The Temporal Relationship Between Police Killings of Civilians and Criminal Homicide: A Refined Version of the Danger-Perception Theory

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The connection between police use of deadly force and the criminal homicide rate has long been recognized in the literature. Their temporal relationship, however, has seldom been examined. The present study suggests that earlier research has underestimated the importance of the temporal relationship between the homicides that present the greatest level of public danger and police use of deadly force. This research suggests that police use of deadly force can best be understood through a "ratio-threat" version of the danger-perception theory. Through a time-series analysis of data from the Federal Bureau of Investigation's Supplementary Homicide Reports over a 21-year period, the ratio-threat hypothesis is confirmed. The results suggest that, on a national level, there exists a temporal connection between predatory crime and police use of deadly force. Implications for theory and future research are discussed.

Police use of deadly force is a topic of critical interest to police practitioners and researchers. Early research on police killings of civilians focused on the questionable circumstances under which such killings occurred (Knoohuizen, Fahey, & Palmer, 1972; Kobler, 1975) or on the issue of racial disproportion in police killings, particularly of African Americans (Inn, Wheeler, & Sparling, 1977; Kobler, 1975; Meyer, 1980; Robin, 1963; Takagi, 1974). Some of these authors propose that homicides caused by police are associated with the social status of those killed, thus implying a

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conflict explanation (e.g., Knoohuizen et al., 1972; Takagi, 1974). In recent years, more sophisticated ecological applications of the conflict perspective have been empirically tested as explanations for police killings (Jacobs & Britt, 1979; Jacobs & O'Brien, 1998; Sorensen, Marquart, & Brock, 1993).

It also has been suggested that police are more likely to shoot and kill civilians who are disproportionately involved in criminal activity, particularly violent crime (Fyfe, 1980; Kania & Mackey, 1977; Matulia, 1985; Robin, 1963; Sherman & Cohen, 1986; Sherman & Langworthy, 1979). These researchers argue that shootings by police are best explained by officers' exposure to dangerous places and persons. This view has been referred to as the "community violence" perspective (Sorensen et al., 1993), the "reactive hypothesis" (Jacobs & O'Brien, 1998), and the "danger-perception" theory (MacDonald, Alpert, & Tennenbaum, 1999). However, prior research has provided conflicting evidence concerning the temporal relationship between police and civilian homicides (see, e.g., Langworthy, 1986; MacDonald et al., 1999). The purpose of this study is to further examine the temporal connection between police use of deadly force and civilian homicides on a national level.

PRIOR LITERATURE

John Goldkamp (1976), in an early presentation and clarification of the major explanations for homicides caused by police, identifies the two opposing perspectives that form the basis for later theoretical explanations and accompanying empirical tests. First, the "quasi-labeling view" argues that minorities are shot more often by police not because of their differential involvement in criminal activity but because of differential policing of minority groups as a consequence of a belief in their greater criminal involvement. Perceptions among police that racial minorities are more criminally active leads to more frequent contacts and interactions—including violent interactions—which in turn lead to more frequent shootings of minorities relative to Whites. Goldkamp (1976) notes that a logical extension of this view is that police are "labelers actively and consciously participating in the oppression of minorities" (p. 172). This view forms the basis of the conflict perspectives tested empirically by later researchers (Jacobs & Britt, 1979; Jacobs & O'Brien, 1998; Sorensen et al., 1993). The second position explicated by Goldkamp (1976, p. 173) is that a disproportionate number of minority suspects are shot and killed by police because a disproportionate number are involved in criminal activity. This position "imputes an essentially active role to racial minorities in bringing about high crime rates resulting in high death rates where confrontations with police occur" (Goldkamp, 1976, p. 173). Goldkamp (1976) further writes that the essence of this position is that "more minorities are killed by police because more minorities are involved in violence—and that neither prejudice nor discrimination figures in" (p. 177). As mentioned previously, this view forms the basis for the community violence perspective, the reactive hypothesis, and the danger-perception theory (Jacobs & O'Brien, 1998; MacDonald et al., 1999; Sorensen et al., 1993).

The theories (and their empirical tests) used to explain observed racial disparities in police shootings are important because they influence how the problem is defined and understood and thus may affect the formulation of social policy and decision making in law enforcement (Goldkamp, 1976, p. 170). A review of the three major comparative studies to date, however, shows support for both perspectives (Jacobs & Britt, 1979; Jacobs & O'Brien, 1998; Sorensen et al., 1993).

