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LESS CRIME, MORE (VULNERABLE) VICTIMS: GAME THEORY AND THE DISTRIBUTIONAL EFFECTS OF CRIMINAL SANCTIONS

by

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Less Crime, More (Vulnerable) Victims: Game Theory and the Distributional Effects of Criminal Sanctions

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Harsh sanctions are conventionally assumed to primarily benefit vulnerable targets. Contrary to this perception, this article shows that augmented sanctions often serve the less vulnerable targets. While decreasing crime, harsher sanctions also induce the police to shift enforcement efforts from more to less vulnerable victims. When this shift is substantial, augmented sanctions exacerbate—rather than reduce—the risk to vulnerable victims. Based on this insight, this article suggests several normative implications concerning the efficacy of enhanced sanctions, the importance of victims' funds, and the connection between police operations and apprehension rates.

1. INTRODUCTION

Conventional law and economics has primarily associated criminal sanctions with deterrence. Treated as a cost imposed on the transgressor, criminal punishments have been theorized as a means of reducing crime and diminishing the risk of victimization to potential targets. Extending the conventional model, this article highlights the distributional effects of criminal

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sanctions. Using insights from game theory, this article shows that, in addition to their impact on overall crime rates, criminal sanctions also shape the distribution of victims across sectors of potential targets. For example, if potential targets are composed of both defenseless homeowners and those homeowners who can more ably oppose a burglar, the magnitude of the sanction for burglary will determine not only the total level of crime, but also the relative number of victims in each sector.

Integrating the distributional effects with the conventional deterrence model shows that the level of sanctions affects the behavior of criminals and that of the police differently. From the perspective of the offender, the magnitude of the sanction determines the volume of his activity; yet the size of the sanction does not bear on the allocation of the offender's efforts across victim-sectors. In contrast, the size of sanctions often determines the allocation of police activity.

More specifically, our model suggests that when enforcement efforts are effective, *harsher* sanctions serve the *less* vulnerable targets. By increasing deterrence, higher sanctions reduce offenders' activity across all sectors of targets. Higher sanctions, however, make the police reallocate enforcement efforts from vulnerable to less vulnerable targets. Thus, whereas the less vulnerable victims necessarily benefit from subjecting burglars to augmented sanctions, defenseless homeowners might, paradoxically, end up facing an enhanced risk of victimization.

The distributional effects of criminal sanctions raise important normative and policy implications. In this article, we discuss three such implications. First, our analysis suggests that unequal distribution of the harm caused by criminal activities is often inevitable. Minimizing the number of victims mandates that the police allocate their efforts such that some sectors shoulder a greater portion of the harm than others. As our analysis shows, the actual distribution of harm depends on the magnitude of the sanction. This insight suggests that fair-distribution concerns may demand *ex post* reallocation of the costs of crime through victims' funds or selective taxation.

Second, our analysis casts doubt on the efficacy of the increasing implementation of "enhanced sanctions," which impose aggravated penalties on criminals who target especially vulnerable victims. We argue that these differential sanctions may actually harm the vulnerable targets they seek to benefit. This result is based on the prediction that the police, aimed at minimizing crime, will respond to "enhanced sanctions" legislation with a redistribution of their enforcement actions, shifting their protection efforts from the vulnerable targets that this legislation seeks to protect to other, less vulnerable, sectors. This observation supports the idea that enhanced sanctions legislation should also introduce binding rules on the police, to prevent the police from adjusting the distribution of their enforcement efforts in response to the change in the incentive schemes that the perpetrators face.

Finally, the article discusses the connection between police operations and apprehension rates. Although high apprehension rates of criminals are considered socially desirable, our analysis demonstrates this may be illusory. More specifically, it is shown that police, by manipulating the distribution of their efforts, may raise the number of apprehended offenders at the expense of increasing the number of victims. When the police overprotect *less vulnerable* sectors, both apprehension rates and the overall number of victims will rise. High apprehension rates may thus indicate that the police operate sub-optimally.

