods. They likely move from one place to another over by months or even weeks or days. As Groff et al. (2015, p. 46) suggested, "Hot spots of violent crime identified using violent crime for the previous year may not appear as 'hot' when viewed through the lens of the preceding 90 days." Although hot spots of crime may move geographically in time frames shorter than a year, the police may not adapt their reaction with that level of granularity. Nonetheless, as a robustness check, the data were analyzed two other ways. First, hot spots of violent crime that occurred in one month (e.g., January) were identified and compared with the proportions of SQFs and violent crimes in the next (e.g., February). Second, hot spots of violent crime in one quarter of a year (e.g., January–March) were identified and compared with the proportions of SQFs and violent crimes in the next quarter (e.g., April–June). Data from 2011 were used for both analyses. The results showed that the percentage of hot spots in which the proportion of SQFs significantly exceeded the proportion of violent crimes was even lower than what was found in the analyses presented in this paper.

Table 1
Descriptive statistics.

Year	# of SQFs in the original data	# of SQFs that could be assigned to street elements	% of SQFs that could be assigned to street elements
2006	506,491	479,941	95
2007	472,096	444,953	94
2008	540,302	507,453	94
2009	581,168	546,949	94
2010	601,285	556,127	92
2011	685,724	636,881	93
2012	532,911	497,827	93
2013	191,851	177,530	93
2014	45,787	42,131	92
2015	22,563	20,793	92
2016	12,405	11,214	90
2017	11,629	10,423	90
2018	11,008	10,323	94

Year	# of crimes in the original data	# of crimes that could be assigned to street elements	% of crimes that could be assigned to street elements
2006	512,622	490,726	96
2007	535,094	514,719	96
2008	528,715	511,650	97
2009	511,044	493,655	97
2010	510,070	492,123	96
2011	498,588	480,634	96
2012	504,652	486,011	96
2013	495,715	477,770	96
2014	491,851	473,119	96
2015	478,351	468,813	98
2016	477,639	470,077	98
2017	466,697	457,609	98
2018	452,997	445,217	98

Year	% of SQFs in street segments	% of SQFs in intersections	% of street segments with SQFs	% of intersections with SQFs
2006	36	64	17	41
2007	37	63	17	41
2008	36	64	18	42
2009	35	65	18	43
2010	34	66	18	43
2011	34	66	19	44
2012	34	66	18	42
2013	36	64	11	31
2014	36	64	5	16
2015	36	64	3	10
2016	0	100	0	9
2017	48	52	2	5
2018	46	54	2	6

Year	% of crimes in street segments	% of crimes in intersections	% of street segments with crimes	% of intersections with crimes
2006	70	30	38	44
2007	70	30	38	44
2008	69	31	38	44
2009	69	31	37	44
2010	69	31	37	44
2011	70	30	37	43
2012	70	30	37	43
2013	70	30	37	42
2014	71	29	36	42
2015	70	30	36	41
2016	72	28	37	41
2017	73	27	37	40
2018	74	26	36	38

one exception. In 2016, all SQFs occurred at intersections. In contrast, 69%–74% of the crimes occurred on street segments, while the remainder occurred at intersections.[13] About 17%–19% of the street segments and 41%–44% of the intersections had one or more SQFs until 2014, when the number of SQFs decreased substantially. The remainder of the street elements had no SQFs. About 37%–38% of the street segments and 43%–44% of the intersections had one or more crimes. The remainder of the street elements had no crimes.

Table 2 shows the bivariate relationships between the number of crimes and the number of SQFs on street elements. Spearman's rank-order correlation was used to analyse the relationships because both the number of crimes and the number of SQFs had skewed distributions (Weisburd, Telep and Lawton, 2013). The first column in the table shows the correlations for all street elements that had at least one crime or one SQF; the second column shows correlations for hot spots of violent crime. The correlations range from 0.118 to 0.474 in the first column and from 0.078 to 0.602 in the second column.[14] Note that for the years 2016, 2017, and 2018, the correlation for the level of concentration of crimes and SQFs on street elements is quite weak. However, at violent-crime hot spots for all years except for 2016, the strong correlation between the level of concentration of crimes and SQFs is consistent. The scatterplot in Fig. 2 shows the relationship between the numbers of crimes and the number of SQFs in violent-crime hot spots. The relationship supports the argument made in the previous section (i.e., that the locations where crime incidents and SQFs should be correlated).[15]