All three studies include measures of violent crime—either an index of violent crime (Jacobs & Britt, 1979; Sorensen et al., 1993) or the homicide rate (Jacobs & O'Brien, 1998)—as key indicators of the danger-perception theory. Each study also includes indicators of the conflict perspective, such as measures of economic inequality or poverty and percentage of the population that was Black, as well as a variety of other indicators.[1]

Because these studies were conducted using different statistical methods, units of analysis, and time frames, or because variables were operationalized differently, it is difficult to draw definitive conclusions regarding support for any of the theoretical perspectives. Nevertheless, an examination of the results in all three studies shows consistent support for the danger-perception theory (either a violent crime index or the general homicide rate). A limitation of these studies, however, is that they ignore the differences that exist in both the patterns of homicides (Cook, 1987) and their regularities (Tennenbaum & Fink, 1994). These differences suggest that differentiating between types of homicide may be important. Clearly, further specification of the danger-perception theory is warranted.

A review of the broader set of related studies, which use different data sources, also suggests one fairly consistent finding in support of the danger-perception theory: The number of criminal homicides is correlated with police use of deadly force. These findings, therefore, lend some credence to the danger-perception argument (Fyfe, 1980; Jacobs & O'Brien, 1998; Kania & Mackey, 1977; Sherman & Cohen, 1986; Sherman & Langworthy, 1979). Langworthy (1986), however, noting that the studies in which the observed correlation between police homicides and general homicides was based on cross-sectional analyses, conducted a time-series analysis using New York

City data provided by Fyfe (1980). Langworthy (1986) found no association and argued that the previously found correlation between police use of deadly force and criminal homicides was spurious.

The present study builds on the work of Langworthy (1986) and examines the temporal association between homicides and police killings of civilians. The general homicide[2] rate has been consistently used as a key explanatory variable in tests of the danger-perception theory. The present study is designed to further specify the danger-perception theory through an examination of the temporal relationship between police killings of civilians and civilian homicides. This issue is examined by estimating a monthly (national-level) time-series model for the period from 1976 to 1996 using data from the Federal Bureau of Investigation's (FBI) Supplementary Homicide Reports (SHR). Specifically, this relationship is explained by disaggregating civilian homicides into three groups distinguished by the nature of the killing. These categories, which are selected for pedagogical purposes, are the number of justifiable homicides by civilians, the number of robbery-related homicides, and the number of homicides occurring as a result of a love triangle. The necessity for distinguishing between homicide types has been explained by Tennenbaum and Fink (1994, p. 339):

> Homicide is one of the few crimes that is defined by its *outcome* instead of by the *process* that led to this outcome. Many researchers believe, for example, that robbery-homicides (homicides that occur in the performance of robberies) are more similar to general robberies than to lover-triangle homicides. . . . By the same token it has been suggested that some kinds of homicide are similar to aggravated assault, despite their different legal definitions. . . . This suggests that homicide should not be thought of as a coherent category of crime, with its own particular causes; rather, it should be part of other criminal categories that are created by considering the processes involved instead of their outcome. . . .

Justifiable citizen homicides generally occur when a citizen's life is threatened by a stranger (e.g., his or her home is being broken into by an armed burglar). Such incidents presumably have a significant impact on both the general public's and police officers' perceived risk for violence. Similarly, robbery-related homicides are more likely to be viewed as random, violent events in which the perpetrator is a stranger (e.g., carjacking) and as a result instill fear in both the public and the police. Homicides that result from love triangles, in contrast, are more likely to be viewed as either premeditated or spontaneous events that occur between intimates (e.g., a husband murders his wife after discovering that she is having an affair). Therefore, the homicides that occur between intimates are viewed as less threatening to the public and the police than homicides that occur between strangers. This inference is based on the fact that fear of crime is "largely shaped by one's perceived risk of victimization" (Ferraro, 1995, p. 120). The issue of perceived threat in terms of homicide directly applies to police work compared with other occupations because "in the former there is a calculated risk . . . while other occupations are accidental and the injuries are self-inflicted" (Robin, 1963, as quoted in Geller & Karales, 1981, p. 65).[3] The issue of calculated risk explains why prior research on police killings of civilians indicates that the most common shooting of a civilian by a police officer occurs in "urban America, at night in a public location, in connection with an armed robbery" (Geller & Karales, 1981, p. 56).[4] This issue of perceived threat and calculated risk for police officers sets the foundation for this study's conceptual framework.