This assessment of the distributional effects of the magnitude of criminal sanctions is, to our knowledge, a novel one. The intensive empirical and theoretical research on deterrence focuses on the effect of the severity of criminal sanctions on aggregate levels of crime, but disregards the sanctions' distributional consequences. In recent years, there has emerged a growing body of research exploring the distribution of crime across geographical areas or sectors of victims (e.g., Tao, 2005; Reilly and Witt, 1996; Craig and Heikkila, 1989). This literature identifies several variables that may explain variations in crime in different areas, but it disregards the possible importance of the magnitude of criminal sanctions in this context. This article aims to fill this gap by offering a theoretical framework that can serve as a basis for future empirical research.

Our discussion unfolds as follows. Part 2 presents the basic model. Particularly, it shows that harsher sanctions not only deter offenders, but may also induce the police to shift their enforcement efforts from vulnerable to less vulnerable targets. Part 3 discusses the robustness of our predictions, by assessing the plausibility of the central assumptions of our model. In Part 4, we turn to some normative implications.

2. THE MAGNITUDE OF CRIMINAL SANCTIONS AND THE DISTRIBUTION OF CRIME

Due to factors such as age, gender, and location, some groups of individuals are more attractive targets for criminals. In the category of property offenses, for example, vulnerable individuals (say, the elderly) who can less successfully protect their assets present a special appeal to burglars. This Part discusses the effect of sanctions severity on the distribution of victims among different sectors of targets. The discussion shows that where law enforcement by the police is effective, harsher sanctions primarily serve the less-vulnerable targets. Section 2.1 presents a model for predicting the behavior of parties given different levels of sanctions. Section 2.2 illustrates the model through a numerical example. Section 2.3 discusses the model's results.

2.1. THE MODEL

2.1.1. Setting and Motivations

Consider a burglar who plans to break in to houses. The burglar faces two potential neighborhoods of victims: V (vulnerable) and LV (less vulnerable). In both places, the burglar expects to derive a similar benefit, B, if he succeeds. Due to the higher vulnerability of the residents of neighborhood V, the burglar's likelihood of success in breaking in is higher there than in LV. Assume that the police apprehend the perpetrator with certainty whenever they are patrolling the same neighborhood as the perpetrator. Because of their limited resources, however, the police cannot be in both neighborhoods at the same time. Whenever the perpetrator is apprehended, the owners receive their property back (thus no harm occurs), and the burglar bears a sanction, S. For simplicity, we assume that the police may apprehend the burglar only when he actually breaks in. As shown below, accounting for the possibility of imposing a sanction in the case of a failed burglary attempt does not change the insights of the model. Finally, assume that the volume of the perpetrator's criminal activity is positively correlated with the net expected value from burglary (based on his opportunity cost).[1]

Where the level of S is sufficiently high, such that the net expected benefit from burglary is negative, potential perpetrators are fully deterred. Assume, however, that the net expected benefit from burglary is positive.[2] How would the perpetrator, looking to maximize his expected payoff, and the police, aiming to minimize the number of victims, allocate their efforts between the two neighborhoods? If the perpetrator commits all his criminal activity in neighborhood V, in which he is more likely to succeed in breaking in, the police would allocate all their resources to V as well. Given this strategy of the police, the perpetrator would move to the other neighborhood; the police would react by diverting all their resources to that other neighborhood, and so on. Because the perpetrator cannot avoid detection when the police patrol the neighborhood in which he operates, one can expect that the perpetrator would

[1] Alternatively, one may assume that there are numerous types of perpetrators, who differ in the benefit each is expected to derive from their crime (or in their opportunity costs). Under either assumption, augmented sanctions result in increased deterrence (less criminal activity). For the correlation between criminals' opportunity costs and activity volume, see Fajnzylber et al. (2002).

[2] Sanction size is typically restricted by several factors, such as marginal deterrence, perpetrators' limited solvency, and enforcement costs. See, e.g., Garoupa (1997), Polinsky & Shavell (2000).

choose to commit some of his attempts in neighborhood V and some in neighborhood LV. Similarly, the police are expected to spread their efforts between the two neighborhoods. Indeed, as is well known, "playing any strategy with certainty is likely to be foolish in the case of law enforcement… or in any situation in which one party monitors another" (Baird et al., 1994:43).