As mentioned above, a high correlation between the concentration of crimes and SQFs shows that the police are more likely to conduct SQFs in crime-prone areas; however, it would be implausible, based only on this high correlation, to conclude that the police engage in hot spots policing activities in those areas. Rather, it is plausible to assume that the police engage in hots pots activities only if they spend more time or do more work at hot spots than what is expected of them—an issue at the heart of this study and therefore the primary analyses. Table 3 shows the results of these analyses. The table indicates a yearly distribution of the number and percentage of hot spots that are grouped under three categories: (1) Proportion of SQFs (P_{SQR}) is significantly less than the proportion of crime (P_{Crime}), (2) no significant difference between P_{SQR} and P_{Crime}, and (3) P_{SQR} is significantly higher than P_{Crime}.

A total of 375 hot spots of violent crime were identified in data from 2006. P_{SQF} was significantly smaller than P_{crime} in 134 (36%) of these hot spots. That is, police engaged in significantly fewer SQFs than expected at these hot spots. In 69 (18%) of the hot spots, P_{SQF} was not significantly different from P_{crime}. That is, police did as many SQFs as expected at these hot spots. In 172 (46%) of the hot spots, P_{SQF} was significantly higher than P_{crime}, which means that police engaged in significantly more SQFs than expected at these hot spots. The numbers and percentages in the first row of the table show that New York City police engaged in more SQFs than what was expected in 172 (46%) of the violent-crime hot spots in 2007. In other words, they performed hot spots policing in 46% of the violent-crime hot spots. In the remaining hot spots, the police engaged in as many SQFs as expected, or fewer SQFs than expected based on the proportion of crimes that occurred in those hot spots. The numbers and percentages in the other rows of Table 3 are similar to the data in the first and can can be interpreted the same way. Therefore, the details of these results are not presented here. Overall, police engaged in more SQFs than expected in 35%–46% of the hot spots identified in the years 2007 through 2018.

In summary, the data showed that of the 4210 hot spots of violent crime from 2007 through 2018, the proportion of SQFs significantly outnumbered the proportion of crimes in 1704 (40%) of these hot spots. In the remaining hotspots, the proportions of SQFs and crime incidents were either not significant (19%), or the proportion of SQFs was smaller than the proportion of crime incidents (41%). The peak year for the number of hot spots in which the proportion of SQFs was significantly higher than the proportion of crimes was 2007.

5. Discussion and Conclusion

Hot spots policing has become a popular crime prevention strategy among many police agencies. These agencies declare that they use hot spots policing in their daily operations. While there is much and robust evidence about the effectiveness of hot spots policing, the research is scant about whether the police's day-to-day operations reflect hot spots policing. As discussed above, only Weisburd et al.'s (2014) study addresses this issue by examining the relationship between SQFs and crime incident data.

In this context, the aim of this study was to address a research gap by answering the following research questions: (1) Do the police use the hot spots policing strategy in their day-to-day operations? And (2) If yes, then to what extent? To answer those questions, NYPD crime and SQF data were used for an empirical investigation of the common rhetoric among many metropolitan police chiefs who say that their officers do engage in hot spots policing as part of in their daily operations.

As expected, the results of the study showed a high correlation between the concentration of crimes and SQFs. Places with more

[13] These percentages—i.e., percentages of SQF/crime incidents that occurred on street segments vs. at intersections—are slightly different from what Weisburd et al. (2014) found in their study. The pattern of the findings, however, is similar. For example, Weisburd et al. found that, in 2009, 43% of the SQFs occurred on street segments (the current study found 35%), while 57% occurred at intersections (the current study found 65%). Weisburd et al. also found that, in 2009, 77% of the crimes occurred on street segments (the current study found 69%), while 23% occurred at intersections (the current study found 31%). Table A1 in the Appendix compares the Weisburd et al. findings with the findings from the current study. The differences in the statistics from the two studies may be the result of the different techniques used in the current study for data preparation. These issues are discussed in the Discussion and Conclusion section.

[14] The difference in the sizes of the coefficients in the two columns may be the result of differences in the number of crimes and SQFs on all street elements versus the number of violent-crime hot spots. The variations in the number of crimes and SQFs are larger in violent crime hot spots than they are for all of the street elements.

