Document Title: Intra-Metropolitan Crime Patterns Predictors, and Predictions, Executive Summary

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Document No.:   249740

Date Received: February 2016

Award Number: 2009-IJ-CX-0026

EXECUTIVE SUMMARY
July, 2014
GRANT: 2009-IJ-CX-0026
From the National Institute of Justice

Intra-Metropolitan Crime Patterns Predictors, and Predictions

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1. Overview

This summary presents in capsule form the questions examined in the current project, describes the data collected to answer these questions, recounts the most significant difficulties with that collection efforts, notes the most important findings, and outlines their policy, practice, and theory implications. In brief, this project connected yearly crime counts or crime rates at the jurisdiction level across 355 jurisdictions in one large metropolitan area, for nine years (2000-2008), with yearly information on demographic fabric and police coverage in these jurisdictions. The data describe the Philadelphia (PA)-Camden (NJ) primary metropolitan area.

Four aspects of these connections drew our interest: the size and direction of the impacts of community fabric and law enforcement coverage on crime; the spatial patterning of crime and crime links, the spatiotemporal patterning of crime and crime links; and the predictability of one- or three-year-look-ahead crime rates using the available variables.

The summary is intended for a generalist audience. Readers more versed in the research or policy topics addressed here will find details on data collection procedures and challenges, expanded treatment of the questions addressed and analyses used, further details of the main findings, and additional findings, in the main project report.

2. Context

The Philadelphia/Camden primary metropolitan area, hereafter the Philadelphia metro area, covers 3,830 square miles; 5,383,081 people called it home in 2013.The Philadelphia metro area spans two states, Pennsylvania and New Jersey, and contains within it nine counties (New Jersey: Burlington, Camden, Gloucester, Salem; Pennsylvania: Bucks, Chester, Delaware, Montgomery, and Philadelphia). [1] These counties host a total of 355 jurisdictions, politically

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recognized municipalities or civil divisions (MCDs). [2]The MCDs are of several types: cities (e.g., Philadelphia, Camden, Chester, Pottstown, Coatesville, Salem City), townships (e.g., Lower Merion, Haddonfield, Upper Dublin) and boroughs (Narberth, Pine Valley, South Coatesville). The most common municipality type is the township. Jurisdiction populations range widely from over 1.52 million (Philadelphia in 2003) to 24 (Tavistock in 2000).

Policing arrangements across the metro area are complicated. A previous examination of smaller metro areas in the US found similar complexity in policing organizational patterns. [3] That complexity has several components. Safety is produced by different types of police agencies. Most frequently found here are municipal producers: city, township or borough-level police departments. State police agencies also play a major role in producing safety. In New Jersey the state police provide exclusive police coverage in 15 jurisdictions; the Pennsylvania State Police provide exclusive police coverage in 40 jurisdictions. A small number of rural departments demonstrated an "alternation in time" pattern of police patrolling, with state police assuming those functions during certain hours. [4] Not surprisingly, given the variation in populations across jurisdictions, local police department sizes vary widely as well. Local police departments dedicated to just one jurisdiction and with at least one sworn full time officer ranged in size from 1 to 6,781 sworn officers. The typical (median) local police department employed 14 sworn officers.

3. Links with Crime Levels

3.1. Demographic Community Structure

Community criminologists have been examining the connections between the fundamental fabric of geographic communities, and levels of crime or delinquency, for close to a

century. [5] Much of this work has focused on communities with the geographic size of neighborhoods within cities. For example, community criminologists like Bursik and Grasmick have described how three fundamental features of community demography – residents' socioeconomic status (SES), residential stability, and racial composition or heterogeneity – affect community levels of crime and delinquency. In their basic systemic model of crime they describe how these three features of community fabric shape social dynamics within and outside the community. These social dynamics in turn affect crime and delinquency levels. [6] The work here addresses links between the starting point and the end point of these postulated dynamics: the connections between community demographic structure and crime.

What kinds of connections have community criminologists previously observed? A systematic review of work suggested that indicators of SES and racial/ethnic composition linked most consistently to community crime rates. [7] Crime levels were generally lower in communities with higher SES levels and lower percentages African-American population. Residential stability proved important in only about half the studies examined.

Here, the units of interest are at a different geographic scale – jurisdictions within a large metropolitan area – than is often examined in community criminology. Therefore, an important question is whether these three demographic community factors link in different ways to jurisdiction crime levels than they do to intra-city neighborhood crime levels, the type of connection most frequently examined in the previous communities and crime work. Researchers often find that crime correlates shift when they switch to different size geographic units. [8] So of interest here is whether race, SES and residential stability link as strongly to crime at the jurisdiction level as suggested by models like the basic systemic model of crime. If they do, that suggests the potential generalizability of this model to jurisdiction level crime might prove worth

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investigating. Of particular interest given past patterns across studies is whether the crime-fabric connection is weaker for residential stability, as suggested by the recent review, than it is for SES and race.

Results from the current work showed that both fundamental features of community structure connecting most strongly to crime in previous research – SES and racial composition – linked consistently in the expected direction to violent crime levels. As anticipated by the recent review of community crime correlates, jurisdictions with lower SES and higher fractions of African-American residents simultaneously experienced higher violent crime rates. This link persisted even after controlling for police coverage, temporal crime trends, and surrounding violent crime levels. Jurisdictions a standard deviation higher on SES experienced current violent crime levels about 9.6 percent lower. Jurisdictions a standard deviation higher on percent African-American simultaneously experienced violent crime levels about 9.4 percent higher. But more surprisingly, residential stability's connection to violent crime was the strongest of the three. Jurisdictions scoring a standard deviation higher on residential stability on average experienced a violent crime level 29.8 percent lower.