The concrete distribution of the parties' efforts is a function of their objectives. Consider initially the police. To reduce the number of victims, the allocation of police must account for two factors. First, the police must curtail the *volume* of the burglar's activity. The fewer attempts the burglar makes, the fewer victims there will be. The police therefore must distribute their efforts such that the net expected utility from burglary is minimized. Second, police must also diminish the *likelihood* that the burglar will succeed in his attempts to break in and avoid detection. Because homeowners suffer no harm where the perpetrator fails to enter or where he is detected after burglary, diminishing the number of undetected break-ins results in fewer victims. As we show below, realization of the first goal (fewer attempts) might be in conflict with the attainment of the second (decreasing the probability of success in each attempt). To this extent, our analysis assumes that the former factor dominates the latter. Thus, the police look first to curtail the perpetrator's activity to a minimum level, and then, for this activity level, to diminish the likelihood that the perpetrator will succeed in breaking in and avoiding detection. We discuss this assumption (and show the robustness of our results even when this assumption is relaxed) in Section 2.3 below. As for the burglar's objective, looking to maximize payoff, he will allocate his efforts such that the number of successful, unapprehended break-ins is as high as possible.

2.1.2. Nash Equilibrium

As indicated above, given the competing objectives of the parties, neither will act exclusively in a single neighborhood. Rather, the police and the burglar will apply "mixed" strategies forming a Nash equilibrium. Under this equilibrium, each party is indifferent as to the neighborhood in which they act, given the strategy of the other party. Specifically, the police randomize so that the burglar's net expected utility is identical in each neighborhood. Under such randomization, the police curtail the burglar's level of activity (by minimizing his net expected gain) and, for this activity level, also minimize his likelihood of success. Similarly, the perpetrator will randomize the distribution of his activity between the two neighborhoods so that the number of victims (break-ins) in each neighborhood is equal. This behavior on the part of the burglar minimizes the rate at which he is apprehended. Such a pair of "mixed" strategies forms an equilibrium since, given the randomization of the rival player, neither player can enhance its interests by opting for a different strategy.

Formally, the randomization that each player is expected to choose in equilibrium is as follows. Denote B – the value that the perpetrator expects to derive from an unapprehended burglary; S – the level of the sanction; v and lv – the likelihood of breaking-in in neighborhoods V and LV, respectively; p – the probability that the police will act in neighborhood V; and c – the probability of the perpetrator acting in neighborhood V.

In equilibrium, the randomization of the police is set such that the offender's net expected value from burglary is identical in both neighborhoods:

$$(1) \qquad v[(1-p)B - pS] = lv[pB - (1-p)S]$$

The left-hand side expresses the net expected value for the perpetrator from acting in neighborhood V: with probability v the perpetrator breaks in; with probability (1 - p) he is not apprehended and derives the benefit B; and with probability p he is apprehended and bears a sanction S. The right-hand side similarly expresses the net expected value from acting in neighborhood LV.

The randomization that the burglar applies is such that the police are indifferent between the two neighborhoods; namely, the number of break-ins in each neighborhood is identical:

$$(2) \qquad cv = (1-c)lv$$

The left-hand side describes the number of break-ins in neighborhood V, and the right-hand side is the number in neighborhood LV.

Equations (1) and (2) yield the following results:

$$(3) \qquad c^* = \frac{lv}{v+lv} \;;\; p^* = \frac{Bv + Slv}{(v+lv)(B+S)}$$

This combination of probabilities forms the only stable equilibrium. Any deviation of one of the players allows his rival to maximize by adopting a "pure" strategy. As indicated above, once one of the players adopts such a strategy, his rival will react by also adopting a "pure" strategy, and so on.

As it may appear, the police can try to reduce the number of victims by (a) slightly decreasing the portion of their activity in LV—as compared to their Nash equilibrium strategy—such that the burglar will act exclusively in this neighborhood, where he is less likely to break-in; and (b) maintaining this new allocation constantly (avoid diverting all their resources to LV as a response to the burglar's allocation). Such a Stackelberg-like strategy on the part of the police will decrease the perpetrator's likelihood of success in each attempt. However, it will also increase the expected value from each burglary and hence the number of attempts. As far as this increase in the burglar's activity level outweighs the reduction in the probability of break-ins—as our analysis assumes—the result is a larger number of victims.[3] Thus, the police have no incentive to deviate from the mixed strategy of acting in probability p^* in neighborhood V and $1 - p^*$ in LV. Similarly, given p^*, the perpetrator cannot profit from a deviation from c^*.[4]

