THE SPATIAL ASPECTS OF CRIME

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Abstract
This paper aims to explain the spatial variations of crime, both between and within cities. Two types of mechanisms are put forward: Social interactions that stipulate that an individual is more likely to commit crime if his peers commit than if they do not commit crime, and distance to jobs that indicates that remote residential location induces individuals to commit more crime. Both mechanisms are shown to have strong empirical support. (JEL: K42, R1)

1. Introduction

It is well known that there is more crime in big cities compared to small cities or rural areas (Glaeser and Sacerdote 1999). For example, the rate of violent crime in cities with more than 250,000 population is 346 per 100,000 inhabitants whereas in cities with less than 10,000 inhabitants, the rate of violent crime is just 176 per 100,000. Similar figures can be found for property crimes or other less violent crimes.

It is also well documented that, within cities, crime is highly concentrated in a limited number of areas. For instance, in U.S. metropolitan areas, crime rates are much higher in central cities than in suburbs. Between 1985 and 1992, crime victimizations averaged 0.409 per household in central cities, while they averaged 0.306 per household in suburbs (Bearse 1996, Figure 1). Grogger and Willis (2000, Table 2) also show that central cities are more crime-ridden than suburbs for most crimes. For instance, the mean murder rate in central cities is five times greater than that in the suburbs and for property crimes they differ by a factor of two or three. More generally, U.S. central cities have higher crime and unemployment rates, higher population densities and larger relative black populations than their corresponding suburban rings (South and Crowder 1997, Table 2).

The aim of this paper is to provide some theoretical explanations of these facts and to evaluate their empirical relevance.

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2. Theories

2.1 Social Interactions

Social interactions models state that individual behaviors not only depend on the individual incentives but also on the behavior of peers and neighbors. An individual is more likely to commit crime if his peers commit than if they do not commit crime. These models are a natural way to explain the concentration of crime by area.

Let us explain in more details this type of model. As we have seen in the introduction, there are huge spatial (but also temporal) variations in crime rate between different cities and between different areas of a city. In fact, less than 30 percent of the spatial variation of crime (both inter- and intracities) can be explained by differences in local attributes.[1] Glaeser, Sacerdote, and Scheinkman (1996) stipulate that the 70 percent left can be explained by social interactions, i.e., agents' decisions about crime are positively correlated.

To illustrate their model, let us give a very simple example. Consider a society with two individuals. We do not model the crime decision but rather focus on the role of social interactions in crime behavior. Let us start with the model without social interactions. Four cases are possible: (a) both individuals are criminal, (b) both individuals are noncriminal, (c) individual 1 is a criminal but individual 2 is not, (d) individual 2 is a criminal but individual 1 is not. If individuals decide to become criminals by tossing a coin (probability 1/2), then each case occurs with probability 1/4. This implies that the expected number of criminals is equal to:

$$E(C) = \tfrac{1}{4}(2) + \tfrac{1}{4}(0) + \tfrac{1}{4}(1) + \tfrac{1}{4}(1) = 1$$

while the variance is given by:

$$V(C) = \tfrac{1}{4}(2-1)^2 + \tfrac{1}{4}(0-1)^2 + \tfrac{1}{4}(1-1)^2 + \tfrac{1}{4}(1-1)^2 = 1/2$$

Let us now focus on the social-interaction model. Assume again that they are two types of individuals but only individual 1 takes the decision to become a criminal while individual 2 imitates 1. Thus, if 1 decides to become a criminal, then 2 is also a criminal. On the other hand, if 1 does not become a criminal, then 2 is not a criminal. As a result, both individuals are either criminal or noncriminal. We easily obtain:

1. For example, Glaeser, Sacerdote, and Scheinkman (1996) note that East Point, Georgia has 0.092 crimes per capita while El Dorado, Arkansas, which has more unemployment, less education, more poverty, and lower per capita income has 0.039 crimes per capita (between cities). Similarly, the 51st precinct of New York City 0.046 crimes per capita whereas the wealthier 49th has 0.116 crimes per capita (within cities).

$$E(C) = \tfrac{1}{2}(2) + \tfrac{1}{2}(0) = 1$$

$$V(C) = \tfrac{1}{2}(2 - 1)^2 + \tfrac{1}{2}(0 - 1)^2 = 1$$

Now, if we compare the two models, it is easy to see that they share the same expectation (the expected number of criminals is 1 in this society of two individuals) but the social-interaction model has a much higher variance (exactly the double) than the one without social interactions.

