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Cause or Consequence?

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Abstract:

Inner-city crime is a motivating factor for middle-class flight, and therefore crime is a cause of suburbanization. Movement of the middle- and upper-classes to the suburbs, in turn, isolates the poor in central city ghettos and barrios. Sociologists and criminologists have argued that the concentration of poverty creates an environment within which criminal behavior becomes normative, leading impressionable youth to adopt criminal lifestyles. Moreover, from the perspective of routine activity theory, the deterioration of social capital in high-poverty areas reduces the capacity for guardianship. Therefore, suburbanization may also cause crime. We argue that prior research has not distinguished between the causal and compositional effects of suburbanization on crime. We show that the causal component can be identified by linking metropolitan-level crime rates, rather than central-city crime rates, to measures of suburbanization. Using UCR and Census data from 2000, we find a positive relationship between suburbanization and metropolitan crime.

Introduction

Urbanization has both costs and benefits (O'Sullivan, 2003). On the positive side, large cities encourage innovation, production, and trade, so they are able to improve the standard of living. Cities also provide consumers with a wide variety of goods and services. However, cities also become home to concentrations of social and economic problems. Central cities in the U.S generally have much higher crime rates than their associated suburbs. Violent crime rates in cities with populations over 250,000 in 2005 were almost three times higher than in suburban counties and more than four times higher than in rural counties.[1]

In the United States, metropolitan areas have been suburbanizing rapidly for many decades. Both residential and commercial activities have moved toward greater spatial dispersion and lower population densities. Inner-city crime is often cited as a motivating factor for middle-class flight, and therefore crime is a potential cause of suburbanization. Movement of the middle and upper classes to the suburbs, in turn, leaves behind and isolates the poor in central city ghettos and barrios, and reduces the fiscal capacity of central cities to address social and economic problems. Rapid suburbanization and large scale urban blight have caused declining tax bases in central cities, shrinking federal subsidies (based in part on population size), and poor public services. Sociologists and criminologists have long argued that the concentration of poverty creates an environment within which criminal behavior can become normative, leading impressionable youth to adopt criminal lifestyles. Moreover, from the perspective of routine activity theory, the deterioration of social capital in high-poverty areas reduces the capacity for guardianship. For these reasons, suburbanization may also cause crime indirectly by causing the social and economic isolation of inner-city neighborhoods.

This paper addresses the potential causal effect of suburbanization on crime using data

from the U.S. Census and Uniform Crime Reports. Using the metropolitan area as the unit of analysis, we ask whether there is evidence that suburbanization leads in a causal way to increases in crime. We find that past research has failed to demonstrate this relationship and propose a method that does have the potential to identify this relationship. We present empirical models that support the hypothesis that suburbanization plays a causal role in crime, although the findings depend on the type of crime and the particular measure of suburbanization employed. Our findings suggest that the rapid suburbanization of U.S. metropolitan areas does not merely redistribute crimes and victims, but also contributes to higher overall levels of criminal activity.

The next section reviews the prior literature on the relationship between crime and suburbanization, highlighting methodological difficulties encountered in previous research. The section after that discusses a framework for thinking about the relationship between suburbanization and crime that points to an empirical strategy with the potential to isolate the causal effect of suburbanization on crime. Succeeding sections present the data and variables used in our analysis, the regression models employed, the findings of our analysis, and concluding remarks.

Previous Literature

The level of crime in one's neighborhood, particularly violent crime, is a top concern for most Americans (Pew Center for Civic Journalism, 2000). As a result, high central-city crime levels have been linked to depopulation of the inner city (Morenoff & Sampson, 1997; Oh, 2005). Crime, or more precisely the desire to avoid it, is said to be a major factor in the rapid suburbanization of U.S. metropolitan areas (Bursik, 1988; Cullen & Levitt, 1999; Liska & Bellair, 1995; Liska *et al.*, 1998; Mieszkowski & Mills, 1993).[2] The suburbanization process, and particularly the class-selective nature of out migration from the central cities, has contributed

to increasing economic segregation and concentration of poverty (Jargowsky, 1997, 2002; Wilson 1987; Yang & Jargowsky, 2006). White and middle-class flight to the suburbs also reduces the fiscal capacity of central cities to provide public services, including police protection (Joassart-Marcelli *et al*., 2005).

High levels of neighborhood poverty, in turn, have long been suspected as a causal factor in crime. Shaw and McKay (1942), following in the Chicago School tradition of Park and Burgess (1925), studied the relationship between crime and poverty commonly observed in transitional neighborhoods. They focused on three structural factors: "low economic status," "ethnic heterogeneity," and "residential mobility." They argued that these factors lead to the disruption of local community social organization, which explains variations in crime and delinquency rates. In particular, they tried to address the strong relationship between social structural elements and crime by proposing that the spatial distribution of crime in a city was a product of "larger economic and social processes characterizing the history and growth of the city and of the local communities which comprise it" (Shaw & McKay, 1942).