The demographic correlates linked less consistently to property crime than to violent crime. Of the three demographic elements, only higher residential stability connected significantly to lower property crime levels. Each standard deviation increase in residential stability was associated with expected property crime levels about 11.8 percent lower.

In sum, cross-sectional crime correlates of metro area jurisdiction-level crime rates provided some confirming but also some surprising results, compared to work in the last few decades on community crime correlates. First, residential stability appears more important than

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suggested by earlier work. It is the only community demographic feature to link to both violent and property crime levels. Second, SES and racial composition proved relevant to crime levels, as shown in previous work, and in the expected direction. But here they apply only to violent crime levels.

3.2. Law enforcement coverage

Considerable sophisticated work in the last few decades has examined impacts of police coverage rates, officers per 1,000 residents, and policing practices, on community crime levels.[9] Most of this work relies on a broad ecological deterrence framework.[10] The current work did not have access to indicators of policing style, but did examine impacts of police coverage rates.[11] Police coverage rates failed to link in the expected negative direction with either property or violent crime levels.

3.3. Spatial inequality, nearbycrime and sub-regions of relative danger and safety

Scholars of the Philadelphia region such as Carolyn Adams, David Bartelt, David Elesh their colleagues, and earlier researchers, have observed patterns of sizable and increasing spatial inequality over the last handful of decades.[12] They have documented racial, economic, employment, housing and service differentials. Adams and colleagues have argued that "governmental fragmentation in our metropolitan region establishes incentives that exaggerate social and economic inequalities."[13] They describe a region "that is decentering and has balkanized into hundreds of small, separate jurisdictions that offer their residents widely differing opportunities to work, live, and educate their children."[14]

But the analyses to date of jurisdiction-level spatial inequality in the Philadelphia metro area offered by Adams and colleagues has been limited in two important respects. First, their

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analysis failed to include reported crime. So it is not clear whether patterns of inequality will be reflected in crime levels in the same ways that they have been reflected in SES, housing, and education. Second, their analyses failed to take into account the extent to which the inequalities they described were explicitly spatially patterned. The analyses here included spatial analyses of crime patterning so we can see exactly how, and how strong statistically, the crime inequalities across the region are.

Certainly, the above cross-sectional analysis linking SES, racial composition and stability to crime differences suggest we will see spatially patterned crime inequalities. If SES and racial composition are spatially patterned, which Adams and colleagues have noted, this increases the chances that spatial crime differentials will be observed. Since the cross sectional structural links are stronger for violent than property crime, the metro-wide spatial patterning of violent crime patterns may be stronger than the patterning of property crimes.

Two lines of evidence would suggest spatial crime inequalities across the region. Analyses might reveal evidence of spatial dependence of reported crime rates, that jurisdiction crime levels are influenced by the crime levels of nearby jurisdictions. In addition, observing significant local geographic clusters of jurisdictions with similar crime rates would be relevant. A geographic cluster of jurisdictions with relatively low crime levels would suggest a sub-region of relative safety in the metro area. A geographic cluster of jurisdictions with relatively high crime rates would suggest a sub-region of relative danger.

Voluminous work in the geography of crime documents impacts of community crime levels on nearby communities' crime levels. [15] Such spatial dependencies have been observed in crime geographies ranging from hot spots to communities to counties to states in the U.S.. Such

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spatial dependencies may suggest "that underlying causes of crime can drive the crime rate in small [or large] areas." [16]

The same influences were observed here at the intra-metropolitan jurisdiction level. A spatially lagged crime outcome variable, capturing the average surrounding crime level for each target jurisdiction, significantly influenced crime levels in focal jurisdictions, even after taking into account jurisdiction fabric, policing arrangements, and police coverage. The cross-sectional link was significant both for property and violent crime levels. Therefore, thinking broadly about the entire metro region, crime concentration effects appear operative. Jurisdictions are nested within and influenced by crime-based sub-regions of the metro area.

The second line of evidence seeks to geographically locate sub-regions of relative safety or danger. Sub-regions of geographically-adjoining jurisdictions were statistically identified each year. [17] An example appears in Figure 1. It shows significant sub-regions – clusters of geographically adjoining jurisdictions -- of relative safety and relative danger in the metro area for the year 2004. The pattern is typical of what was seen in other years as well. A sub-region of relative danger, in red, includes Philadelphia, Camden, and surrounding jurisdictions, especially on the Pennsylvania side between southwest Philadelphia and the city of Chester, and extending further south of Chester. Jurisdictions in this cluster share a higher than locally typical violent crime level. Three large sub-regions of relative safety appear in blue: in lower Chester County; stretching northwestward from Delaware into upper Chester County; and in central Bucks and mid-Montgomery County. These clusters share a lower than locally typical violent crime level.