CONCEPTUAL FRAMEWORK

As discussed above, one major explanation for police killings is the danger-perception theory. According to this theory, the level of police use of deadly force is contingent on the danger police officers experience (real or perceived). Thus, it is expected that police officers are more likely to use deadly force during time periods when (or in places where) they encounter greater levels of violence or view their jobs as being particularly hazardous.[5] We build on this perspective by borrowing a concept from the political science literature known as the "ratio goal" model (Ostrom & Marra, 1986).[6] The basic hypothesis of the danger-perception theory remains the same, but we suggest that aggregate levels of police killings of civilians over time can be explained through the ratio-threat model. Specifically, this model explains police killings of civilians as a fixed ratio or function of the level of violence (real or perceived) in society. Therefore, the ratio-threat model predicts that as the frequency of particularly dangerous criminal incidents increases, police killings of civilians increase proportionally. The statistical model for this hypothesis is stated by the following equation:

$$Y_t = \alpha + \beta X_t + e_t , \qquad (1)$$

where Y_t is the frequency of police killings of civilians in a given month (t), X_t is the level of violence in society, α is the constant risk of being a police officer, β is the ratio-threat, and e_t is the random disturbance term over time (Ostrom, 1990). The ratio-threat represents police officers' defensive stance toward the danger of their work. Therefore, this model predicts that as the level of social violence increases, so will the level of police killings of civilians.

Hypothesis

The ratio-threat model predicts a stronger temporal relationship between police killings of civilians and the types of criminal homicide that involve the greatest perceived risk to society compared with those homicides that pose a lesser perceived risk. Accordingly, we predict that justifiable citizen homicides and robbery-related homicides will have the strongest temporal associations with police killings of civilians. Conversely, we predict that homicides caused by love triangles will have the weakest temporal relationship with police use of deadly force. To test our hypothesis, we estimate several time-series models to assess the temporal relationship between the various homicide types and police killings of civilians.

METHOD

Data

Data for the analysis are from the SHR as provided by the FBI to the Inter-university Consortium for Political and Social Research (ICPSR) for the years 1976 to 1996.[7] Law enforcement agencies that report criminal homicides on the basic Uniform Crime Reports form are requested (but not required) to submit an SHR for each month.[8] The SHR is not submitted by agencies for months in which no homicides are reported to the police. Every record in the SHR includes detailed information on the victims and offenders (if known). Information on the circumstances of the event is available as well and is used to characterize the nature of the incident ("love triangle," "robbery," "justifiable homicide—civilian," or "justifiable homicide—police").[9]

Time Series

The data available for the 21-year period (1976 to 1996) were separated into 252 months. The monthly periods were used to examine the temporal relationship of police killings of civilians to the other types of homicide. For each month, there were four variables of interest: (a) the number of justifiable homicides by police, (b) the number of justifiable homicides by citizens, (c) the number of robbery-related homicides, and (d) the number of homicides that resulted from love triangles. The dependent variable is the number of justifiable homicides by police.

To test the ratio-threat model longitudinally, we employed a time-series model. To examine the model, however, one must take into account the possibility that the disturbance terms are not independent of one another but are correlated in some systematic way. In a time-series approach, for example, it is possible that the random disturbances in a statistical model share some factor(s) that affect their relationship over time (Ostrom, 1990). In other words, the random disturbances that affect one point in time may have an effect at other points in time. It is possible, for example, that a theoretically relevant random component may produce a correlation in the error term over time. The level of social violence in a given month, for example, may affect the perceived risk of violence in a subsequent month. Regarding the ratio-threat model, this type of relationship would suggest that the level of violence in June, for instance, would affect perceptions of danger in July. This process of correlation in error terms is referred to as *autocorrelation* (Pindyck & Rubinfeld, 1998). Autocorrelation would bias our estimates toward rejecting the null hypothesis that the ratio-threat has no effect on police killings of civilians and as a result could lead us to erroneously conclude that the ratio-threat explains the level of police killing of civilians.[10]

In addition to the concerns of autocorrelation, there are methodological concerns regarding the underlying stochastic process generating the data. Is the process driving these series stationary (invariant with respect to time)? If the stochastic process generating these series is nonstationary (it changes over time), it will be difficult to represent this process over time through the linear algebraic model proposed (Pindyck & Rubinfeld, 1998). More important, there is the danger of finding spurious results if one nonstationary time series is regressed against another (e.g., justifiable citizen homicide on police killings of civilians). Regarding the ratio-threat model, this would suggest that if a relationship is found between police killings of civilians and other types of homicide, it may be a result of a third, spurious factor. However, if the series are stationary, using the proposed linear model (Equation 1) would be appropriate method to analyze the relationship between the two series (Enders, 1995).