Elevated crime levels have been attributed to neighborhood social disorganization stemming from urban structural changes, residential instability, and racial/ethnic transitions (Bursik & Grasmick, 1993; Sampson & Wilson, 1995; Sampson, Raudenbush, & Earls, 1997). The population and family instability of inner-city high-poverty neighborhoods is associated with high inner-city crime rates (Sampson, 1987; Sampson & Wilson, 1995). Neighborhood poverty may alter the real or perceived returns to schooling or work, and the high-levels of crime may alter the costs and benefits of criminal activity, inducing more criminal behavior from persons on the margin (Ludwig, Duncan & Hirschfield, 2001).

Routine activity theory provides another perspective to understand the effects of

suburbanization on central city crime. For a crime to occur, there must be a convergence in time and space of a suitable target, a motivated offender, and a lack of capable guardians (Cohen and Felson, 1979). Violent crime "should be more highly related to the presence of motivated offenders," whereas property crime "should be more sensitive to opportunities for crime and guardianship" (Stahura and Sloan, 1988: 1104). Suburbanization affects the distribution of all three crime precursors across the metropolitan region (Logan, 1978; Stahura and Sloan, 1988). On the one hand, to the extent that wealthier persons leave the central city and/or lower-income persons are excluded from the suburbs, there may be relatively fewer suitable targets and relatively more motivated offenders in the central city. Potential offenders residing in the central city far from access to entry-level jobs in rapidly-growing suburban neighborhoods may become more motivated to turn to crime to satisfy immediate needs. Most importantly, the out-migration of stable middle-class families, and the deterioration of social capital in inner-city neighborhoods, reduces informal neighborhood guardianship capacity (Stahura and Sloan, 1988). Erosion of the per-capita property tax base reduces the ability of central city communities to provide adequate police protection, further reducing guardianship. Stahura and Sloan (1988) find that motivation more strongly affects violent crime while guardianship more strongly affects property crime. Moreover, they find a multiplicative affect of the three crime preconditions for property crime, but not for violent crimes (Stahura and Sloan, 1988: 1110-1112).

Merely observing that crime rates are higher in poorer neighborhoods, however, does not provide evidence of a *causal* effect of neighborhood-level poverty in the sense implied by Shaw and McKay. Krivo and Peterson (1996), for example, estimate census tract level regressions purporting to show that neighborhood poverty causes crime. Yet these models are equally consistent with a non-causal explanation based on the relationship between poverty and crime at

the individual level. Lower income people on average have a higher incidence of involvement in criminal activity; a high-poverty neighborhood will have a higher crime rate than a better off neighborhood based solely on its demographic composition (Alba, Logan, & Bellair, 1994; South & Messner, 2000).

Many analyses of neighborhood effects on criminal activity suffer from the inability to isolate causal effects from compositional effects. Even with individual-level data, neighborhood effects are hard to pin down, because persons may self-select into and out of high-poverty or high-crime neighborhoods based on unobserved characteristics relevant to the probability of engaging in crime. Several strategies have been attempted to overcome selection bias. Case and Katz (1991) use instrumental variables to control for selection, and find some evidence of peer effects on juvenile crime. Ludwig, Duncan, and Hirschfield (2001) use experimental data from the Moving to Opportunity program, and find reductions in violent crime for juveniles if they move to low-poverty neighborhoods, but some evidence of increases in property crimes.[3]

These findings suggest that suburbanization may lead indirectly to higher levels of crime through its effect on economic segregation and the creation of high-poverty neighborhoods in the inner city. However, the majority of literature has not dealt with the causal effect of suburbanization on central city crime in a direct way. Historically, the criminology literature has focused on the relationship between crime and population density, based on the notion that suburbanization leads to lower population density. Many previous studies before 1980s focused on analysis of simple correlations between population density and crime, but their results were not consistent.[4]

Several researchers have attempted to estimate the causal effect of suburbanization on crime directly. These studies have used percent of the metropolitan area population residing in

the central city as an inverse measure of suburbanization. Gibbs and Erickson (1976) and Skogan (1977) both noted the correlation between crime rates *in the central city* and the degree of suburbanization in the metropolitan area. However, such a correlation could be produced solely by differential suburbanization rates of criminals and non-criminals. While a compositional effect explains why crime rates in central city are higher than in the more affluent suburbs, it does not show that the effect of suburbanization is causal. Shihdadeh and Ousey (1996) also fail to distinguish causal and compositional aspects of the relationship.

Farley (1987) replicated the relationship between suburbanization and certain central city crime rates after controlling for the percent poor and percent black in the central city. Farley also noted the problematic nature of central city boundaries, which encompass greater or lesser portions of a metropolitan area for a host of historical reasons and variations in local laws concerning annexation. Central city crime rates would be lower in almost any metropolitan area if the boundaries of the central city were extended to include more of the suburban area. At the same time, these boundary changes would increase the percent of the metropolitan area population in the central city, reducing the measured level of suburbanization, and thus induce a positive association between suburbanization and crime that is merely a statistical artifact.

Stafford and Gibbs (1980) note that both criminals and victims frequently cross the central city/suburb boundary, so that the central city crime rate can be misleading, as it is based only on crimes and the population base within one area. They define suburbanization as the inverse of the percent of the metropolitan area's residence in the central city. They also add a variable for "dominance": the central city's proportion of the metropolitan retail sales. Finally, they add the interaction of these two variables. However, it seems that their measures of suburbanization and dominance should be very nearly the reciprocal of one another, making their

results hard to interpret, especially with the addition of the interaction term. The suburbanization measure by itself was not significant for either property or violent crimes in regressions controlling for central city demographics. Moreover, none of the studies discussed above addresses the fact that higher crime might also cause suburbanization, so that the direction of causality is not established by these analyses.

