



A temporal and spatial analysis of homicides



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ABSTRACT

The temporal analyses of crime date back almost 200 years with mixed empirical support. In this paper, we contribute to this literature investigating the temporal variations (seasons, months, days of week, and periods of day) of homicide in a city with a tropical climate, Recife, Brazil. Invoking both temperature aggression and routine activity theory as theoretical explanations, we found no statistically significant differences across seasons or months despite modest increases in the hottest and driest months. We did, however, find statistically significant increases in homicides during the weekends and evenings. Moreover, we found evidence for changes in the spatial patterns of homicide at different temporal dimensions. Overall, we found little empirical support for temperature aggression theory and strong support for routine activity theory.

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1. Introduction

The temporal dimension of crime is a well-established literature dating back to the mid-1800s, but with mixed empirical support (Abel, Strasburger, & Zeidenberg, 1985; Cheatwood, 1988; Landau & Fridman, 1993; McDowall, Loftin, & Pate, 2012; Rock, Judd, & Hallmayer, 2008; Tennenbaum & Fink, 1994). Though there is a general consensus that there is a seasonal component to assault (see, for example, Harries, Stadler, & Zdorkowski, 1984), this consensus dissipates rather quickly when considering other crime types (McDowall et al., 2012; Uittenbogaard & Ceccato, 2012). The cited reasons for this lack of consensus in empirical results are debated, with some authors considering the different time frames of analysis and a lack of significant seasonal variations in weather. We investigate this temporal phenomenon in the context of homicide in Recife, Brazil.

The temporal analysis of homicides has been widely explored in some places, such as the United States. In fact, Ceccato (2005) asserts that this research is dominated by studies undertaken in temperate climates, with few papers considering hotter climates. As shown in the literature review, below, there is an increasing

body of research on homicides in hotter climates; more generally, the temporal dimension of crime literature has expanded with significant research undertaken in other contexts, including the developing world—see, for example, Breetzke and Cohn (2012), Uittenbogaard and Ceccato (2012), and Breetzke (2015).

Our study aims to answer two research questions: (1) is there temporal variation in homicides in Recife taking into account seasons, months, days of week, and periods of day?; and (2), is there a difference between the spatial patterns of homicides when we consider seasons, months, days of week, and periods of day? To answer these two questions we compared the temporal dimensions through ANOVA and the spatial patterns using an area-based point pattern spatial similarity test (Andresen, 2009)—see Melo, Matias, and Andresen (2015) for another application of this spatial point pattern test in a Brazilian context. Our expectations are as follows: there is not any significant temporal variation for seasons, because there is not much annual temperature variation in Recife; we have the same general expectation for months, but there is the possibility of some significant variations because of this finer scale of temporal resolution (December and January may be more violent because of the vacation, and February because of the carnival, for example); and lastly, we expect that Saturday, Sunday, and evening will have greater volumes of homicides, because of changes in routine activities. In relation to spatial patterns, we do not expect differences for seasons and months, but because people

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spend their time in different places on the weekend and during the evening we do expect varying spatial patterns in these contexts.

This current work differentiates itself from the literature on the temporal dimension of crime in three ways: (1) the investigation is undertaken with data from a tropical climate, where the annual temperature variation is not large; (2) we consider four different temporal dimensions: seasons, months, days of week, and periods of day; (3) and we perform a spatial analysis to verify if there are distinct spatial patterns into each temporal dimension.

2. Literature review

2.1. Theoretical explanations for on temporal variations of crime

There are essentially two theories used to explain the seasonality (of homicide): temperature/aggression theory and routine activity theory (Ceccato, 2005; Cheatwood, 1995; Hipp, Bauer, Curran, Bollen, & a, 2004; McDowall et al., 2012). Each theory has its basic premise to explain this seasonal pattern of homicides: (1) homicides are more frequent during the summer because heat stimulates aggressive behavior in people; and (2) homicide patterns are a consequence of increased social interaction during summer months because of vacations from school and work.

Temperature/aggression theory was first proposed by Quetelet and “this theory suggests that hot temperatures lead to greater discomfort, which in turn gives rise to more aggressive behavior” (Hipp et al., 2004). Thus, according to this theory, there may be more violent crime during hotter days because of higher stress caused by heat. It is important to highlight that this theory is adequate to explain violent crimes, but not property crimes. Despite this limitation of its application, Hipp et al. (2004) assert that there are many works in the literature that give support to temperature/aggression theory. One of the key empirical findings that emerges from this theoretical perspective is the relationship between temperature and (violent) crime: an inverted-U, or quadratic, relationship (Cohn, 1996; Cohn & Rotton, 1997). In short, increases in temperature initially increase violent behavior, but at some point (an inflection point) it becomes too hot to fight.