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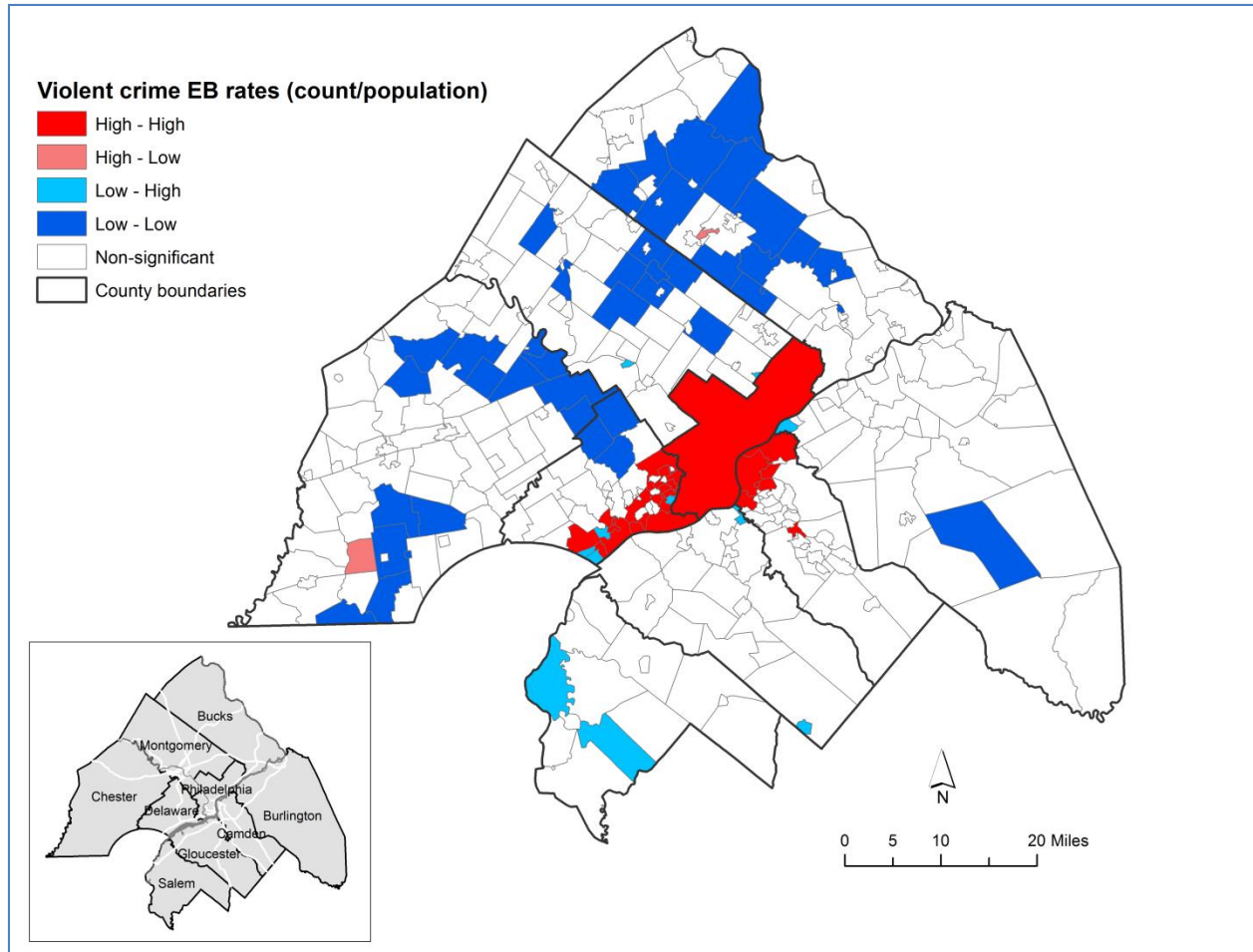
Figure 1. Local clusters based on significant local spatial autocorrelation of violent crime rates: 2004

In sum, crime inequality connections suggest four points. First, nearby crime dynamics are operating "above" the jurisdiction level, and affecting sub-regions within the metro area. Second, sub-regions of local relative danger, or local relative safety, can be geo-located for every year examined. Third, the spatial patterning of these crime inequalities, at least for violent crimes, roughly matches what we would expect given the other structural inequalities described for the region. [18] A surprise with the patterning, however, is that the safe sub-regions appear almost exclusively on the Pennsylvania side of the metro area. Finally, community crime rates can affect community structure. [19] Therefore, these results potentially present one pathway whereby crime differentials by sub-region may deepen existing inequalities already present across the region.

4. Links with Crime Changes

4.1. Deepening crime inequalities

The above suggested point, that geographic patterning of sub-regions of relative safety and danger may be contributing to increasing inequalities across the region in services and community quality, implies three points. First, that over time some jurisdictions are likely to experience faster increasing crime levels than others. Second, those changes will geographically cluster by sub-regions. Third, that the geographic sub-regions where crime levels are increasing faster are the same ones where high crime jurisdictions are surrounded by other high crime jurisdictions.

Analyses of the yearly crime levels within jurisdictions supported all three points for violent crime. Analyses confirmed that the jurisdictions as a group were experiencing significantly disparate crime changes over the period 2000-2008. Some places were getting

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significantly safer compared to the average yearly violent crime change, and some were getting

significantly more dangerous compared to the average yearly violent crime change. Further,

those change patterns were geographically clustered overall, and, further, generated statistically

significant sub-regions where crime was getting worse faster or slower than average. Figure 2

shows those sub-regions. Jurisdictions in red were in geographic sub-regions experiencing

violent crime risks increasing faster than the local average across the region. Jurisdictions in blue

were experiencing violent crime risks that were either increasing more slowly than average, or