[15] Fig. 2 shows the scatterplot for 2006 only; however, the pattern is similar for the other years analyzed for the study. These scatterplots are available from the first author upon request.

Table 2
Correlation coefficients (Spearman's *rho*) between crime incidents and SQFs at street elements (i.e., segments and intersections).

Year	all street elements	hotspots of violent crime
2007	0.443	0.558
2008	0.456	0.553
2009	0.454	0.578
2010	0.470	0.568
2011	0.474	0.602
2012	0.464	0.570
2013	0.391	0.538
2014	0.257	0.479
2015	0.223	0.429
2016	0.118	0.078
2017	0.211	0.408
2018	0.225	0.424

Table 3
Numbers and percentages of hotspots by P_{SQF} vs. P_{crime}

Year		$P_{SQF} < P_{crime}$		No significant difference between P_{SQF} and P_{crime}		$P_{SQF} > P_{crime}$		Total
(Time 1)	(Time 2)	N	%	N	%	N	%	N
2006	2007	134	36	69	18	172	46	375
2007	2008	123	33	82	22	167	45	372
2008	2009	131	35	74	20	169	45	374
2009	2010	138	37	79	21	155	42	372
2010	2011	131	35	85	23	159	42	375
2011	2012	136	36	78	21	159	43	373
2012	2013	147	40	76	21	147	40	370
2013	2014	164	46	67	19	122	35	353
2014	2015	143	44	66	20	119	36	328
2015	2016	157	53	34	11	106	36	297
2016	2017	148	47	47	15	120	38	315
2017	2018	142	46	55	18	109	36	306
	Total	1694	40	812	19	1704	40	4210

* 410 hotspots were excluded from the analyses because either the number of crimes or the number of SQFs at time 2 was zero. The number of hotspots excluded from the analyses was largest in 2016 (N = 88).

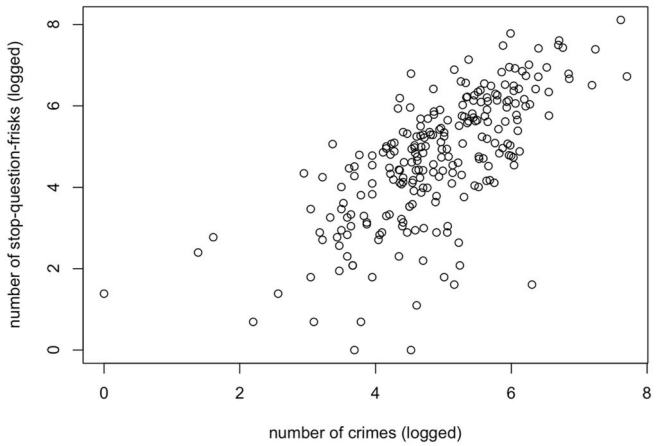

Fig. 2. Numbers of crimes and SQFs at violent crime hotspots (2007).

crimes were likely to have more SQFs and vice versa. However, although SQF is a form of proactive policing, a large overlap of the concentration of SQFs and crime does not necessarily mean that the police engage in hot spots policing activities. A formula that could discern hot spots policing practices from regular police activities was needed, and an innovative one was developed by the study's authors. According to that formula, if police are not engaging in hot spots policing, then the proportion of SQFs that occur in a hot spot should be equal (or not significantly different from) to the proportion of crimes that occur in that hot spot. On the other hand, according to the formula, if police are engaging in hot spots policing, then the proportion of SQFs must be significantly larger than the

proportion of crimes.

Hot spots of violent crimes were identified from data for the years 2006–2017. We compared the yearly data on the proportion of SQFs to the proportions of crimes of the same data from the subsequent year. Overall, the proportion of SQFs was significantly larger than the proportion of crimes in about 40%–45% of the hot spots. That is, the police engaged in significantly more SQFs than expected in these hot spots—an indication that the police engaged in hot spots policing as part of their day-to-day operations. In the remaining 55%–60% of hot spots, the police engaged in as many or fewer SQFs as they should have (i.e., proportional to the number of crime incidents), given the level of crime in the corresponding hot spots. In these cases, it is not correct to say that the police had engaged in hot spots policing as part of their day-to-day operations.

The primary finding of the study is that New York City police have engaged in hot spots policing in less than half of the violent-crime hot spots. This finding is surprising, unexpected, and not in line with most of the previous research on hot spots policing (e.g., Weisburd et al., 2014). Two probable causes of the divergent findings are offered: (1) the method used to assign crime and SQF incidents to street element and (2) the method used to identify hot spots.