The expected Nash equilibrium enables us to assess how a change in the magnitude of the sanction affects the distribution of victims. The severity of a sanction determines the net utility from crime. Given that the volume of the offender's activity is positively correlated with the net expected value from a burglary, the level of sanction sets the total number of break-ins. However, the distribution of the burglar's activity is independent of the magnitude of the sanction. As explained, the burglar is expected to allocate his efforts such that the number of break-ins in each neighborhood would be identical. This allocation is exclusively a function of the victims' relative vulnerability. Unlike the burglar, the police are affected by the magnitude of sanctions in their allocation decisions. Since the police randomize between the two neighborhoods such that the net expected value from burglary in each neighborhood is identical, alterations in the severity of sanctions result in a different allocation. Specifically, harsher sanctions induce the police to shift enforcement efforts from V to LV. As such, a given level of sanction determines not only the total number of break-ins, but also the distribution of the harm that is inflicted on each sector of victims. In the next section we demonstrate this prediction and its rationale through a numerical example.

2.2. NUMERICAL EXAMPLE

Assume that the benefit (B) for the burglar from an unapprehended break-in is \$130; the likelihood of breaking into a house is 1 in neighborhood V and 0.1 in LV; the sanction (S) for being caught after a break-in is \$20; police apprehend

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[3] We further discuss and demonstrate this result in Section 2.2. See note 6 below. A related result is presented by Andreozzi (2004), who discusses a 2x2 "inspection game" in which the perpetrator chooses whether to violate the law, and the law enforcement agency chooses whether to inspect, when both complying and inspecting are costly. It is shown that, even when the inspector can credibly commit to a certain probability of inspection, in a Stackelberg-like game, her best strategy is to play a Nash equilibrium mixed strategy. However, in this model, the potential perpetrator may well be induced to adopt a "pure" strategy, of either fully complying or fully violating the law.

[4] Our analysis explains why a party reaching this set of probabilities is not likely to deviate from them. For a possible explanation about the mechanism that is expected to bring the parties to this equilibrium, see Osborne and Rubinstein (1994:37-43).

the perpetrator with certainty whenever they are patrolling the same neighborhood; and, finally, the number of the burglar's attempts per day—determined by his opportunity costs—is $\frac{N}{5}$, where N is the net expected value from burglary.

For these values, the following equilibrium is expected: the burglar will invest 1/11 of his efforts in V (and 10/11 of his efforts in LV); while the police will patrol neighborhood V 8/10 of the time (and patrol LV 2/10 of the time). With these randomizations, the burglar breaks in to the same number of houses in each of the neighborhoods. The net expected value from an attempt to commit a burglary in each neighborhood is $10, and the burglar will thus act twice a day $(\frac{10}{5} = 2)$. These randomizations form a stable equilibrium, such that neither the police nor the burglar can gain from changing their strategy.[5] Table 1 presents, for arithmetic convenience, the expected results for a period of 110 days, in which the police and the burglar each act on a daily basis.

Table 1: $S = \$20$; $B = \$130$

	Neighborhood V (likelihood of a break-in: 1)	Neighborhood LV (likelihood of a break-in: 0.1)	Total
Days in which Burglar Operates	10 days (1/11 of the time)	100 days (10/11 of the time)	110
Number of Burglaries	(10 × 2) 20	(10 × 2) 20	40
Days in which Police Operate	88 days (8/10 of the time)	22 days (2/10 of the time)	110
Solved Burglaries	16 (0.8 of all burglaries)	4 (0.2 of all burglaries)	20
Unsolved Burglaries	4	16	20

To understand this prediction, consider first the perpetrator's choice. The "mixed" strategy of the police equalizes the net expected value that the

[5] For illustration, consider the case in which the police, rather than acting 0.8 of the time in neighborhood V (and 0.2 in LV), spread their efforts equally between the two neighborhoods. Under this strategy, the net expected payoff from crime in LV exceeds that in V ($55 in LV as compared to $5.50 in V). The burglar would thus act exclusively in neighborhood V. Yet, once the burglar acts only in neighborhood V, the police would be better off by also acting exclusively in neighborhood V; the perpetrator would then opt to shift to neighborhood LV; and so on.