Linking Suburbanization and Central City Crime

In this section, we describe a framework for thinking about suburbanization and central city crime that isolates the causal component of the relationship. Previous research has provided evidence that crime and other social problems concentrated in the central city are contributing factors to flight to the suburbs (Bradford & Kelijian, 1973; Burnham, Feinberg, & Husted, 2004; Cullen and Levitt, 1999). Households maximize utility in the choice of residential locations based on household characteristics and neighborhood amenities, and crime is considered a disamenity (Mieszkowski & Mills, 1993). In this section, we illustrate how suburbanization might influence crime by describing a series of hypothetical scenarios. Although simplistic, the scenarios provide useful insights. They illustrate that suburbanization can lead to increased central city crime rates whether or not the effect is causal, which presents a challenge for empirical research.

In the first scenario, we assume there is no suburbanization: all 100 persons reside in the central city. Ninety percent are law abiding, and 10 percent are criminals. Each criminal commits two crimes per unit of time, so that 20 crimes occur. The crime rate (defined here simply as crimes per person) is therefore 20/100 or 0.2. This situation is depicted in the top panel of Figure 1. From this base, we examine three different possible patterns of suburbanization. The first, shown in the middle panel of Figure 1, is neutral suburbanization,

which consists of a proportional redistribution of 80 percent of the population to the suburban area. Criminals are just as likely to move to the suburbs as the law abiding, so that the both the suburban area and the central city (CC) consist of 90 percent law-abiding persons and 10 percent criminals. Assuming no change in the rate of offending, and assuming that most crimes are committed locally, the suburban crime rate will equal the central city crime rate and the overall metropolitan crime rate will not change. In this scenario, crime has merely been redistributed. Clearly, this scenario is unlikely, because actual suburbanization tends to be selective with respect to income, lifestyle, and preferences.

In the second suburbanization scenario, we model a highly selective movement from the central city to the suburbs. Eighty law-abiding persons move to the suburbs, presumably in part to escape the possibility of becoming a crime victim. Since all criminals remain in central city, the crime rate in the suburbs is zero. The central city population now consists of ten law-abiding persons and ten criminals. The central city crime rate quintuples to 1.0 because the reduced population base divides the same number of crimes. This gives rise to the commonly observed pattern of higher crime rates in the central city relative to the suburbs, but only because of the change in the denominator of the central city crime rate. The overall metropolitan crime rate remains unchanged, because in the metropolitan area as a whole there is the same population and the same number of criminals committing the same number of crimes. The apparent rise in crime is, in a sense, an illusion driven by the different suburbanization patterns of the criminal and law-abiding segments of the population.

As discussed previously, many researchers going back to Shaw and Mckay (1942) have argued that crime is not an exogenous phenomenon but is a function of the ecological environment within which it occurs. In other words, criminal behavior, especially among

adolescents, is in part a response to social disorganization – neighborhoods with high levels of stressful conditions such as poverty, family breakup, racial and ethnic discrimination, etc. If we assume the criminals in our hypothetical models have disproportionate levels of economic and social disadvantage, then the central-city neighborhoods in the selective suburbanization scenario experience higher levels of poverty, family breakup, and other forms of disadvantage than suburban neighborhoods. According to social disorganization theory, these extant social conditions of the central city neighborhoods will have an independent effect of criminal offending. Moreover, according to routine activity theory, the absence of capable guardians in high-poverty neighborhoods will contribute to criminal offending, especially for property crime.

The bottom panel of Figure 1 describes a third suburbanization scenario, the problematic central city, in which there are causal effects of neighborhood composition as alleged by Shaw and McKay. First, there are three crimes per criminal because the harsh environment leads people to commit more crimes, perhaps due to lax enforcement or reduced stigma. In addition, the case assumes that the number of criminals also increases from 10 to 15 because of the contagion effects of living in a very disadvantaged neighborhood. In other words, five people who might have been law abiding under other circumstances capitulate to the environmental influences of the central city neighborhood. For example, they may join a criminal gang to be protected from other criminals. Clearly, the central city crime rate is higher in this scenario: it rises to 2.25. Unlike the previous case however, the overall metropolitan crime rate is also affected, rising from 0.2 to 0.45.

As in the selective suburbanization scenario, the problematic central city results in an uneven pattern of crime rates. In the former case, however, the higher central city poverty rates are the result of population movements that affect only the denominator of the crime rate

calculation. In the latter case, the higher central city crime rate results from changes in both the numerator and the denominator of the crime rate. The changes in the numerator are casually induced by post-sorting neighborhood conditions.

There are several important implications. First, an observed neighborhood-level correlation between poverty (or some other measure of disadvantage) and crime is a necessary but not sufficient condition to conclude that the former causes the latter. Both selective suburbanization and the problematic central city scenarios result in such a correlation, but only in the latter case is correlation causal. Even in that case, only part of the correlation results from Shaw and Mckay-type effects, while the rest of the correlation is a reflection of sorting. It also follows that an observed correlation between some measure of suburbanization and central city poverty rates is not sufficient to conclude that suburbanization contributes to central city crime. However, if problematic social conditions do exacerbate crime, *metropolitan-level* crime rates will also be affected, because the total amount of crime is increased. The change in metropolitan crime rates, unlike the change in central city crime rates, does potentially identify a causal effect.