The raw datasets from the NYPD contained more than 6.5 million crime incidents and about 3.5 million SQF incidents. These incidents had XY coordinates, which were used to geocode their locations. Initially, an attempt was made to assign each incident to the nearest street element using the *near* function in the ArcGIS software; however, the large number of street features the software could read, use of the *near* function would not meet the needs of the study. Instead, the ArcGIS software was used to create 10-m buffers around street centerlines. An R program was developed to create 17-m buffers around each incident and intersect the buffered incidents with the buffered street segments 1000 incidents at a time. Each incidents that intersected with only one street segment was assigned to that street segment. Each incident that intersected with multiple street segments was assigned to an intersection. Given the limited resources available for the project, the buffering-and-assignment approach was the most feasible strategy available to deal with large datasets. It is likely that some errors occurred in the assignment of incidents to street segments and intersections.

The extent of the errors that occurred is shown in Table A1 in the Appendix. Table A1compares statistics from the Weisburd et al. (2014) study. That study used nearly the same datasets as those in the current study, sought to measure the same types of relationships between hot spots policing and crimes and SQFs, and used a similar methodology—including the assignment of crimes and SQF incidents to street segments and intersections. In the Weisburd et al. study, for example, about 43% of the SQFs from 2009 were assigned to street segments and the remainder to intersections. For that same year in the current study, about 35% of the SQFs were assigned to street segments and the remainder to intersections. Similarly, Weisburd et al. assigned 77% of the crime incidents to street segments and the remainder to intersections, while in the current study, about 69% of the crime incidents were assigned to street segments and the remainder to intersections. Although the pattern is the same (i.e., both studies assigned more of the SQFs to intersections and more of the crime incidents to street segments), sizable differences exist between the percentages. The differences between the percentages can be attributed to the way that crime and SQF incidents were assigned to street elements in the current study. What cannot be attributed to the method used for assigning street elements in the current study is the study's finding that New York City police engaged in hot spots policing in less than half of the violent crime hot spots that were analyzed.

A more likely explanation could be that some SQF incidents [about 8%, assuming that Weisburd et al. (2014) study had no errors] were erroneously assigned to intersections when they should have been assigned to street segments. At the same time, some crime incidents (again, about 8%, assuming that the Weisburd et al. study had no errors) were erroneously assigned to intersections when they should have been assigned to street segments. If the erroneously assigned SQFs and crimes were not correlated with hot spots, then it is unlikely that the results of the current study were affected. If the erroneous assignments are correlated with hot spots, the results of the current study will have been influenced if two conditions hold: (1) The error was made differentially for street elements that *were* in hot spots than for street elements that were *not* in hot spots (i.e., the size of the error would be larger for crimes and SQFs that *were* in hot spots than for crimes and SQFs that were *not* in hot spots and vice versa), and the error was made differentially for crimes versus SQFs (i.e., the size of the error would be larger for crimes than for SQFs and vice versa), and (2) more crimes were assigned to intersections in the hot spots when they should have been assigned to street elements. It is not likely, however, that both of these systematic errors were made at the same time. Thus, the way that crimes and SQFs were assigned to street elements cannot explain the results of the current study.

Another possible explanation for why the results of the current study differed from most of the previous research on hot spots policing is how spots were identified. The current study used clusters of street elements (i.e., street segments and intersections) to delineate hot spots, though other options were available. One option was kernel density mapping or a similar technique that could use the grid cells of the resulting raster file as markers for hot spots. A second option was to identify the hottest street elements and then drawn circles around those elements (e.g., 200 yards) to designate hot spots (e.g., Santos and Santos 2015). A third option was to identify the hottest *N* number of street elements and use those for hot spots (e.g., Weisburd et al., 2014). The selection of one of these alternate techniques, however, likely would have had little effect on the boundaries of the hot spots that ultimately were identified for the current study. Each alternative technique would have resulted in many hot spots that overlapped the hot spots identified in the current study, given the need for spatial autocorrelation on crimes and SQFs in the hot spots. Therefore, selection of a different technique for designating hot spots would have had little to no effect on the results of the current study. Future researchers should replicate this study by identifying hot spots with these different techniques.