perpetrator would derive from acting in each neighborhood. In the vulnerable targets' neighborhood, the burglar is certain to succeed in breaking in (probability 1), but he is also more likely to be apprehended (a probability of 8/10). In neighborhood LV, the perpetrator is less likely to succeed in breaking in (probability 0.1), but he also faces a lower risk of apprehension (probability 2/10). As a result, in both neighborhoods the net expected value from burglary is $10. Thus, *given* that the police act 8/10 of the time in neighborhood V and 2/10 of the time in LV, the perpetrator cannot increase his payoff by changing the "mix" between the two neighborhoods. This allocation of police efforts also minimizes the expected utility of each burglary. With any other allocation, the offender's expected utility from each burglary will exceed $10, resulting in a higher volume of activity on the part of the offender.[6]

A similar rationale explains the allocation of the burglar's efforts. The actual randomization that the burglar is expected to choose is the one that makes the police indifferent as to which neighborhood they patrol. In our example, the perpetrator will act in neighborhood V 1/11 of the time and in LV 10/11 of the time. Under such a randomization, the burglar breaks in equally in both neighborhoods. As the perpetrator acts twice a day (given the net expected value of $10), he breaks in to 20 houses in each neighborhood. Attempts by the police to reduce the number of victims (unsolved burglaries) in one neighborhood through an increase of police presence there will result in an equal number of additional victims in the other neighborhood. Regardless of the police's strategy, 20 homeowners in total will suffer the harm resulting from a burglary.

The expected strategies of the parties also allow us to predict the distribution of the harm resulting from the burglar's activity. While the number of break-ins in each neighborhood is equal (20 houses), the allocation of police efforts results in a higher number of victims in neighborhood LV. Because the police patrol neighborhood V 8/10 of the time and neighborhood LV only 2/10 of the time, homeowners in LV suffer greater harm; residents of neighborhood V suffer only 4 cases of unsolved burglaries, in contrast to 16 such cases in neighborhood LV.

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[6] Police can apparently reduce even further the number of unsolved burglaries by slightly decreasing the portion of their activity taking place in neighborhood LV. Assume the police reduce their presence in LV from 0.2 to 0.15. The burglar's net expected value from burglary in LV will exceed that in V, inducing him to act solely in LV. If the police resist the temptation to respond by diverting all of their efforts to LV, the number of burglaries will ostensibly diminish, as the likelihood of a successful break-in in LV is only 0.1. Such behavior on the part of the police, however, raises the perpetrator's net expected value. When police patrol LV 15% of the time, the perpetrator's net expected utility from burglary is increased to $10.75. The burglar's volume of activity rises from 2 to 2.15 attempts per day. Consequently, the total number of unsolved burglaries increases from 20 to a little more than 20.1. The police's initial goal of minimizing the volume of the criminal activity is achieved only under the described Nash equilibrium.

Consider now how increasing the sanction for burglary will affect the parties' randomization. For example, consider our basic scenario, but assume that the sanction imposed on the offender is $125 (rather than only $20). Because the expected payoff for burglary remains positive, the offender will continue to operate. Moreover, since the burglar is expected to randomize so that the number of break-ins in both neighborhoods is identical, he will not alter the allocation of his efforts. The burglar will continue to act 1/11 of the time in neighborhood V (and 10/11 in LV). In contrast, the police would change the allocation of their efforts. To make the burglar indifferent, the police must reduce the share of their activity in neighborhood V from 0.8 to nearly 0.51. Although the augmented sanction does not affect the distribution of the burglar's activities, it increases deterrence. The augmented sanction, combined with the reallocation of police patrols, would decrease the expected value from burglary to only $5. The perpetrator would therefore cut in half the total volume of his criminal activity, from two attempts per day to only one. Table 2 summarizes the expected results for a period of 110 days, under sanction levels of $20 and $125.