ANALYSIS AND RESULTS

To test for the potential bias of autocorrelation in the SHR data, we examined the autocorrelation function (ACF), which shows the relationship between the correlation of error terms over time of our independent (robbery homicide, homicide caused by a love triangle, and justifiable citizen homicide) and dependent (police homicides) variables. The results (not shown) indicated a large positive correlation in the first month that declines substantially over subsequent time periods. These findings provided partial evidence of the presence of autocorrelation.[11] These results, along with examination of the partial ACF and Box-Ljung statistic (after differing all four series by one), indicated evidence that the data follow a first-order autoregressive integrated moving average (ARIMA) process (1, 0, 0; see Ostrom, 1990).

To provide an additional test for autocorrelation, we examined the Durbin-Watson statistic on three ordinary least squares (OLS) regression models. All Durbin-Watson tests produced values less than the conventional minimum Durbin-Watson value of 1.75 and thus provide evidence of positive autocorrelation. Together, the ACF and Durbin-Watson test provided good evidence of the presence of autocorrelated error terms that followed a first-order ARIMA process (1, 0, 0).

Test of Stationarity

Before employing a first-order autoregressive error model, however, we examined the stationarity of the four series. As previously mentioned, if one nonstationary series is regressed against another, there is a threat of spurious findings. Therefore, we used the augmented Dickey-Fuller (DF) test in an effort to diagnose whether the series were in fact nonstationary (Pindyck & Rubinfeld, 1998).[12] Specifically, we examined whether the series followed a random walk, stochastic, or deterministic trend (Enders, 1995). The process involves regressing the difference of the series and its lagged values according to the three following equations:[13]

$$\Delta Y_t = \beta Y_{t-1} + \beta \Delta Y_{t-1} + e_t \text{ (random walk)} \tag{2a}$$

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \beta \Delta Y_{t-1} + e_t \text{ (stochastic trend)} \tag{2b}$$

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \text{Time} + \beta \Delta Y_{t-1} + e_t \text{ (deterministic trend).} \tag{2c}$$

First, we tested for random walk process across all four series (police killings of civilians, justifiable citizen homicides, robbery-related homicides, and homicides caused by love triangles). Results from the DF test failed to reject the null hypothesis of nonstationarity (random walk; $DF_{crit} = -1.94$; see Table 1).[14] Second, we tested for a stochastic trend across all four series. The results from the augmented DF test of a stochastic trend across all four series rejected the null hypothesis of nonstationarity ($DF_{crit} = -2.87$). Third, we tested for a deterministic trend across all four series. The augmented DF test for the deterministic trend also rejected the null hypothesis of nonstationarity across all four series ($DF_{crit} = -3.43$).[15] Therefore, results from the DF test indicate that the series are in fact stationary, suggesting that regressing any of

TABLE 1: Augmented Dickey-Fuller Tests, 1976 to 1996

Series	*t-Value*	*Dickey-Fuller Critical Value*
Police (random walk)	−1.68	−1.94
Police (stochastic trend)	−8.63*	−2.87
Police (deterministic trend)	−8.65*	−3.43
Robbery (random walk)	−1.23	−1.94
Robbery (stochastic trend)	−4.53*	−2.87
Robbery (deterministic trend)	−4.99*	−3.43
Civilian (random walk)	−1.53	−1.94
Civilian (stochastic trend)	−5.49*	−2.87
Civilian (deterministic trend)	−5.66*	−3.43
Love triangle (random walk)	−1.35	−1.94
Love triangle (stochastic trend)	−4.83*	−2.87
Love triangle (deterministic trend)	−8.39*	−3.43

NOTE: $N = 250$ months.
*$p < .05$.

the stationary civilian homicide series (justifiable citizen, robbery-related, and love triangle) on police killings of civilians is an appropriate method.

Graphical Trends

Graphical trends were constructed to examine the variation in police homicides and the other homicide types over time. First, we examined the monthly counts of homicide by type. The degree of variability in the number of homicide types by month was apparent. Beyond that information, it was difficult to decipher any temporal relationships. Therefore, to simplify the visual depiction of homicide types over time, the monthly series were smoothed and differenced between police killings of civilians and the three types of civilian homicides. The differenced series are displayed in Figure 1. Robbery-related homicides were divided by 10 so that the series would be on a scale similar to that used for the other homicide categories. Figure 1 indicates that the difference between justifiable citizen and robbery-related homicides and police killings of civilians is less variable over time than the difference between homicides caused by love triangles and police killings of civilians. These graphical depictions are consistent with our ratio-threat hypothesis, which predicts that homicides perceived by the police and the public to be more threatening will be the most strongly correlated with police killings of civilians. Visual inspection of differences in trend lines, however, may not represent "true" differences over time. Also, this figure represents