Our final explanation for why the results of the current study differed from the previous research is how the data were analyzed. The study was based on the premise that the mere concentration of SQFs in crime hot spots does not mean that the police are performing hot spots policing. Therefore, the study was set up to compare the proportion of SQFs to the proportion of crimes in each hot spot while assuming that the proportion of crimes in each hot spot is what one would expect the proportion of SQFs to be in each hot spot if the police were not engaging in hot spots policing and that when the police are engaging in hot spots policing, the proportion of

SQFs will be larger than the proportion of crimes in the hot spot. The technique used for analyzing the data to answer the research questions is the unique contribution of this study to the literature on hot spots policing.[16]

This study is only one study and probably the only study to argue that the New York City police may not be engaging in hot spots policing as part of their day-to-day operations in violent-crime hot spots.[17] This study also has limitations, as discussed in the above paragraphs. Nevertheless, its analytical strategy was novel, and the findings were challenging. Thus, it may have triggered more issues for future research. For example, researchers may want to address the current study's analytical strategy and the assumption that the proportions of SQFs and crimes should be equal (and not significantly different from each other) when police are not performing hot spots policing. In other words, police distribute their resources, or proactive activities, in proportion to the demand for those resources in various geographical areas. Because high-crime areas demand more police activity, the police are likely to concentrate their resources and proactive policing efforts in high crime areas—just as they do with their reactive policing efforts. This allocation of proactive and reactive policing efforts, however, should be done even when the police are not engaging in hot spots policing. It is plausible to assume that the police will allocate their resources appropriately, but no studies have been conducted to test the validity of that assumption. Future research should attempt to do so. Another avenue for future research is an exploration of the factors that differentiate New York City police precincts that use hot spots policing from those precincts that do not use hot spots policing in an attempt to understand why some precincts choose to use the policing technique and others do not. A third avenue for future research is an exploration of the structural and socioeconomic characteristics of the neighbourhoods that influence police use of hot spots policing.

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Declaration of competing interest

Authors declare no conflict of interest regarding this work.

Table A1

	2009				2010			
	Weisburd et al. (2014)		our estimates		Weisburd et al. (2014)		our estimates	
	N	%	N	%	N	%	N	%
street segments								
total number of SQFs on street segments	248,705	43.3	193,386	35.4	246,268	41.6	189,772	34.1
street segments with SQFs	26,481	24.2	20,899	17.5	28,028	25.6	21,691	18.2
SQFs in the top 1% street segments	131,891	53.6	107,228	55.4	116,640	47.4	94,568	49.8
intersections								
total number of SQFs on intersections	325,975	56.7	353,550	64.6	345,755	58.4	366,349	65.9
intersections with SQFs	27,185	50.5	24,517	42.5	27,491	51.0	24,720	42.9
SQFs in the top 1% intersections	79,379	24.4	107,190	30.3	91,706	26.5	103,997	28.4
street segments								
total number of crimes on street segments	332,819	77.4	341,171	69.1	333,574	77.5	340,413	69.2
street segments with crimes	48,927	44.7	44,655	37.4	48,546	44.3	44,218	37.1
crimes in the top 1% street segments	51,454	24.5	84,629	24.8	82,005	24.6	84,445	24.8
intersections								
total number of crimes on intersections	97,414	22.6	152,477	30.9	96,802	22.5	151,705	30.8
intersections with crimes	22,034	40.9	25,337	44.0	21,963	40.8	25,353	44.0
crimes in the top 1% intersections	21,059	21.6	40,232	26.4	21,435	22.1	41,143	27.1

[16] NYC experienced a large crime drop since the 1990s. However, the crime drop was not unique to the city, the rest of the US, and several other countries (Farrell et al., 2014). The crime drop started even earlier than the 1990s for property crimes (Farrell et al., 2014; Baumer and Wolff 2014). Several scholars attributed the crime drop in NYC to targeted policing efforts. Some of them argued targeted policing had large effects (Kelling and Sousa 2001), others suggested no association (Halcourt and Ludwig, 2006) to a modest association (Messner et al., 2007; Rosenfeld et al., 2007). As one of the reviewers reminded, the question is, which side of the debate does this study's findings support? Did targeted policing have any (or large) effect on the crime drop, since our findings indicate that the NYC police did hot spot policing in about 40% of violent crime hotspots? Targeted policing may have had some effect on the drop in violent crimes in NYC. To the extent that violent crime hot spots and hot spots of other types of crime are correlated, targeted policing may have influenced crime drop in other types of crime. However, that was not the primary research question of this study, and that question has been extensively investigated in the previous research (Baumer and Wolff 2014).