These insights point to an empirical strategy. There is an expected level of crime in any metropolitan area base on its population size, demographic composition, age structure, and income level. If suburbanization affects the incidence of crime in a causal way, suburbanization should predict crime *at the metropolitan level* after controlling for these baseline characteristics. Further, to obtain unbiased estimates of the effect of suburbanization on crime net of baseline characteristics, we must take into account the reciprocal relationship between suburbanization and crime. If the spatial organization of the metropolitan area has causal effects on crime, these effects could vary by the specific type of crime committed, so we distinguish violent crimes from property crimes in our analysis.

Data and Variables

Crime Rates.

The crime rate is defined as the number of crimes per some unit of population, usually 100,000. Data on the number of crimes of different types are obtained from the Federal Bureau of Investigation's Uniform Crime Reports (UCR) program. Over 18,000 policing jurisdictions across the United States provide UCR data. However, because UCR is "a voluntary program," the first-line police agencies do not submit mandatory reports, introducing another source of error (Maltz & Targonski, 2002). Moreover, crime data is subject to errors based on inconsistent enforcement and underreporting by victims.

UCR data is available in two different types: agency-level data and county-level data, each with its own advantages. Police agencies have highly varied and sometimes overlapping jurisdictions. Because we focus on metropolitan areas, which are composed of counties, we aggregate county-level data to calculate the overall metropolitan area crime rate. Though the study uses county-level crime data that is more appealing than agency-level data for our purposes, the county-level data has some problems as well (Maltz & Targonski, 2002). Because agencies' jurisdictions sometimes overlap, and because the agencies may use incorrect or inconsistent ways to estimate the population they serve, population figures in this data may not be correct. We observed gross discrepancies between Census and UCR population figures. We therefore use the population figures from Census data.

The county-level data set provides arrests for Part I offenses (murder, rape, robbery, assault, burglary, larceny, auto theft, and arson) and for Part II offenses (forgery, fraud, embezzlement, vandalism, weapons violations, sex offenses, drug and alcohol abuse violations, gambling, vagrancy, curfew violations, and runaways). We focus on arrests for Part I offenses

(murder, rape, robbery, assault, burglary, larceny, auto theft, and arson). We subdivide these into two categories: violent crime, including murder, rape, robbery, and assault; and property crime, including burglary, larceny, auto theft, and arson.

Suburbanization Indicators

Several different measures of suburbanization are used to capture different dimensions of the concept (Galster, et al., 2001; Yang & Jargowsky, 2006). The first suburbanization measure is the density gradient. Although previous literature often focused on the relationship between crime and population density in a given neighborhood or city, population density in a single jurisdiction does not fully capture the meaning of suburbanization. If we define suburbanization as "the enlargement and spread of a functionally integrated population over an increasingly wide expanse of territory" (Berry & Kasarda, 1977), a measure is needed that captures the degree to which a metropolitan area's population is spread over a large area and that explicitly compares density in the central city with density in the suburban areas. The density *gradient* gets at the contrast between a centralized urban population and one that is more spread out. The density gradient shows us how much the population density declines with increasing distance from the central city. As an area becomes more suburbanized, the density gradient would increase because the density gradient flattens out, i.e. the gradient becomes less negative. Given that we hypothesize that suburbanization leads to higher crime levels, a positive coefficient is expected.

Although we prefer the density gradient, we also include the metropolitan area's average population density as a second measure of suburbanization. Though there are a variety of concerns about usefulness of population density, it has frequently been used as a tool to estimate whether a metropolitan area is compact or not. Some metropolitan areas including Los Angeles have a high population density yet are also considered to have a high level of suburban sprawl.

Lower population density would be expected with a higher level of suburbanization, so we expect a negative coefficient on density.

The third suburbanization measure is the percentage of the metropolitan area's population residing in the central city. Although frequently used in prior research, this measure may be criticized on several grounds. It varies with region, era of metropolitan growth, land configuration, and other factors. Since U.S. metropolitan areas tend to have significantly different central city sizes relative to their total area, the percentage of central city population might reflect factors other than suburbanization *per se*. With that caveat, a lower percentage of central city population indicates metropolitan area is more suburbanized, so a negative coefficient is expected.

The fourth measure of suburbanization is the average commuting time to work, which reflects changing preferences for location and greater mobility of workers and firms. As suburbanization increases, we expect longer travel time for metropolitan residents.

In summary, we have four measures of suburbanization: the density gradient, the average population density, the percentage residing in the central city, and the average travel time to work. If suburbanization increases crime net of other factors, we expect positive coefficients for the density gradient and average travel time. We expect negative coefficients for average population density and percentage in the central city, which vary inversely with suburbanization. Factor analysis could be used to combine these four indicators into a single measure. However, each of these factors represents a distinct aspect of suburbanization, rather than alternative measures of a single underlying construct. Moreover, we believe that at least one of the measures (percent of population in the central city) is inherently flawed. Given these considerations, we have retained the individual indicators rather than combining them.