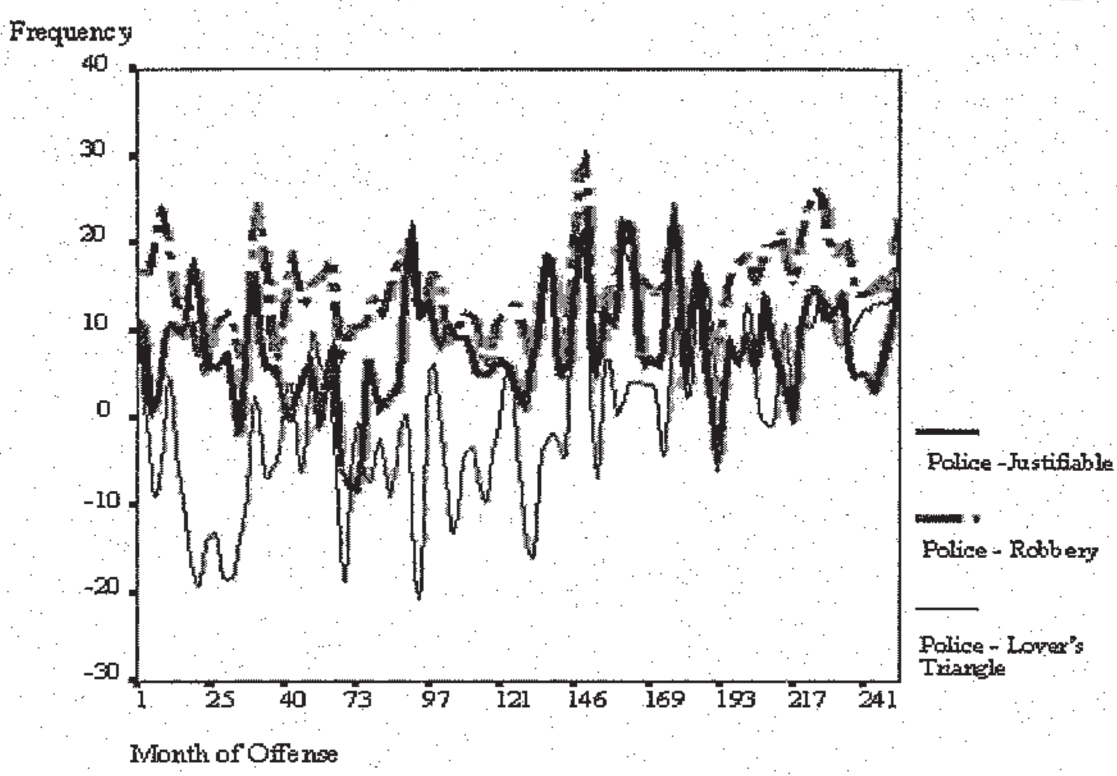

Figure 1: Monthly Differences Between Police Killings of Civilians and Civilian Homicides, 1976 to 1996

only the smoothed monthly incidence and not the true month-to-month variation as proposed in the ratio-threat model.

Descriptive Statistics

Table 2 displays the descriptive statistics for the measures employed. On average, for example, there were approximately 36 police killings of civilians per month nationally compared with roughly 35 homicides caused by love triangles and 28 justifiable citizen homicides. Therefore, it appears that the average monthly frequencies of the different types of homicide specified do not differ greatly from one another. The standard deviation measures for each of the aforementioned homicide types were also similar.

In contrast, robbery-related homicides were more frequent, with roughly 203 per month. However, these descriptive measures do not provide an indication of how the incidences of these different homicide types vary from month to month, a key factor for testing the ratio-threat hypothesis.

TABLE 2: Descriptive Statistics, 1976 to 1996

Variable	M	SD	*Minimum*	*Maximum*
Police killings	35.7	9.0	16	69
Robbery-related homicides	203.4	50.2	109	352
Justifiable civilian homicides	27.5	8.9	10	66
Love triangle homicide	34.9	10.2	6	60

NOTE: $N = 252$ months.