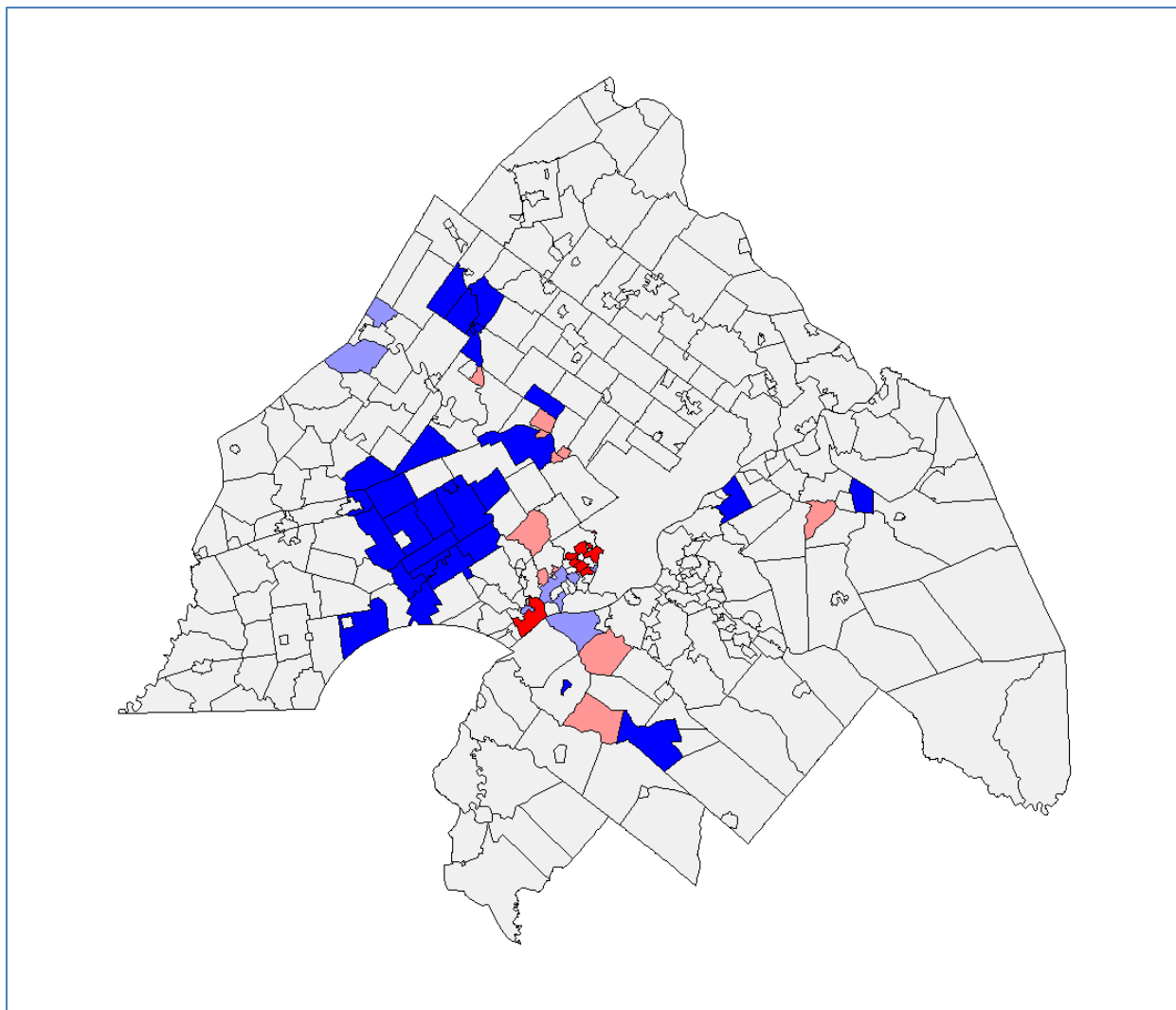decreasing faster than the local average.

Figure 2. LISA statistics, annual net linear rate of violent crime rate change. Dark blue = low-low; dark red = high-high; light blue = low surrounded by high; pink = high surrounded by low.

In several small jurisdictions immediately southwest of Philadelphia, and in the city of Chester itself, there is evidence of spatial inequalities in crime becoming compounded over the first years of the millennium. There were several jurisdictions that had high violent crime levels, and were often surrounded by other high crime jurisdictions, which also were increasing on violent crime, on average over the period, faster than other places. In short, existing public safety inequalities across the region were geographically identifiable and, more importantly, were

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deepening during the study period. These widening spatial inequalities on crime during the period may have been contributing to increasing non-crime inequalities in community quality or public safety during the study years, or may do so in years to come.

4.2. Structural differences drive crime changes

Adams and colleagues highlighted structural and service inequalities across the Philadelphia metro area. Another way that crime inequalities within the region may deepen over time is if later crime changes are linked to earlier structural features of jurisdictions. For example: are the higher SES jurisdictions less likely to experience later increases in violent crime?; Are more stable jurisdictions less likely to experience increasing property crime? Stated generally, are places that are structurally disadvantaged to begin with – lower SES or more residential instability – the same places where safety erodes more quickly or crime levels worsen more quickly? We have significant evidence from a number of community-level studies that this is so.[20]

Here, over the study period, jurisdiction crime changes proved to be structurally patterned. [21] Jurisdictions became increasingly violent, relative to the violence changes in all other jurisdictions in the metro area, if in the year prior they had lower SES, lower residential stability, and were more predominantly African-American. Jurisdictions experienced increasing property crime, relative to the property crime changes in all other jurisdictions in the metro area, if in the year prior they had lower SES and lower residential stability.

In short, "better off" places with higher SES and more stable residents got progressively better off in terms of crime, year by year through the period; and, "worse off" places with lower SES and less stable residents got even worse off, year by year, through the period. These links

showed for both violent and property crime changes. Intra-regional crime inequalities were worsening over time, and these deepening crime divides were driven by extant structural differences across jurisdictions.