Demographic Controls and Instruments

Our analysis strategy is to test whether suburbanization predicts crime rates at the metropolitan level. Suburbanization is likely to be correlated with population demographics, which also contribute to crime. Therefore, our analysis includes demographic variables measured *at the metropolitan level*, such as population size, age structure, race and ethnic composition, and median household income, derived from the U.S. Census. The question addressed is whether, holding these population composition variables constant, the arrangement of the population into cities and suburbs affects the crime rate.

In view of the possibility of reverse causality, i.e. a causal effect of crime on suburbanization, we employ instrumental variables estimation in our final set of models. Plausible instrumental variables must affect suburbanization but not crime (net of the demographic variables mentioned above). In our analysis, eight variables are used as instruments for suburbanization. The first three are the number of governments, public transit usage, and air pollution. When metropolitan areas are politically fragmented, the level of suburbanization is likely to be higher since multiple suburban communities can develop in a rapid and uncoordinated way and engage in exclusionary zoning. Public transportation might be also associated with suburbanization since highly suburbanized areas are more automobile dependent and tend to have poor public transportation system. The number of governments in the metropolitan area and the percentage of metropolitan area residents using public transportation are both derived from the Census. High levels of air pollution, often exacerbated by congested streets in the downtown area, might drive people out of the central city area and towards the suburban fringe. The Air Quality Index (AQI) index is provided by U.S. Environmental Protection Agency (EPA).

Another set of five instruments reflect geographic characteristics of metropolitan areas. These variables were obtained from Professor Stephen Malpezzi's website, which provides useful datasets about population, housing, and urban development by metropolitan area.[5]

Model Specification

The unit of analysis is the metropolitan area. A metropolitan area generally consists of one or more central counties including one or several central cities, along with surrounding counties closely related to the central city by commuting patterns and other factors. In the 2000 Census, the Census Bureau defined stand-alone Metropolitan Statistical Areas (MSAs), such as Indianapolis, and Primary Metropolitan Statistical Areas (PMSAs), such as the Dallas PMSA and the Ft. Worth PMSA. PMSAs are part of larger units known as Consolidated Metropolitan Statistical Areas (CMSAs). In this paper, we combine MSAs and PMSAs, and do not employ CMSAs, which are extremely large relative to MSAs.

We model metropolitan area crime rates as follows:

$$VC_i = \alpha_1 + \alpha_2 P_i + \alpha_3 B_i + \alpha_4 H_i + \alpha_5 A13_i + \alpha_6 A18_i + \alpha_7 A65_i + \alpha_8 IN_i + \alpha_9 G_i + \alpha_{10} D_i + \alpha_{11} CC_i + \alpha_{12} T_i + u_i$$

$$PC_i = \beta_1 + \beta_2 P_i + \beta_3 B_i + \beta_4 H_i + \beta_5 A13_i + \beta_6 A18_i + \beta_7 A65_i + \beta_8 IN_i + \beta_9 G_i + \beta_{10} D_i + \beta_{11} CC_i + \beta_{12} T_i + v_i$$

The dependent variables, VC_i and PC_i represent violent and property crime rates of metropolitan area *i*, respectively. Crime rates in metropolitan areas vary by demographic and economic characteristics such as population, race, age, and income. P_i is the log of population, B_i is percentage Black, H_i is percentage Hispanic, $A13_i$ is the percentage of the MSA population that is 13 to 17 years old, $A18_i$ is percentage 18 to 24 years old, $A65_i$ is percentage age over 65, and IN_i is the median income. We observe the impact of suburbanization net of metropolitan demographic factors by adding the four suburbanization indicators: G_i is the density gradient, D_i

is the population density, CC_i is the percentage of central city residents, and T_i is the mean travel time to work. Finally, u_i and v_i are disturbance terms.

To address bias in the OLS regressions due to the endogeneity of suburbanization and crime, we also employ instrumental variables regression (IV Regression), a general way to obtain consistent estimators of the unknown coefficients when a regressor is correlated with the error term (Stock & Watson, 2003). Theoretically, a valid instrumental variable has to satisfy two conditions, know as instrument relevance and instrument exogeneity. First, an instrumental variable should be correlated with the regressor, X. Second, an instrumental variable should be uncorrelated with the error term. In the IV Models, the effect of our preferred suburbanization measure, the density gradient, is estimated by instrumental variables:

$$VC_i = \gamma_1 + \gamma_2 \hat{G}_i + \gamma_3 P_i + \gamma_4 B_i + \gamma_5 H_i + \gamma_6 A13_i + \gamma_7 A18_i + \gamma_8 A65_i + \gamma_9 IN_i + \varepsilon_i$$
$$PC_i = \delta_1 + \delta_2 \hat{G}_i + \delta_3 P_i + \delta_4 B_i + \delta_5 H_i + \delta_6 A13_i + \delta_7 A18_i + \delta_8 A65_i + \delta_9 IN_i + \eta_i$$

where $\hat{G}_i$ represents the density gradient instrumented with the variables described in the previous section.

Metropolitan areas vary widely in size; as a result, smaller metropolitan areas have larger error variances than larger ones. Thus, all models are weighted by the square root of metropolitan population (Maddala, 1977: 268-269). In addition to regression coefficients and standard errors, standardized coefficients are presented to facilitate comparisons across variables measured in different scales; they may be interpreted in terms of the effect in standard deviation units of a one standard deviation change in the independent variables.