Granger Causality

According the ratio-threat hypothesis, the different types of civilian homicide should move together with police homicides over time. If this is the case, one can say that the variables are cointegrated (Pindyck & Rubinfeld, 1998).[16] If time-series variables are cointegrated, using a linear method such as OLS regression is an appropriate technique for analyzing the relationships between the series (Enders, 1995). Therefore, we tested whether the three types of citizen homicide (justifiable, robbery-related, love triangle) were cointegrated with police killings of civilians. Engle and Granger (1991) provide a method of testing whether two series are cointegrated.[17] We used the augmented Engle-Granger test to remove autocorrelation and test whether the three citizen homicide types were in fact cointegrated with police killings of civilians over time. The following equation was used:

$$\Delta\text{residual}_t = \beta\text{residual}_{t-1} + \beta\Delta\text{residual}_{t-1} + e_t\,. \qquad (3)$$

The results from our analysis are displayed in Table 3. They indicate that all three types of citizen homicide are cointegrated with police killings of civilians. With two series and 250 observations, the Engle-Granger critical value is –3.36.[18] All three civilian homicide types revealed t-values of their lagged residuals larger than the Engle-Granger critical test value. The lagged residual t-values also indicate a hierarchy in terms of cointegration. Specifically, justifiable citizen homicides ($t = -9.67$) and robbery-related homicides ($t = -9.91$) appear to be more cointegrated with police killings of civilians than homicides caused by love triangles ($t = -8.91$). Together, these findings indicate that we reject the null hypothesis and conclude that justifiable citizen homicides, robbery-related homicides, and homicides caused by love triangles are cointegrated with police killings of civilians. This implies that all three civilian homicide types share a common source of stationarity and are therefore causally related to police killings of citizens. The cointegration results also indicate that using OLS regression is an appropriate method for analyzing the relationship between these series.

TABLE 3: Cointegration Tests, 1976 to 1996

Series	*t-Value*	*Engle-Granger Critical Value*
Justifiable civilian homicides on police killings	–9.67*	–3.36
Robbery-related homicides on police killings	–9.90*	–3.36
Love triangle homicides on police killings	–8.91*	–3.36

NOTE: N = 250 months.
*$p < .05$.

OLS Regression

To provide a more robust test of the theory, we estimated the effects of the different types of homicide on police killings of civilians using OLS regression. Additionally, we reestimated the models using the Cochrane-Orcutt method to correct for autocorrelation in the residuals.[19] The results (Table 4) indicate, as predicted, that more threatening types of homicide (justifiable citizen and robbery-related) are the most strongly correlated with police use of deadly force over time. The models indicate a clear hierarchy in terms of the temporal relationships between particular types of homicide and police killings, with justifiable citizen homicides having the strongest association in both the OLS ($R^2 = .15$) and the Cochrane-Orcutt ($R^2 = .10$) models. The next best predictor of police use of deadly force is robbery-related homicides. Consistent with our expectations, the worst predictor of police killings of civilians is homicides caused by love triangles ($R^2 = .01$).[20] Overall, these models do not provide strong predictors of police killings of civilians, but they do suggest that this hierarchy (justifiable and robbery-related) is useful for predicting the number of citizens killed by police per month.[21]

In addition, one can examine the substantive interpretation of the coefficients in these models to see how much influence they have in predicting monthly counts of police use of deadly force. Interpretation of the coefficient for justifiable citizen homicides in a month, for example, suggests that for every 10 additional justifiable citizen homicides per month, one would expect on the average approximately 4 additional police killings of civilians. Similarly, for each additional 100 robbery-related homicides per month, one would expect on the average 6 additional police killings of civilians. The coefficient for homicides caused by love triangles indicates that for every 10 additional such homicides per month, one would expect roughly 1 additional police killing of a civilian. Based on the regression coefficients, it is evident that homicides caused by love triangles have the weakest predictive relationship with police killings of civilians.

TABLE 4: Estimated Models for Police Killings of Civilians

Model	*Type*	*Variable*	*Coefficient*	*Standard Error*	*T-Ratio*	*95% Confidence*	R^2	*Durbin-Watson Test*
1	OLS	Justifiable homicides	0.39*	0.06	6.59	0.27-0.50	0.15	1.46
2	Cochrane-Orchutt	Justifiable homicides	0.34*	0.06	5.30	0.21-0.47	0.10	2.00
3	OLS	Robbery-related homicides	0.06*	0.01	5.83	0.04-0.08	0.12	1.56
4	Cochrane-Orchutt	Robbery-related homicides	0.05*	0.01	3.93	0.03-0.07	0.06	2.00
5	OLS	Love triangle homicides	0.12*	0.06	2.14	0.01-0.23	0.01	1.32
6	Cochrane-Orchutt	Love triangle homicides	0.08	0.06	1.32	–0.04-0.21	0.01	2.02

NOTE: OLS = ordinary least squares.
*$p < .05$.