More generally, in a society of n individuals, where C are criminals and N are noncriminals ($n = C + N$), it is easy to see that the variance of the model without social interactions (i.e., each individual takes his crime decision independently of the decisions of the others so that nobody imitates the other) is given by:

$$V(C) = np(1 - p)$$

where $p = C/(C + N)$ is the probability that a randomly chosen individual is a criminal. For the social-interaction model (i.e., crime decisions are interdependent) with n individuals, where C are criminals, N are noncriminals and I individuals imitate the others ($n = C + N + I$), Glaeser, Sacerdote, and Scheinkman (1996)[2] show that the variance is given by:

$$V(C) = np(1 - p)f(\pi)$$

where $\pi = (C + N)/n$ is the probability that a randomly chosen individual is not someone that imitates the others and $f(\pi) = (2 - \pi)/\pi$ indicates the covariance between agents and captures the degree of imitation of individuals. It is easy to see that when $\pi = 1$, there is no imitation (crime decisions are independent) and we are back to the model without social interactions. When $\pi \rightarrow 0$, all individuals are imitating the others but there is nobody to imitate since nobody takes the decision to become criminal independently of the others. As a result, there is no specific pattern of crime (the variance becomes infinite). The general tendency of this model with social interactions is that, when $f(\pi)$ increases, there is more imitation and the variance of crime rises.

This model allows us to explain why there is so much spatial variation in crime (between and within cities). The main idea is that social interactions amplify the effects of crime and if these interactions are localized, then it becomes easy to explain very high levels of crime in some areas of the city.[3] Indeed, if there are already a lot of criminals in a particular location, crime becomes contagious by spreading around like a virus and amplifies the number of criminals in this location. Crime is here viewed as a disease. This also means

2. See Calvó-Armengol (2002) for a very nice and pedagogical presentation of this model.

3. In fact, it has been shown that social interactions and thus since social networks are very localized (see e.g., O'Reagan and Quigley 1993 or Topa 2001).

that peer effects of crime are driven by individuals' behavior that can have social *multiplier* effects through a feedback loop (Manski 1993, Becker and Murphy 2000, Glaeser, Sacerdote, and Scheinkman 2002): Negative social behavior such as crime leads to more negative social behavior. This is even more important if this behavior is localized. As a result, measuring the (local) size of the social multiplier in crime is of paramount importance for policy-makers. Indeed, a high social multiplier implies large amplifying effects of crime and thus one should absolutely avoid the concentration of individuals with similar crime background in the same area.

2.2 Distance to Jobs and Local Police

We can also explain why crime is localized and concentrated in certain areas of the city by a different but complementary model (Freeman, Grogger, and Sonstelie 1996, Zenou 2002). When there are a lot of criminals in a certain area of a city, the probability of arrest will be relatively low so that criminals create a positive externality to each other. However, the proceeds of crime will also be relatively low since there are more criminals so that criminals also create a negative externality to each other. The decision to commit crime in a certain area will then depend on the trade off between the probability of arrest and the possible loot there (see also Deutsch, Hakim, and Weinblatt 1987, and Deutsch and Epstein 1998).

Let us describe one of the models (Zenou 2002) in more details. All individuals are located in a line where all jobs are situated at the origin (monocentric city). First, individuals must decide where to commit crime. As stated above, individuals trade off between committing crime where they reside (relatively poor neighborhoods compared to the Central Business District, CBD hereafter, but badly protected from crime) and in the CBD (profitable businesses but highly protected by police). With some conditions on parameters (low commuting costs of accessing the CBD and rich enough CBD), it can be shown that it is always optimal to only commit crime in the CBD. Thus, crime is localized in the CBD since all crimes are committed there. Second, because crime is localized in the CBD, the loot l each criminal obtains depends on the number of criminals n residing in the city since when there are more criminals operating in the CBD, there is less remaining for a particular criminal. As a result, we have: $l = l(n)$, with $l'(n) < 0$ and $l''(n) \leq 0$. Third, also because crime is localized in the CBD, the probability of arrest is a increasing function of the police resources and a decreasing function of the number of criminals in the city. Indeed, the more police resources are allocated to the city, the higher is the probability to arrest a criminal. However, the higher the number of criminals in the city, the lower is this probability. If m denotes the police resources in the city, then the probability of arrest for a criminal is given by: $p(m, n)$ with

$$\frac{\partial p}{\partial m} > 0, \frac{\partial p}{\partial n} < 0, \frac{\partial^2 p}{\partial m^2} \geq 0.$$