Findings

Table 1 summarizes the variable descriptions and Table 2 displays descriptive statistics for the variables. Crime rates vary significantly across metropolitan areas. For example, for

violent crime the minimum value of is 6.86 per 100,000 people while the maximum level is 1449.96 per 100,000 people. Population density tends to decrease with distance from central city, so the density gradient is usually negative. As expected, except for Jersey City, NJ, all metropolitan areas have a negative density gradient. Population densities, percentage of central city population, and – to a lesser extent – mean travel time to work also vary a great deal from one metropolitan area to another.

Table 3 shows the OLS regression results for metropolitan violent and property crime rates. For violent crime, population size, black, and Hispanic are positive and statistically significant, so large populations and high percentages of black and Hispanic residents are associated with higher violent crime rates. Income is negative and significant, as expected. However, some signs are not consistent with general expectations. For instance, "Age 13-17" and "Age 18-24" are negatively significant, implying that a higher percentage of young population leads to less violent crime. "Age 65 and more" is not statistically significant for violent crime.

The estimated impact of suburbanization on crime differs depending on the measurement of suburbanization. For violent crime, population density and the proportion of population in the central city are significant. The negative coefficient of population density indicates that high population density leads to a lower crime rate, consistent with the hypothesis that suburbanization causes a higher crime rate. However, the sign of the coefficient for the proportion of population in the central city is positive, contrary to expectations. As noted previously, we question the efficacy of this measure and include it to demonstrate the importance of the choice of the measure of suburbanization used. The density gradient and the mean travel time are positive as expected, but not statistically significant. As a group, the suburbanization

measures are jointly significant ($F=3.19$, $p<0.05$). Taken together, these results are weakly supportive of an impact of suburbanization on violent crime, particularly if one discounts for the reversed sign on proportion in the central city. However, the endogeneity of suburbanization may plague these results, which will be addressed below.

Table 3 also displays the results for the property crime rate as a dependent variable. Note that there are many more property crimes than violent crimes, so the regression coefficients have a different scale. For this reason, standardized coefficients are provided in the column labeled "beta." Several demographic and economic factors are statistically significant. Both percentage black and Hispanic are significant and positive, so higher percentages of black and Hispanic residents are associated with higher property crime. However, a few control variables have different impacts on property crime than on violent crime. Income is negative but not significant. Gross population is negatively related with property crime. The age structure variables are not significant.

The impact of the various suburbanization measures also differs depending on the type of crime. For property crime, both the density gradient and population density are significant and consistent with suburbanization leading to more crime. The standardized coefficients show that the effect is larger in magnitude for property crime than violent crime. The coefficient on central city population, as in the case of violent crime, is inconsistent with the hypothesis. Travel time is insignificant. A joint test of the suburbanization variables is significant ($F=15.85$, $p<0.001$).

The results from two-stage least squares model in Table 4 allow for the endogeneity of suburbanization. The model includes our preferred measure of suburbanization (the density gradient) as a regressor and crime (both violent crime and property crime) as dependent variables. The model employs eight instruments for suburbanization: the number of governments, public

transit, air pollution, and five geographic characteristics of the metropolitan area. As shown in Table 4, the coefficients of the instrumented density gradient in both the violent and property models are positive and significant, further supporting the hypothesis that suburbanization leads to higher crime rates.

Discussion

Both demographic and geographic characteristics play a role in explaining high crime rates in central cities or specific inner-ring suburban regions. Sociologists and criminologists have long argued that truly disadvantaged neighborhoods in central cities are likely to lead to higher crime rates. Even though many researchers have noted ecological effects of poor neighborhoods on crime, generally these analyses have not separated the causal and compositional effects of suburbanization on central city crime. We argue that Shaw and McKay-type effects of neighborhood environment on crime can be identified by linking metropolitan crime rates to measures of suburbanization. This method suffers from the relatively small number of metropolitan areas and the high correlation and endogeneity of variables measured at the metropolitan level, and therefore is relatively weak in the empirical sense. The benefit of this empirical strategy is that it does not confuse true causal effects with changes in the central city crime rate caused by the out-migration of the denominator.

The regressions in Tables 3 and 4 provide support for the hypothesis that suburbanization increases crime rates in the central city over and above compositional effects. The increase in crime is great enough to be measured at the metropolitan level. In particular, the relation between suburbanization and crime seems to be stronger for property crime than violent crime. The contrast between violent crime and property crime is consistent with empirical research on routine activity theory (Stahura and Sloan 1988). The results, however, are sensitive to the

specific indicator used to measure suburbanization. The percentage of metropolitan population residing in the central city, for example, indicates that suburbanization reduces crime in most models. Why does it differ from other indicators in regression results? As Farley (1987) noted, the percent of the population in the central city is related to regional and historical factors other than suburbanization. For example, there are 31 metropolitan areas with more than 70 percent of their residents residing in central cities, 12 of which are located in Texas. Yet most analysts consider metropolitan areas in Texas to be highly suburbanized. Therefore, we are skeptical of using the percentage of the population in the central city as an indicator of suburbanization, as is common in prior literature.