[17] To be more precise, the police may not be engaging in hot spots policing as part of their day-to-day operations for violent crime hot spots. They may instead be engaging in hot spots policing for other types of crime. This is an issue that future research should address.

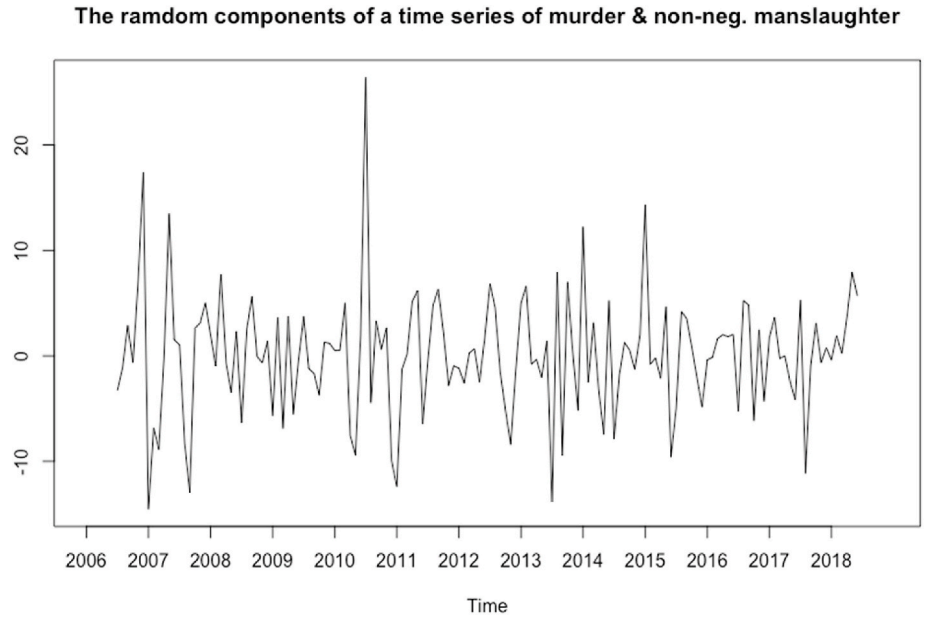

Fig. A1. The random components of a monthly time series of murder & non-neg. manslaughter in New York City 2006–2018.

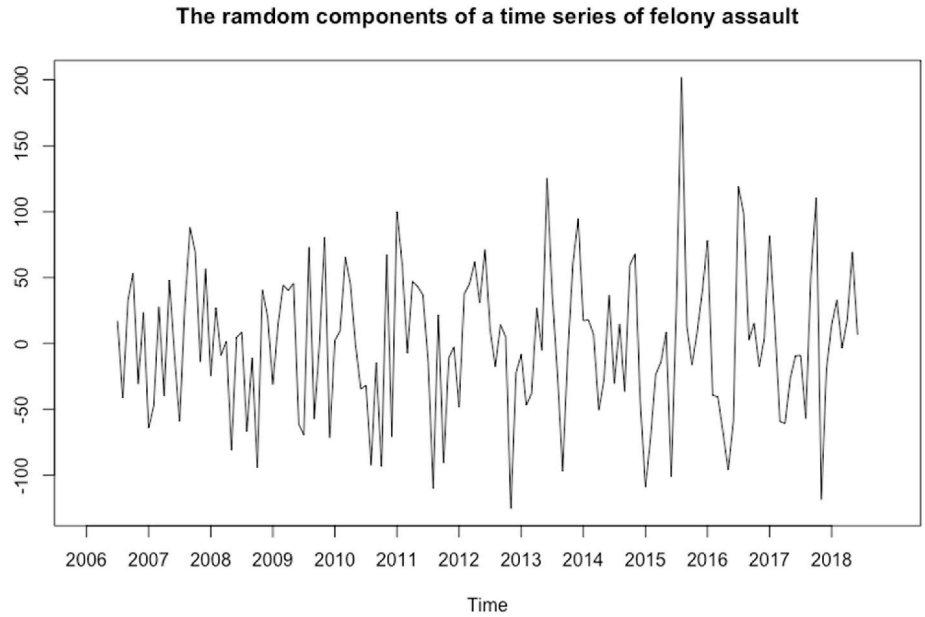

Fig. A2. The random components of a monthly time series of felony assault in New York City 2006–2018