DISCUSSION

The findings in our analysis provide support for the ratio-threat hypothesis in explaining police killings of civilians over time. Robbery-related and justifiable citizen homicides represent patterns of social violence that police may view as presenting a greater threat than homicides caused by love triangles. However, the ratio-threat model was proposed to address the temporal relationship through proxy measures: police use of deadly force as a function of citizen-on-citizen violence. Other measures more directly related to officer safety, such as serious assaults and wounding, may provide an exogenous test of the ratio-threat model. However, reliable national monthly estimates of these data are not presently available. Regardless, our findings are consistent with the hypothesis that predicts a temporal relationship between particular types of violent homicide. Specifically, during time periods when the incidences of particular types of homicide are at their highest levels, police will be more likely to use deadly force. Our national-level findings of the temporal relationship between police killings of civilians and homicides are incongruent with the longitudinal analysis of New York City data by Langworthy (1986). But, our findings appear to be consistent with other longitudinal work (see MacDonald et al., 1999) and much of the prior cross-sectional research (see Fyfe, 1980; Jacobs & O'Brien, 1998; Kania & Mackey, 1977; Sherman & Cohen, 1986; Sherman & Langworthy, 1979).

Our findings suggest important analytical tools for police administrators and researchers to use in the assessment of police shootings and trends of those shootings. Traditionally, a shooting critique is limited to factors present at the scene, officer and suspect demographics, situational and crime-related information, and even tactical details. A more thorough understanding of the incident trend should include information concerning the history of the location and specifically the number of civilian homicides that result from violent acts between strangers. This information can assist in understanding the patterns of police shootings and can also build toward a theory of police use of deadly force.

CONCLUSION

The present study helps clarify the question of whether there is temporal regularity in police killings of civilians. First, we found that the average monthly counts of police killings of civilians, homicides caused by love triangles, and justifiable citizen homicides do not differ greatly from one another. Second, there was a relationship over time between justifiable citizen homicides, robbery-related homicides, and police killings of civilians. Finally, we found a weak temporal relationship between homicides caused by love triangles and police killings of citizens.

Although there is no grand theory that explains police use of deadly force, many factors are used to explain its causes or correlates. The present study adds to that list of factors and takes a step toward building a theory of police killings. Certainly, the danger-perception theory is a popular way of explaining police killings. However, the data show that the refined ratio-threat model demands further research. Future research should also examine the roles that serious assaults and felonious killings of police play in the ratio-threat model. Although felonious killings of police by themselves are too rare to provide a national test of the ratio-threat model, if these data were combined with accurate data on serious assaults on police, a clearer picture of the ratio-threat model may unfold. Presently, the data gathered on serious assaults on police are not uniformly collected from agencies and are not reliable enough to warrant inclusion in a predictive model. However, this situation could change in the near future as police departments invest more resources in data collection. Future research should also investigate at the individual city level the concurrent effects that police policies, training programs, and disaggregated violent crime patterns have on police killings of civilians over time. Such research could provide a guide to policy makers on possible methods for reducing the number of incidents in which police kill citizens. Although police killings of civilians are relatively rare given the number of dangerous encounters to which police officers are daily exposed, the public attention such events generate and the potential they have for causing mass civil disturbances necessitate that research continue to examine this issue.

NOTES

1. Jacobs and Britt (1979) used data from the National Center for Health Statistics's *Vital Statistics of the United States* to obtain information on the number of persons killed by police. Using states as their unit of analysis, they estimated an ordinary least squares (OLS) regression model, regressing the Gini index, the percentage of the population who were Black, the number of police per capita, the percentage change in population, the percentage of the population who were residents of large cities, a violence index based on the violent crime rates and the number of riots in each state, an indicator of whether the state is a border state, and an indicator of whether the state is located in the South on the number of homicides caused by police per million state residents aggregated for the period from 1961 to 1970. Sorensen et al. (1993) used the Federal Bureau of Investigation's Supplementary Homicide Reports (SHR) for data on persons killed by police, aggregated for the period from 1980 to 1984. Using 169 cities with populations greater than 100,000 (as of 1980) as their unit of analysis and employing OLS regression, they regressed the Gini index, the percentage of the population living below the poverty level, the percentage of

the population who were Black, the number of police per capita, the population density, an indicator of whether the state is located in the South, and the rate of violent crimes on the rate of police killings of felons per million residents. The authors also estimated a model using 56 cities with populations greater than 250,000 and an analysis of all killings by police aggregated for the period from 1976 to 1988. In the latter analysis, the independent variables were age, sex, race/ethnicity, and elective versus nonelective shootings.