Implications follow. First, structurally driven *shifts* in relative crime advantages or disadvantages continue to take place, despite the maturity of the metro area. The entire metro area is continuing to evolve in terms of both structure and safety differentials. Second, because the deepening crime divides are structurally driven, these shifts are reinforcing already substantial intra-regional patterns of inequality. Third, the pattern is geographically linked, as shown by identifiable sub-regions in the metro area where passing time is associated with different rates of crime change. More specifically, the portion of the region that seems to be the most disadvantaged initially in terms of both structure and crime, the stretch from roughly the city of Chester in Delaware County up to the southwest edge of the city of Philadelphia, is also the sub-region where violence problems during the period intensified most quickly.

4.3. Street, land use and public transport networks link to crime changes

Land use, street network geographic patterns, and public transit geographies also shape crime changes at the jurisdiction level. Jurisdictions whose interior geography was less accessible as a result of public transit networks and road networks were less likely to experience increasing property or violent crime. Jurisdiction boundary impermeability, the difficulties of getting into or out of a jurisdiction, also played some role in dampening violent crime increases. Places with more easily traversable road networks, or more public transit transfer points were more at risk of future violent crime increases. These results suggest outlines for a macro-level,

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jurisdiction level, crime pattern theory. [22] They also highlight how non-demographic features of jurisdictions, features laid down well in the past, continue to shape jurisdiction-level crime shifts.

4.4. Police coverage and crime changes

Do police coverage levels link to later crime shifts, controlling for current crime levels? In the case of property crime shifts, they do. Jurisdictions with higher coverage rates were more likely to experience lower later relative property crime levels.

4.5. Forecasting crime changes

Jurisdiction-level crime rate forecasts were carried out for both property and violent crime. See Figure 3 and Figure 4. Forecasts were built based on one set of years, and then tested using a different set of years. Models used either crime, or demographic structure, or crime and demographic structure as predictors. All models also controlled for policing arrangements and coverage levels. Models were compared using a statistical benchmark that took into account both accuracy and model complexity.[23]
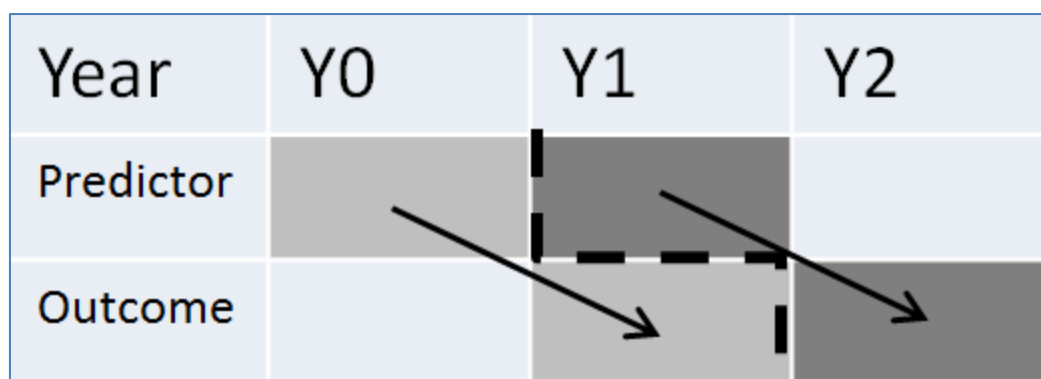
Figure 3. Short term autoregressive relationship with lag of one. Dashed line separates model development data from out-of-sample model test data
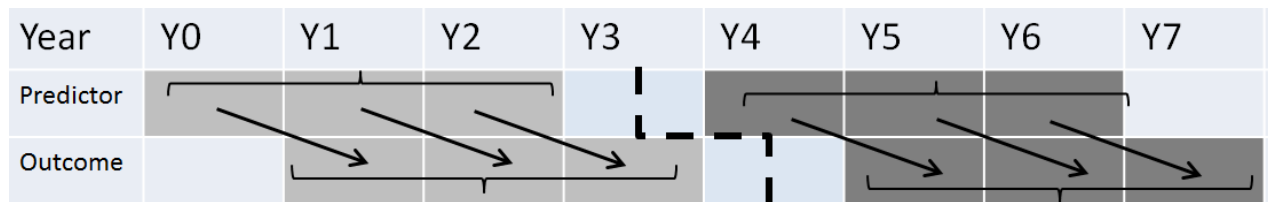
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Figure 4. Autoregressive relationship with a lag of one, but presumed stable over a longer period. Dashed line separates model development data from out-of-sample model test data. Each of the three arrows reflects the *same* statistical relationship.

Forecasting results for property crime proved acceptably accurate. Depending on the year forecasted and the model used, mean absolute percentage errors (MAPEs) in the one year look-ahead forecasts ranged from 2.4 percent to 5.9 percent. Generally, when taking both model complexity and accuracy into account, models using just earlier crime looked preferable. Models making three-year-look-ahead forecasts generated MAPEs between 2.2 percent and 3.0 percent. Here models using just earlier demographics appeared preferable.

Forecasting efforts were not as successful for violent crime forecasts, but nevertheless seemed worthwhile. One-year-look-ahead forecasts generated MAPEs between 10.2 and 14.5 percent. Three-year-look-ahead forecasts generated MAPEs between 7.3 and 10.6 percent. For the one-year forecasts, models with both crime and demographic structure looked best. Models with earlier demographics only looked preferable for the three-year-look-ahead forecasts.

These forecast models address a task different than the models predicting unexpected crime changes. There, the purpose was to gauge impacts of current demographic structure and policing on later crime levels, while controlling for current crime levels. Here, the question is simpler: relying on current jurisdiction demographic structure, and current crime levels, or just

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one of these, how well can we predict crime levels one year out or three years out? The answer is: pretty well, especially for property crime.