Based on the remaining suburbanization measures, we conclude that suburbanization has a positive impact on the overall crime rates in metropolitan areas. In particular, the effect is more robust in the property crime models than in the violent crime models. As a result, the evidence presented here supports an argument that there is a positive relationship between suburbanization and metropolitan crime, operating via the effect on the economic and social isolation of central city neighborhoods.

The models presented here must be considered preliminary, and are likely to suffer from left out variable bias. Factors such as era of construction, topography, and idiosyncrasies of the local housing market may affect both crime and suburbanization. In future research, we will attempt to control these factors, at least to the extent that they were constant over time, by estimating fixed effects models based on several decades of census and crime data. Whether or not the findings presented here are confirmed by longitudinal analyses, this paper establishes an important methodological point: past research has not clearly distinguished between the compositional and causal effects of suburbanization on central city crime levels.

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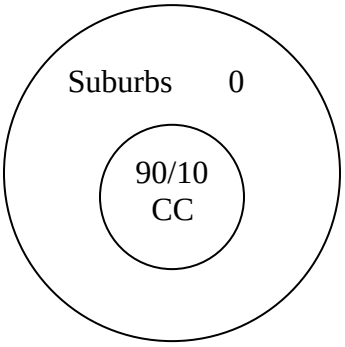
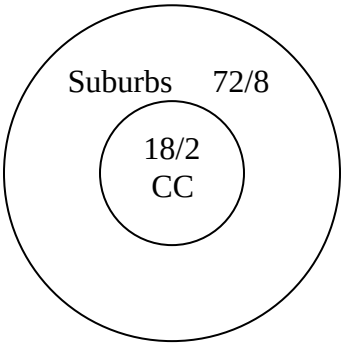
Figure 1. Suburbanization Scenarios



No Suburbanization

	CC	Suburbs
Law Abiding:	90	0
Criminal:	10	0
Crimes:	20	0
Crime rates:	20/100=0.2	-

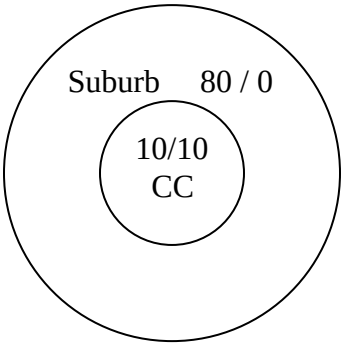
Metropolitan crime rate: 20/100 = **0.2**



Neutral Suburbanization (80 in suburbs)

	CC	Suburbs
Law Abiding:	18	72
Criminal:	2	8
Crimes:	4	16
Crime rates:	4/20=0.2	16/80=0.2

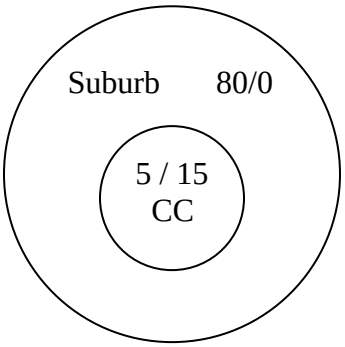
Metropolitan crime rate: 20/100 = **0.2**



Selective Suburbanization (80 in suburbs)

	CC	Suburbs
Law Abiding:	10	80
Criminal:	10	0
Crimes:	20	0
Crime rates:	20/20=**1.0**	**0**

Metropolitan crime rate: 20/100 = **0.2**
Elevated central city rate.
Metropolitan rate is unchanged.



Suburbanization with problematic CC
→ 5 more criminals, 3 crimes per criminal

	CC	Suburbs
Law Abiding:	5	80
Criminal:	15	0
Crimes:	45	0
Crime rates:	45/20=2.25	0

Metropolitan crime rate: 45/100=**0.45**
Central city rate is substantially elevated.
Metropolitan rate is also elevated.

Table 1: Description of variables

Types of Factor	Variables	Description
Crime	Violent Crime	The number of violent crimes per 100,000
	Property Crime	The number of property crimes per 100,000
Suburbanization	Density Gradient	Population density gradient of MSA/PMSA
	Population Density	Avg. Population density of MSA/PMSA
	Central Population	Percentage of MSA/PMSA residents in the central city
	Travel Time	Mean travel time to work
Race/Ethnicity	Black	Percentage black
	Hispanic	Percentage Hispanic
Age Structure	Age 13-17	Percentage of population age 13-17
	Age 18-24	Percentage of population age 18-24 (ex. college students)
	Age 65more	Percentage of population who are more than 65
Size	Population	Natural log of population
Income	Income	Median Household Income (thousands)
Instruments	Government	The number of governments
	Public Transit	Percentage of population using public transportation
	Air pollution	The number of days with Air Quality Index (AQI) daily values greater than 100
	Adjacency to park	MSA located adjacent to park, military base, or reservation (Dummy)
	Adjacency to water	MSA located on coast or major water (Dummy)
	Adjacency to MSA	MSA located adjacent to another MSA (Dummy)
	Adjacency to State	MSA located adjacent to another State (Dummy)
	Adjacency to county	MSA located adjacent to another county (Dummy)