Individuals can be either employed or criminal (but not both). The utility of an employed worker living at a distance x from the CBD is given by $V^{NC} = w - tx - R(x)$, where w is the wage, t, the commuting per unit of distance and $R(x)$ the land rent at x. The utility of a criminal living at a distance x from the CBD is given by $V^C = (1 - p(m, n))(l(n) - \alpha tx - R(x))$, where $0 < \alpha < 1$ is the number of trips to the CBD for the criminal (he goes mostly to the CBD to commit crime). One can see that if a criminal is caught, then he goes to jail and loses his loot but of course does not pay anymore commuting costs and a land rent. If we only focus on interior solutions (i.e., $n > 0$ and $n < +\infty$), then it is easy to see that criminals locate far from the CBD whereas workers reside close to the CBD because the latter have higher commuting costs.

Inspection of V^C shows that the decision to become a criminal depends on the decision of others to become criminal. The intuition is quite easy. When the number of criminals increases, the probability to be caught decreases (first effect) but the loot is reduced (second effect). Because of our assumptions on the second derivative of $p(\cdot)$ and $l(\cdot)$ with respect to n, when the number of criminals is quite low, increasing n implies that the first effect dominates the second one. However, when the number of criminals is already quite large, then the second effect dominates the first one. Thus, the curve that describes the relationship between V^C and n has a bell shape.

In this framework, the results obtained are as follows. First, not surprisingly, more police resources and/or more labor market opportunities (i.e., higher wages) sharply reduce crime in the city. Second, the most interesting result is the effect of t the commuting cost on n the number of criminals. For a given crime level n, when commuting costs t increase, both the utility of a noncriminal and of a criminal decrease because land prices become higher everywhere in the city (competition in the land market increases since the access to the CBD becomes more costly). However, because the first effect is stronger than the second one, the net effect is positive. In other words, when t increases, the negative effect on land rents (i.e., the increase in housing prices) is stronger for workers than for criminals because the former reside closer to the CBD for which the access becomes more costly. As a result, since in terms of utility workers lose relatively more than criminals, it becomes less costly to be a criminal, and, as a result, the number of criminals n in the city increases.

This result can been seen as at odds to what has sometimes been advocated in the United States. Indeed, some people believe that a policy that makes difficult the access to certain areas (e.g., to refuse to build a new transportation system that links Black inner cities to White rich suburbs) will reduce the crime level in these areas (for example in the CBD or in the White suburbs). Our model says that this type of policy will in fact have some impact on the housing market by increasing the price in the rich area and, as a result, can induce some individuals to become criminal. However, this result strongly depends on our result that crime is always localized in the central business district (CBD), which was true only if access costs (i.e., commuting costs) were quite low. If commuting costs become very high, then indeed criminals will start to commit crime where they live and, as a result, this policy will certainly reduce the crime in the CBD or in the suburbs but increase it in inner cities.

Finally, when the size of the city and thus of the population increases, the price of land increases everywhere in the city, but the increase is higher for a worker than for a criminal. As a result, the relative utility of being criminal is higher so that more people become criminal. Thus, bigger cities imply more crime.

Another paper (Verdier and Zenou n.d.) has also put forward the role of distance to jobs in crime behavior. This paper provides a unified explanation for why Blacks commit more crime, are located in poorer neighborhoods and receive lower wages than Whites. The mechanism is as follows. If everybody believes that Blacks are more criminal than Whites—even if there is no basis for this—then Blacks are offered lower wages and, as a result, locate further away from jobs. Distant residence increases even more the Black-White wage gap because of more tiredness and higher commuting costs. Blacks have thus a lower opportunity cost of committing crime and become indeed more criminal than Whites. The loop is closed and beliefs are self-fulfilling.