5. Implications for Theory, Policy and Practice

5.1. Theory

The current work asked if the predictors providing the starting point in the systemic model of crime, based largely on research with intra-city, neighborhood size units, appeared applicable to intra-metropolitan patterning of jurisdiction-level crime levels and changes. Results suggest the systemic model is indeed applicable. SES, residential stability, and racial composition all linked at some point with crime or crime changes in the ways anticipated by the systemic model. Residential stability, which plays a key role in the model but has been somewhat discounted in recent research reviews, proved especially important. Consequently, research studies of intra-metropolitan crime patterning which have failed to include this factor may have produced misleading results.[24] Of course, the basic systemic model of crime contains many propositions which have not been tested here. Most importantly, links between jurisdiction structure and jurisdiction social and organizational dynamics, and the effects of such dynamics on crime, have not been examined. Nevertheless, the structural impacts seen here suggest it may prove worthwhile to see how structure, crime and these social and organizational dynamics all link up.

Second, in line with voluminous research on the geography of crime with smaller and larger geographic units than are used here, results underscore the crucial and multiple roles of spatial dependence. Jurisdictions' crime levels were shaped by the crime levels around them, and specific sub-regions of relative safety or relative danger surfaced. Taking these spatial

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dependencies into account requires data sources which are geographically complete (see more below under policy). Models failing to do so may provide misleading results. [25]

Third, the spatial patterning of crime levels, the appearance of relatively safe or dangerous sub-regions within the metro area, and the spatiotemporal interaction shown here with crimes getting worse faster in vulnerable sub-regions, all underscore how crime reflects and deepens inequalities across the metro area. Crime reflects current inequalities and contributes to worsening, geographically linked disparities in community quality and services. Attention to crime dynamics adds an important new dimension to discussions of inequalities across the metro region.

5.2. Policy

Four main policy-related implications emerge from this research. All have relevance to state and local governments as well as police. The first relates to the difficulty of assembling complete information for *all* jurisdictions in a major metropolitan area, and the impact this has on our potential for recognizing the important role of jurisdictions in preventing crime. Obtaining accurate and timely data, the first implication, is a necessary precondition if one is to act on the other three implications. The second concerns the movement to evidence-based practice in law enforcement. This requires information about crime and police coverage in order to fuel conversations and evaluations about what is working in policing. The third relates to the critical role of information sharing among jurisdictions. The fourth, and broadest, concerns the important role of the built environment in setting the stage for crime.

Data assembly difficulties. The current study unearthed several difficulties with obtaining complete crime data information for all jurisdictions in the metro area. At the Federal level, the

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Uniform Crime Report Return A data, provided by the FBI, were both incomplete, because there were no data from jurisdictions which did not report their own crime data, and presented some tangles. As an example of the latter, a separate field for counties was not included. So we had to figure out, cross referencing UCR and Census population numbers, where the data for each of the three Springfield Townships in the metro area should be geo-located. The bigger issue, incompleteness, arose because different policing arrangements obtained in different places. If there was no local police department, no crime numbers were funneled up through the respective state police agency and thus to the FBI. The New Jersey State Police at the state level *did* remedy the incompleteness issue. Their annual reports provided separate counts for each jurisdiction where they were the sole police agency. The Pennsylvania State Police (PSP), however, did not do this. The PSP did provide county crime counts for places where they were the sole policing agency. But, *these data are not geo-located to the individual jurisdiction within a county.* Therefore, for the several dozen jurisdictions in the metro area where the PSP were the exclusive policing agency, it was necessary for us to allocate unallocated crime counts at the county level appearing in the PSP reports to individual jurisdictions. This took some work. (See full report, appendix 1).

Analysts whether in police agencies or other local or regional agencies need crime and police coverage data that are consistent across jurisdictions, easily accessible, and timely. Without these data, jurisdictions and law enforcement agencies often lack the basic information necessary to understand crime trends.

This leads to our suggestion that state police agencies should be required to report annually on the reported crimes taking place in *each* of the MCDs where they are the exclusive

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law enforcement agency. Most local police or other local or regional governmental agencies do not have the capability to routinely estimate crime through allocation by population.

The availability of such data is necessary to allow the implementation of the other policy recommendations that follow.

Evidence based practices and nearby crime trends. This initial investigation into jurisdiction-level crime trends highlights the importance of neighboring jurisdictions' crime trends. There is a strong geographic effect especially for violent crime. There are sub-regions identified where jurisdictions near one another were experiencing worsening crime problems at the same time. This suggests that police in these neighboring jurisdictions may have been confronting *a common crime problem shared to a degree across the sub-region.* Therefore, agencies in jurisdictions would do well to consider their neighbors' crime trends when planning their own crime responses.[26] As outlined above, crime analysts will likely encounter significant obstacles in gaining access to those data. But given the recent emphasis on encouraging evidence-based practice in policing, pressure to analyze data and take into account best practice will be increasing and perhaps force greater *shared* availability of crime data.