Table 2: Summary of Descriptive Statistics

	N	Mean	Std. Dev	Min	Max
Violent Crime	323	434.91	237.10	6.86	1449.96
Property Crime	323	3718.29	1394.39	190.59	8104.93
Density Gradient	326	-0.19	0.11	-0.66	0.04
Population Density	323	441.16	957.50	5.41	13043.62
Central Population	323	0.42	0.20	0	1
Travel Time	323	22.58	3.78	15.06	38.93
Black	323	0.11	0.11	0.002	0.51
Hispanic	323	0.10	0.15	0.004	0.94
Age 13-17	323	0.07	.008	0.05	0.10
Age 18-24	332	0.05	0.01	0.02	0.18
Age 65+	323	0.13	0.03	0.05	0.35
Population	323	12.79	1.05	10.97	16.07
Income	323	41.35	8.39	25.87	78.39
Government	331	35.67	44.72	1	319
Public Transit	323	0.02	0.04	0.001	0.47
Air Pollution	307	10.25	18.99	0	159
Adjacency to Park	306	0.23	0.42	0	1
Adjacency to Water	306	0.25	0.43	0	1
Adjacency to MSA	306	0.72	0.45	0	1
Adjacency to State	306	0.40	0.49	0	1
Adjacency to County	306	0.03	0.18	0	1

Table 3. OLS Regression Models for Metropolitan Crime Rates

	Violent Crime			Property Crime		
	b	**S.E.**	**beta**	**b**	**S.E.**	**beta**
Constant	134.38	272.75	--	7906.60**	1811.97	--
Metropolitan Demographic Characteristics						
Population (Log)	49.55**	12.76	0.26	-177.82*	84.75	-0.18
Income	-7.63**	1.67	-0.29	-10.59	11.11	-0.08
Black	1129.77**	123.32	0.46	4885.75**	819.24	0.38
Hispanic	657.07**	78.05	0.43	2581.38**	518.52	0.32
Age 13-17	-3899.74*	1765.29	-0.11	-20138.72	11727.51	-0.11
Age 18-24	-3640.03**	1186.96	-0.17	6699.92	7885.44	0.06
Age 65+	343.79	455.68	0.04	-1843.92	3027.26	-0.04
Suburbanization Indicators						
Density Gradient	96.96	175.20	0.03	3530.61**	1163.92	0.20
Pop. Density	-0.02**	0.008	-0.20	-0.31**	0.06	-0.46
Central Pop	199.58**	64.78	0.17	1472.51**	430.34	0.24
Travel Time	6.91	4.22	0.14	-22.42	28.02	-0.09
F Test on all Suburbanization Indicators	F(4, 306) = 3.19 Prob > F = 0.0138			F(4, 306) = 15.85 Prob > F = 0.0000		
R^2	0.5835			0.3292		
F	38.98**			13.65**		
N	318			318		

** $p \leq .01$; * $p \leq .05$

Table 4. The Results from Two Stage Least Square (IV Regression Model)[+]

	Violent Crime			Property Crime		
	b	**S.E.**	**Beta**	**b**	**S.E.**	**beta**
Population (Log)	5.79	24.36	0.03	-1045.74**	193.08	-1.04
Income	-4.21**	1.97	-0.16	-2.71	15.58	-0.02
Black	1191.16**	133.92	0.49	4182.37**	1061.27	0.33
Hispanic	804.45**	84.34	0.54	2587.51**	668.41	0.33
Age 14-17	-7205.10**	2772.44	-0.17	-16035.67	21971.27	-0.07
Age 18-24	543.53	854.76	0.04	7159.82	6773.84	0.11
Age 65+	350.96	640.97	0.05	-11144.47**	5079.57	-0.28
Density Gradient	1227.70**	620.62	0.34	19235.18**	4918.37	1.04
F		35.19**			7.42**	
N		270			270	

** $p \leq .01$; * $p \leq .05$

[+] The model employs eight instruments; the number of governments, public transit, air pollution, adjacency to a park, adjacency to water, adjacency to another metropolitan area, adjacency to a state boundary, and adjacency to a county boundary.

[1] Calculated from FBI, Uniform Crime Reports, Table 12: Crime Trends by Population Group, 2004-2005. The crime rate is the number of crimes per 100,000 inhabitants. Suburban areas include law enforcement agencies in cities with less than 50,000 inhabitants and county law enforcement agencies that are within Metropolitan Statistical Areas. Suburban areas exclude all metropolitan agencies associated with a central city.

[2]In contrast, Jordan, Ross, and Usowski (1998) found that central city crime reduced suburbanization, the opposite of their expectation.

[3] See also Kling, Ludwig, and Katz (2005).

[4] While it is true that a positive relationship was more common (Lornez, 1967; van den Berghe, 1974; Wolfgang & Ferracuti, 1967; Booth & Johnson, 1976; Galle, 1973; Beasley & Antunes, 1974; Mladenka & Hill, 1976), several studies found a negative relationship (Jacobs, 1961; Angel, 1968; Weathersby, 1970; Pressman & Carol, 1971; Kvalseth, 1977; Schichor, Decker, & O'Brien, 1980). See also Jarrel and Howsen (1990), Kpososwa, Breault, and Harrison (1995), and Barber (2000).

[5] Malpezzi's website address for geographic data is www.bus.wisc.edu/realestate/doc/doc/smallmsa.xls.