The key result of this paper is that these beliefs cannot be self-fulfilling without location and distance to jobs. In other words, if Blacks were to reside close to jobs, then, in this model, they will not be discriminated against and, even with prejudices and negative beliefs, blacks will end up with the same outcomes than Whites (low crime rate, high wages, etc.). It is really the distance to jobs that amplifies the wage difference between blacks and whites and allows beliefs to become self-fulfilling.

3. Empirical Tests

3.1 Social Interactions

Let us see if the social interaction model has some empirical relevance. Glaeser and Sacerdote (1999) show that, in the United States, 27 percent of the crime rate difference between urban and rural areas is explained by pecuniary benefits that are higher in cities, 20 percent by a lower probability to be arrested and to be recognized in cities, and the 45–60 percent left by the observable characteristics of individuals. Glaeser, Sacerdote, and Scheinkman (1996) explain this last number by the fact that there is a positive covariance across agents' decisions about crime so that the variance of crime rate is higher that the predicted variance by local conditions.

In testing their model, they estimate $f(\pi)$, the covariance between agents, which is also an index of the degree of social interactions between agents (see Section 2.1). For the United States (across cities) in 1970, 1985, and for New York (across precincts) in 1985, they find a high degree of social interactions for larceny and auto theft, a moderate (but still large) level of social interactions for assault, burglary, and robbery, and not surprisingly, very low levels of social interactions for arson, murder and rape. They also find that across crimes, crimes committed by younger people have higher degrees of social interaction, while, across cities, for serious crimes in general, and for larceny and auto theft in particular, the degree of social interactions is larger in those communities where families are less intact, i.e., that are more female-headed households.

Furthermore, Case and Katz (1991), using data from the 1989 NBER survey of youths living in low-income Boston neighborhoods, find that the behaviors of neighborhood peers appear to substantially affect youth behaviors in a manner suggestive of contagion models of neighborhood effects. In particular, residence in a neighborhood in which a large proportion of other youths are involved in crime is associated with a substantial increase in an individual's probability of being involved in crime. For example, the direct effect of moving a youth with given family and personal characteristics to a neighborhood where 10 percent more of the youths are involved in crime than in his or her initial neighborhood is to raise the probability the youth will become involved in crime by 2.3 percent.

Ludwig, Duncan, and Hirschfield (2001) explore this last result by using data from the Moving to Opportunity (MTO) experiment that assigned a total of 638 families from high-poverty Baltimore neighborhoods into three treatment groups: (a) Experimental group families receive housing subsidies, counseling and search assistance to move to private-market housing in low-poverty census tracts; (b) Section 8-only comparison group families receive private-market housing subsidies with no program constraints on relocation choices; (c) and a Control group receives no special assistance under MTO. Their results suggest large reductions in arrest for violent crimes among experimental and Section 8-only teens relative to control groups. More precisely, they find that the prevalence and incidence of arrests for violent crimes for experimental teens during the postprogram period equal around one-half of the control-group averages. They also find that the prevalence and incidence of violent-crime arrests for the Section 8-only group are around one-half the rate observed for the control-group. More generally, their paper indicates that the offer to relocate families from high- to low-poverty neighborhoods reduces juvenile arrests for violent offences by 30 to 50 percent of the arrest rate for control groups. This also suggests very strong social interactions in crime behaviors.

3.2 Distance to Jobs and Local Police

It is clear that more police reduces crime. However, the impact of distance to jobs on crime behavior is less clear. Using 206 census tracts in city of Atlanta and Dekalb county and a state-of-the-art job accessibility measure, Ihlanfeldt (2001, 2002) demonstrates that modest improvements in the job accessibility of male youth, in particular Blacks, cause marked reductions in crime, especially within category of drug-abuse violations. Indeed, the elasticity of the neighborhood density of drug crime with respect to the number of jobs held by 16–24 year old males without college degrees is 0.361 within the average high crime neighborhood. Since the average high-crime neighborhood contains 200 jobs that are held by young, less-educated males, an elasticity of 0.361 implies that 20 additional jobs will decrease the neighborhood's density of drug crime by 3.61 percent. Ihlanfeldt (2001, 2002) also shows that inter-neighborhood differences in job accessibility play an important role in explaining the higher crime found in poor neighborhoods. For example, 21 percent of the difference in neighborhood density of drug crime between poor and nonpoor neighborhoods can be attributed to the inferior accessibility found within poor neighborhood.

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