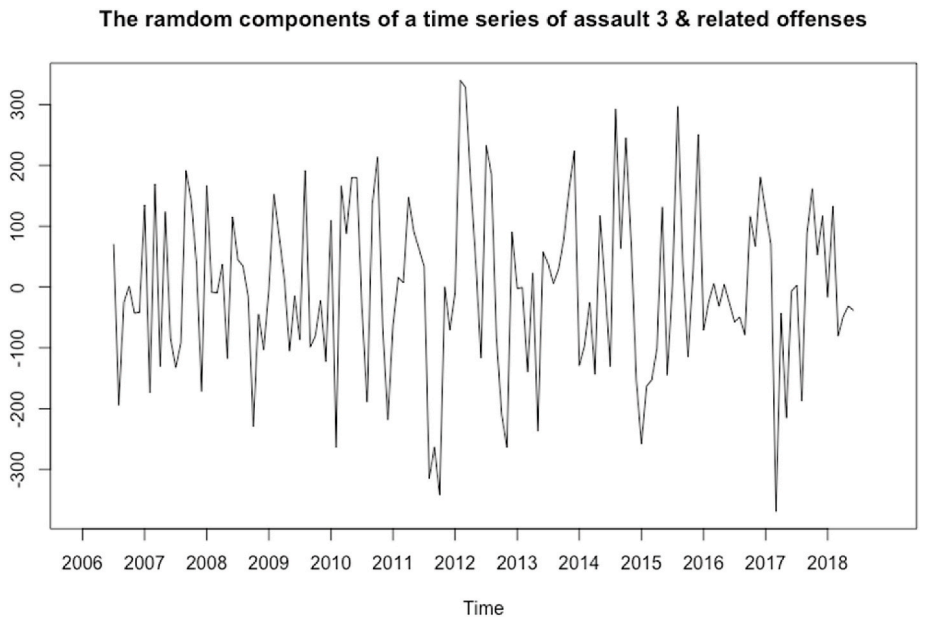

Fig. A3. The random components of a monthly time series of assault 3 and related offenses in New York City 2006–2018

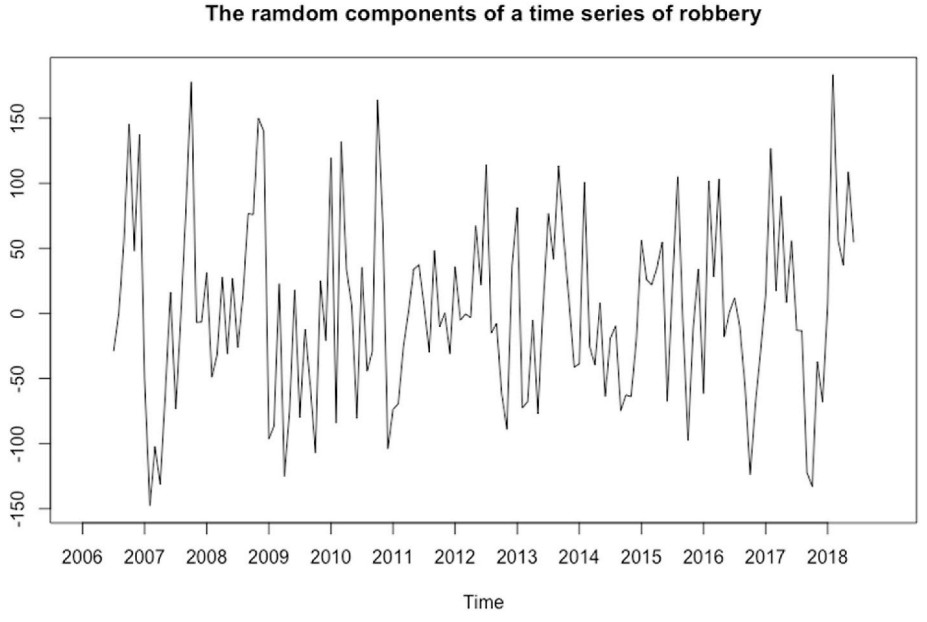

Fig. A4. The random components of a monthly time series of felony assault in New York City 2006–2018

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