Table 2

	B = $130; *S* = $20		*B* = $130; *S* = $125	
	V likelihood of a break-in: 1	LV likelihood of a break-in: 0.1	V likelihood of a break-in: 1	LV likelihood of a break-in: 0.1
Days in which Burglar Operates	10 days (1/11 of the time)	100 days (10/11 of the time)	10 days (1/11 of the time)	100 days (10/11 of the time)
Number of Burglaries	(10 × 2) 20	(10 × 2) 20	10	10
Days in which Police Operate	88 days (8/10 of the time)	22 days (2/10 of the time)	56 days (0.51 of the time)	54 days (0.49 of the time)
Solved Burglaries	16 (0.8 of all burglaries)	4 (0.2 of all burglaries)	5	5
Unsolved Burglaries	4	16	5	5

As Table 2 indicates, the effects of deterrence (a reduction in the burglar's activity) and redistribution (a shift of the police efforts to LV) both benefit targets living in the less vulnerable neighborhood. Both reduction in crime and the change in police distribution diminish their risk of being victimized.

Increasing the sanction from $20 to $125 reduces the number of victims in LV from 16 to only 4. In contrast, given the values in our example, residents of neighborhood V are worse off. Although the volume of criminal activity in their neighborhood is cut by one-half (from two break-ins to only one per day), the significant shift in police activity results in a higher risk of being the victim of an unsolved burglary. Rather than only 4 expected victims, under the augmented sanction this number increases to 5.

2.3. DISCUSSION

The distribution of victims across sectors of potential targets is a function of several factors. This sub-section elaborates on the effect of these factors on the behavior of the perpetrator and the police. In the following discussion, we first investigate the results of our analysis and then explore several extensions of the model. Most importantly, we show that removing the assumption of effective law enforcement may alter some of the model's predictions.

2.3.1. Factors Determining the Distribution of Crime

Individuals' risk of being victimized, as the model suggests, is a function of four related factors: targets' vulnerability, the severity of the sanction, the distribution of the perpetrator's activity against each sector of potential victims, and the distribution of police enforcement activities across the different sectors. The last two factors are correlated with the first two. The larger the difference in vulnerability between target groups and the more lenient the applicable sanction is, the more unequally will the perpetrator and police divide their efforts.

Consider first the connection between targets' vulnerability and the perpetrator's distribution of efforts. Given that $v > lv > 0$, a greater portion of a burglar's activity will be targeted against the less vulnerable victims. The underlying intuition here is that the number of break-ins will be identical in both neighborhoods only if the portion of the perpetrator's activity in neighborhood LV is greater than that in neighborhood V. The perpetrator's activity in the two neighborhoods becomes more evenly distributed when the gap between the respective vulnerabilities of the sectors of victims narrows. A large gap in the relative vulnerability of the victims also results in a more unequal allocation of the police efforts. Yet, the distribution of police efforts is the reverse of the distribution of the perpetrator's activity. The *more* vulnerable a sector, the *greater* the portion of police enforcement efforts it will enjoy. Therefore, whereas a wide disparity between the sectors' relative vulnerability induces the perpetrator to increasingly target the less vulnerable sector, it induces the police to apply a smaller share of their efforts to protecting this sector.[7] As such, the *greater* the disparity in the vulnerability of the sectors, the *larger* the harm imposed on the *less* vulnerable sector.

A second element that affects targets' risk of being victimized is the magnitude of the sanction. As our analysis has demonstrated, the level of sanction determines the offender's activity volume, but not the distribution of his efforts. The distribution of police operations, in contrast, is influenced by the magnitude of the sanction. Specifically, an increase in S decreases p (since $\frac{\partial p^*}{\partial S}<0$), meaning that an increase in the severity of the sanction induces the police to shift part of their enforcement efforts from V to LV. As the probability of a burglar's success is higher in V than in LV, an increase in the sanction reduces the net expected value from crime in V more substantially than it reduces the net expected value in LV. To equalize the net expected values of both places, police must increase the probability of apprehension in LV (and thus, inevitably, reduce this probability in V).

Thus, where law enforcement is effective, increasing the punishment for a given crime has two effects. First, increasing sanctions decreases the level of crime. Second, increased sanctions induce the police to shift enforcement efforts from V to LV. In the less vulnerable sector, these two effects work in the same direction, reducing harm. For the more vulnerable targets, however, these effects work in opposite directions. Contrary to the intuition that harsh sanctions primarily benefit vulnerable targets, our model therefore demonstrates that increased sanctions principally serve the *less* vulnerable ones. Moreover, the vulnerable sector might even be worse off with higher sanctions, if the deterrence effect (crime reduction in V) is more than offset by the effect of reallocation of the police efforts.