Shared data and criminal intelligence analysis. Finding ways to achieve more systematic data sharing would address the related needs for: 1) better quality and more timely data and 2) consideration of crime trends in neighboring MCDs. Since most jurisdictions have several neighbors, regional data sharing initiatives and agreements seem like a 'logical' first step. Potential economies of scale that can be leveraged to maximize local investments in police systems should be explored earlier rather than later. But the most basic policy change would be to recognize and act as if the jurisdiction is a part of a larger group rather than an island, part of a

"metroquilt" [27] or an entire ecological system [28] rather than an isolated patch of fabric. This will require members of government at all levels look beyond their boundaries at neighboring jurisdictions in order to 'see' crime trends. Working collaboratively with neighboring jurisdictions, agencies can work toward policies that discourage crime before it becomes a reality in their own jurisdiction. [29]

Street and public transit networks. Fourth, urban and transportation planners could draw from these findings and consider the potential effects of changing the permeability of their MCD on crime. Features that contribute to internal accessibility such as street networks and public transportation are consistently associated with higher levels of both property and violent crime. At the same time, MCDs with less permeable boundaries were less affected by the crime rates of neighboring MCDs. Thus, planners should consider the negative externalities associated with increased accessibility and include strategies to mitigate crime impacts as a component of their proposals for changes in the number and type of roads and public transportation.

One final related implication is offered based on the effects of suburban large-scale retail complexes (malls and complexes of malls) on property crime. These large-scale land uses are clearly creating additional property crime risk. Although this is not surprising given literatures on crime attractors in crime pattern theory more broadly, it does point up a sizable and often hidden cost. These concentrated retailing complexes are creating significant negative externalities for local governments who have more property crime to manage. Of course, the largest complexes have their own private security forces making security governance in and around these land uses complicated. [30] The implication here is that proprietors of these large-scale retail complexes should perhaps be assessed a negative externality fee by the hosting MCD for the property crime

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risks created by these businesses. It's clear these land uses bring more property crime, and therefore the local jurisdictions need more police.

Of course a matter such as this has troubling political wrinkles. As Adams and colleagues have pointed out, local jurisdictions are often seriously outmatched by outside development interests. [31] Threats of litigation usually result in local government acceding to what these outside groups want. It is a bit challenging to imagine a small local government placing demands on a major corporation running a mall complex. At the same time, it is abundantly clear that these large-scale retail complexes are having sizable adverse impacts on the use value of the hosting community for the residents; quality of life is adversely affected. And right now, it's the MCDs, not the developers behind the retail complexes, who are footing the bill for coping with this adverse impact.

5.3. Practice

There are three main practical implications that emerge from this research effort. Two findings are of particular interest to strategic crime analysts. A third is of interest to local government officials generally, and to police executives at the state, regional, and jurisdiction levels.

First, demographic variables are not critical for forecasting short term crime. Relatively decent one-year, look-ahead crime rate forecasts can be constructed for both property crime and violent crime levels using just current crime. Including social and demographic data can add accuracy to these forecasts but in practical terms the gain is not worth the effort. Using just current crime to predict future crime seems a defensible practice.

Second, crime trends in adjacent MCDs are important to consider when forecasting crime in your jurisdiction. Looking at within-MCD crime trends offers only part of the picture. By sharing crime data across MCDs, each police department could see how its crime dynamics are part of a larger pattern. Exactly how this shared intelligence would translate into tactical policing decisions depends on a range of issues. Could shift supervisors have access to daily or weekly *geolocated* calls for service by crime category and arrests by crime category, for surrounding MCDs within an X mile radius? If they could, that input might prove useful for daily deployment decisions. But providing the infrastructure for such timely information sharing, and getting the cooperation of the relevant agencies, are both daunting tasks.

Nonetheless, there have been different organizational models for such sharing. Fusion centers provide one model. Agencies designed to coordinate information sharing provided yet another. Specifically, regional intelligence sharing centers such as the DVIC (Delaware Valley Regional Intelligence Center) and HIDTA (High Intensity Drug Trafficking Area) which offer investigative support. [32] Finally, ARJIS (Automated Regional Justice Information System) for San Diego and Imperial Counties in California offers an example of a locally sourced information sharing model. So there are at least three different templates for coordinating police information across agencies within sub-regions of an MSA. Which model would be more effective, how these sub-regions should be defined, and how all this gets paid for and incorporated into the operations of individual departments are important open questions. But the data patterns seen here strongly suggest some type of common crime dynamic within sub-regions that would be best addressed by a regional agency.

The third finding of interest to both local government officials generally and police executives is that police coverage rates (sworn officers per 1,000 residents) have a deterrent

impact on later unexpected property crime changes at the municipality level. Years when the

coverage rate is higher are more likely to be followed the next year by a lower property crime

level. So, at least at the jurisdiction level, funding a higher rate of police coverage translates into

reduced property crime.

6. Notes

[1] The city of Philadelphia is coterminous with the county of Philadelphia. The city of Camden, however, is just one of many jurisdictions within Camden County. The same holds for the city of Chester and Chester County.

[2] To see county-by county maps of these jurisdictions, go to: http://mpip.temple.edu and click on "Map of Communities"

[3] In the 1970s Ostrom and colleagues examined policing patterns in a geographically stratified sample of 80 metro areas with at least a population of 1.5 million each. We are not able to compute standardized measures of police service delivery because specialized police agencies were eliminated from consideration. Ostrom, E., Parks, R. B., & Whitaker, G. P. (1978). *Patterns of Metropolitan Policing*. Cambridge, MA: Ballinger.

[4] Ostrom et al. (1978): 30-31.

[5] Taylor, R. B. (2015). *Community Criminology*. New York: New York University Press.

[6] Bursik, R. J. Jr., & Grasmick, H. G. (1993). *Neighborhoods and crime*. Lexington: Lexington.

[7] Pratt, T. C., & Cullen, F. T. (2005). Assessing macro-level predictors and theories of crime: A meta-analysis *Crime and Justice: a Review of Research* (Vol. 32, pp. 373-450).