In the most recent comparative study, Jacobs and O'Brien (1998) also used the SHR for their analysis. They analyzed the rate of police killings (aggregated for the period from 1980 to 1986) in 170 cities with populations greater than 100,000 (as of 1980). The authors used Tobit analyses in separate models of total police killings and killings of Blacks only. The variables employed in their analyses included the percentage of the population that was Black, the percentage change in the Black population, racial inequality (operationalized as the ratio of Black-to-White mean family incomes), the number of total police employees per 100,000 residents, the homicide rate, an indicator of whether the city had a city manager or commission form of government, the total population, the percentage of the population that was divorced, an indicator of whether the city had a Black mayor, the percentage of housing units with more than 1.01 persons per room, the Gini index, and the percentage of families below the poverty line. See Jacobs and Britt (1979), Sorensen et al. (1993), and Jacobs and O'Brien (1998) for additional details.

2. *Criminal homicide* is defined in this research as murder and nonnegligent manslaughter.

3. Prior data, for example, suggest that police officers are more likely to get shot while intervening in armed robberies compared with domestic disturbances (Geller & Karales, 1981, p. 147).

4. This typology is also supported in more recent research that examined Metro-Dade Police Department shootings (Alpert & Dunham, 1995).

5. This analysis provides a macro-level theory test of incidents that occur in micro-level processes (e.g., the decision to shoot a civilian in a particular situation; Geller & Karales, 1981). These methods are similar to research that examines the temporal relationship between aggregate labor market opportunities and crime rates (see Freeman, 1995) or other macroeconomic theories (see Enders, 1995). The empirical research does indicate that homicides are spatially clustered in certain sections of cities (Lattimore, Trudeau, Riley, Leiter, & Edwards, 1997; Sampson & Wilson, 1995). Therefore, this theoretical model should be viewed as a weaker test of police killings of civilians than those that employ exogeneity.

6. The ratio goal model was developed to explain U.S. defense spending as a ratio of the United States's desire to maintain competitive spending with the Soviet Union (Ostrom & Marra, 1986).

7. Neither the ICPSR nor the FBI bear any responsibility for the interpretations presented in this article.

8. The form is incident oriented. If more than one murder occurred during the same incident, only one form will be filled out.

9. These homicide types were selected purely for pedagogical reasons and are not meant to be exhaustive. They were chosen because it was believed that these types of homicide were clearly distinguishable from one another.

10. This refers to the statistical process in which the standard errors of both the constant and coefficient are underestimated.

11. We also examined the data after differencing the ACF by 2 periods and did not find evidence supporting a second-order autoregressive process (2, 0, 0). Previous work by Tennenbaum and Fink (1994) has noted the cyclical nature of homicides in general. Therefore, we examined the ACF for evidence of seasonality in each of the series (K = 12, 24, 36, 48, etc.). The results indicated that seasonality is not a concern with the four individual series. These findings are consistent with other time-series literature in social science data (see McCleary & Hay, 1980).

12. The null hypothesis in the Dickey-Fuller test is that the series are nonstationary.

13. ΔY_t represents the differenced value.

14. For any number of observations *T*, the DF critical value is $\beta_\alpha + (\beta_1 / T) + (\beta_2 / T^2)$. See Mackinon (1991) for critical values.

15. The deterministic term (Time) was significant for the love triangle and robbery-related homicide series. Regression analyses that controlled for the deterministic term did not reveal substantive differences from those reported in this article.

16. This is a common method used in macroeconomic theories. For example, consumption and income tend to move together over time (Pindyck & Rubinfeld, 1998).

17. The test is simple: One simply runs the OLS regression between the two variables and then tests whether the residual (e_t) from this regression is stationary.

18. The Engle-Granger test requires performing the DF test $(\beta_\alpha + [\beta_1 / T] + [\beta_2 / T^2])$ on the residual series. See Mackinon (1991) for critical values.

19. For the analysis, we use the Cochrane-Orcutt estimation method to control for the autocorrelation in the residuals. The Durbin-Watson test, after calculating the Cochrane-Orcutt method, falls close to 2.0, indicating that autocorrelation is no longer a problem. Other methods that control for autocorrelation, such as the Beach-McKinnon method, were also employed. Due to the large number of observations in this time series (252 months), there were no substantive differences in the findings. Additionally, Table 4 shows that controlling for autocorrelation in the residuals does not substantively change the findings. This is because there appeared to be cointegration in these series, which dominates the estimates. This is because the OLS regression estimates are not biased in the long-run predictions between cointegrated series (Enders, 1995).

20. The naive model includes only the prior monthly number of police killings as a prediction of subsequent months.

21. In addition to the national-level analysis, we also disaggregated the SHR data into reporting jurisdictions and analyzed the trends in New York City and Los Angeles. However, there were not enough homicides per month of the classifications used in the national-level analysis to yield meaningful comparative results across the two cities.

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