Routine activity theory does not suggest that higher temperatures may cause an increase in homicides because of the aggressive behavior. Rather, routine activity theory posits that homicides will increase because of changes in routine activities with warmer weather. Routine activity theory states that crime can occur when three fundamental elements converge in time and space: a motivated offender, a suitable target, and the lack of capable guardianship (Cohen & Felson, 1979). In hotter days, people are more likely to enjoy outdoor activities, so the probability of interaction between motivated offenders and suitable targets is greater. Therefore, criminal opportunity is greater due to a greater volume of social interactions, as well as the lower vigilance on property because more people are away from the relatively protective environment of the home. Consequently, routine activity theory is able to explain both violent and property crimes, because there is an interaction between a motivated offender and a suitable target, whether that target be a person or that person's property.

Some authors suggest that routine activity theory is more appropriate to explain homicides than temperature/aggression theory (Anderson, 1987; Ceccato, 2005; Cheatwood, 1988; Falk, 1952; Landau & Fridman, 1993; McDowall et al., 2012). On the other hand, Hipp et al. (2004) asserts that these theories are not mutually exclusive with there being empirical support for both.

2.2. Previous research on temporal variations of homicide

There is a large volume of research investigating crime and

temporal/climate variations, particularly in the United States. Anderson (1987) compared temperature and seven crime types with data from the United States. His findings showed that the period between April and September is the most violent. This period has the longest days, vacations, concentrations of outdoor activities, and higher alcohol consumption. Because of these characteristics, Anderson (1987) concluded that the seasonal crime variation is more related to peoples' activities and not a consequence of temperature. In an investigation of homicide seasonality in Finland, Tiihonen, Räsänen, and Hakko (1997) found that the frequency of homicides during the winter was lower than expected (6 percent) and during the summer it was higher (6 percent). These results, therefore, revealed a seasonal component of homicides in Finland, but not to the same degree as found with assault in other contexts—see Harries et al. (1984).

Other works have not found empirical evidence for the seasonality of homicides: Block (1984) did not find seasonal fluctuations in United States and Canada, Abel et al. (1985) in New York, Cheatwood (1988) in Baltimore, and Landau and Fridman (1993) in Israel. Yan (2000) analyzed homicides in Hong Kong, also not finding evidence for seasonality, or any significant relationships with climate variables. Finally, according to Rock et al. (2008), there was no seasonality of homicides in England and Wales, but there was seasonality for assault.

In relation to the most violent months, the literature also presents mixed results. The studies of Abel et al. (1985) and Cheatwood (1988), for example, did not find monthly variation of homicides in New York and Baltimore. However, other works found greater incidence of homicides in specific months, normally summer months and months that have high levels of social interaction. Falk (1952) used data from eight American cities and found that the most violent month is July. Lester (1979) found a similar result, also for the United States: July and December. In a methodologically sophisticated analysis that investigates the nature of temporal regularity in homicide, not an explanation of any such pattern, Tennenbaum and Fink (1994) found that July and August have more homicides in the United States. McDowall et al. (2012) analyzed 88 cities in United States and found a peak of homicides in August. In Israel, Landau and Fridman (1993) found August to be the most violent month. And in Finland, Tiihonen et al. (1997) pointed out that the months with more occurrences of homicides are July and August, while the months with fewer homicides are January and February.

Despite the mixed results for more aggregated temporal analyses (seasons and months), far more consistency in results emerge in the research that considers particular days of the week: there is a greater incidence of homicides during the weekends (Abel et al., 1985; Falk, 1952; Lester, 1979). Regarding weekdays, Falk (1952) found a high incidence on Mondays while Abel et al. (1985) found the opposite. Greenberg and Schneider (1992) found that homicides are more frequent on weekends, primarily for Caucasians; however, among young African-American males, the frequency was found to be greater on Thursdays. And finally, Lester (1979) found an increase of homicides during national holidays.

This brief summary of the literature clearly shows that there is little consensus regarding the seasonality of homicides with far more consistency within finer temporal scales of analysis. Tennenbaum and Fink (1994) assert that the seasonality effect is not easily detected because the seasonal influences are small within any given year. Therefore, according these authors, data with a longer time span using the appropriate statistical tools would be necessary to capture this effect. However, longer study periods are considered in the works of Tiihonen et al. (1997) and McDowall et al. (2012). McDowall et al. (2012) also states that is not appropriate to aggregate different areas because the seasonal effect can

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