[8] Hipp, J. R. (2007). Block, tract, and levels of aggregation: Neighborhood structure and crime and disorder as a case in point. *American Sociological Review, 72*(5), 659-680; Taylor, R. B. (2010). Communities, Crime, and Reactions to Crime Multilevel Models: Accomplishments and Meta-Challenges. *Journal of Quantitative Criminology, 26*(4), 455-466. doi: 10.1007/s10940-010-9114-6

[9] See for example: Kubrin, C. E., Messner, S. F., Deane, G., McGeever, K., & Stucky, T. D. (2010). Proactive Policing And Robbery Rates Across US Cities. *Criminology, 48*(1), 57-97.

[10] Cousineau, D. F. (1973). A Critique of the ecological approach to the study of deterrence. *Social Science Quarterly, 54*(1), 152-157.

[11] Authors recognize that there is disagreement about how to interpret these rates. As Harries pointed out almost 4 decades ago, "the quality of law enforcement in a given area is a function of a number of factors." (1974: 91) Consequently, the impacts seen here of police/population ratios must be viewed quite cautiously. Harries, K. (1974). *The Geography of Crime and Justice*. New York: McGraw-Hill.

[12] Adams, C. T., Elesh, D., & Bartelt, D. (2008). *Restructuring the Philadelphia Region: Metropolitan divisions and inequality*. Philadelphia: Temple University Press.

[13] Adams et al. (2008), p. 32.

[14] Adams et al. (2008), p. 193.

[15] Chainey, S., & Ratcliffe, J. H. (2005). *GIS and Crime Mapping*. London: Wiley. pp 116-119.

[16] Chainey & Ratcliffe (2005: 117).

[17] Although not described here, these sub-regions were verified statistically. See: Anselin, L. (1995). Local Indicators of Spatial Association—LISA. *Geographical Analysis, 27*(2), 93-115. doi: 10.1111/j.1538-4632.1995.tb00338.x

[18] Adams et al. (2008); Smith, N., Caris, P., & Wyly, E. (2001). The "Camden Syndrome" and the menace of suburban decline: Residential disinvestment and its discontents in Camden County, New Jersey. *Urban Affairs Review, 36*(4), 497-531.

[19] Impacts of crime on house prices is one of the clearest cases in point. Lynch, A. K., & Rasmussen, D. W. (2001). Measuring the impact of crime on house prices. *Applied Economics, 33*(15), 1981-1989; Taylor, R. B. (1995). Impact of crime on communities. *Annals of the American Academy of Political and Social Science, 539*, 28-45.

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[20] To take just one example: Taylor, R. B., & Covington, J. (1988). Neighborhood changes in ecology and violence. *Criminology, 26*, 553-589.

[21] Models used here are cross-sectional time series models, with a time lag of one year. So, for example, 2000 predictors were linked to 2001 crime levels while controlling for 2000 crime levels. Analyses used crime population weighted percentiles to capture the fraction of the population living in jurisdictions with equal or lower crime rates. Therefore, these results capture relative crime changes.

[22] Groff, E. R., Taylor, R. B., Elesh, D., McGovern, J., & Johnson, L. (2014). Permeability across a metropolitan area: Conceptualizing and operationalizing a macro-level crime pattern theory. *Environment and Planning A, 46*, 129-152.

[23] The Deviance Information Criterion was the fit/complexity indicator used. See: Spiegelhalter, D. J., Best, N. G., Carlin, B. P., & van Der Linde, A. (2002). Bayesian measures of model complexity and fit. *Journal of the Royal Statistical Society. Series B (Statistical Methodology), 64*(4), 583-639.

[24] One such study lacking stability indictors is: Kneebone, E., & Raphael, S. (2011). City and suburban crime trends in metropolitan America. Metropolitan opportunity Series. Metropolitan Policy Program at The Brookings Institution.

[25] Kneebone and Raphael (2011) failed to estimate spatial dependencies in their study.

[26] Imagine a township bordered by six other townships, with each of those six neighboring townships sharing an equal portion of the focal township's geographic boundary. Imagine further that the land use patterns along and around the focal township's border are exclusively residential. In addition, consider a situation where the robbery rate in the focal township is increasing over time. Finally, having complete and relatively current information available from neighboring jurisdictions, the police department in the focal township learns that robbery rates are going up simultaneously in three immediately neighboring townships spread along the eastern boundary of the focal township. That information leads to planning a different type of police response than a situation where robbery rates were increasing simultaneously in *all* of the immediately adjoining townships.

[27] Felson, M. (1986). Crime risk at any point on the city map. In R. M. Figlio, S. Hakim & G. F. Rengert (Eds.), *Metropolitan Crime Patterns* (pp. 127-136). Monsey, NY: Criminal Justice Press; Felson, M. (1987). Routine activities and crime prevention in the developing metropolis. *Criminology, 25*(4), 911-932.

[28] Bursik, R. J. J. (1986). Ecological stability and the dynamics of delinquency. In A. J. Reiss & M. Tonry (Eds.), *Communities and crime* (pp. 35-66). Chicago: University of Chicago Press, 60-61.

[29] These strategies only make practical sense under assumptions of relatively low levels of spatial displacement in response to crime prevention initiatives. Weisburd, D., Wyckoff, L. A., Ready, J., Eck, J. E., Hinkle, J. C., & Gajewski, F. (2006). Does crime just move around the corner? A controlled study of spatial displacement and diffusion of crime control benefits. *Criminology, 44*(3), 549-591.

[30] Wood, J., & Shearing, C. (2007). *Imagining security*. Cullompton: Willan.

[31] Adams et al. (2008).

[32] Office of National Drug Control_Policy. (2011). *High Intensity Drug Trafficking Areas Program Report to Congress*. Washington, DC: Executive Office of the President.

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