The preceding analysis, as indicated above, assumes that the police goal is first to minimize the burglar's level of activity and only then, for this activity level, to curtail his likelihood of success. If this assumption is removed, a Stackelberg-like equilibrium, in which the police act in neighborhood LV slightly less than p^* (and the burglar acts only in LV) cannot be ruled out.[8] The police will apply such a strategy where the reduction in the likelihood of break-in (as a result of directing the perpetrator to act only in LV) more than offsets the expected increase in the volume of crime. This possibility, however, does not change the model's main

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[7] For example, in our basic numerical example (where S = \$20), if v is reduced from 1 to 0.3 (and lv remains 0.1), the portion of the perpetrator's activity in V increases from 1/11 to 1/4, and the portion of the activity of the police in V decreases from 0.8 to 0.68.

[8] It is questionable, however, to what extent adopting such a strategy—in which the police would channel *all* the criminal activity to one sector of victims—is "politically viable." We address this issue in Section 3.2 below.

insight. In such a case, imposing a harsher sanction cannot benefit the more vulnerable sector, as under this scenario the number of break-ins in V is zero. It is again only the *less-vulnerable* victims that benefit from an increase in the level of sanction. Under this Stackelberg-like equilibrium, increasing the punishment for burglary will both reduce the burglar's activity level in LV and increase the share of police efforts in this neighborhood.

2.3.2. *Extending the Basic Model*

As the preceding subsection has shown, targets' vulnerability and the burglar's likelihood of apprehension are important factors in setting the parties' allocation of efforts. The following discussion examines how altering the model's assumptions concerning these factors affects the expected results.

Potential victims of criminal activity may differ in a variety of ways. Our model involves targets differing in their ability to oppose an offender. It can similarly be applied to other sources of diversity among potential victims. For illustration, assume that a perpetrator faces two neighborhoods, H and N. Residents in both neighborhoods are identical, except that the perpetrator expects to derive a *higher* benefit when he succeeds in breaking into a house in neighborhood H. Applying the model to this case indicates that the police can minimize total crime by allocating a greater share of their enforcement efforts to protecting the attractive sector (residents in neighborhood H).[9] It also indicates that increasing the sanction for burglary will make the police shift enforcement efforts from neighborhood H to neighborhood N.

A possible implementation of this variation of the model is in the context of hate crimes. Following Wang (1999), Blake (2001), and Dharmapala and Garoupa (2004), assume that potential offenders derive larger benefits from committing a crime against a victim who belongs to one group (H) ("hate crime") than from committing the same crime against a victim from another group (N) ("non-hate crime"). To the extent that police aim at minimizing *total crime*, our model suggests that the police should allocate a greater share of their enforcement efforts to

[9] In this case, the perpetrator is expected to divide his efforts equally between the two neighborhoods (so that the number of victims in each neighborhood is identical). In contrast, the police will allocate a greater portion of their efforts to protecting neighborhood H (in order to equalize the net expected gain from crime in both neighborhoods). Specifically, the probability in which the police act in neighborhood H, p, is set so that $(1-p)B_H - ps = pB_L - (1-p)S$ (where B_H and B_L are the burglar's benefit from committing a crime in H and in N, respectively). Thus, in equilibrium $p = \frac{B_H + S}{B_H + B_L + 2S}; c = \frac{1}{2}$.

protecting the attractive sector (i.e., to preventing hate crimes).[10] In this respect, our model provides an efficiency-based support to the view, previously based only on fairness considerations, that vulnerable victims should enjoy a greater protection against crime (Harel and Parchomovsky, 1999). Our model also shows, however, that imposing harsher sanctions would reduce non-bias-motivated crimes but would not necessarily lower the number of hate-crime incidents. As demonstrated in Section 4.2 below, imposing *enhanced* sanctions for hate crimes might paradoxically intensify this effect.

In practice, it is possible for target sectors to have more than one of the above characteristics. A neighborhood characterized by a low benefit to the perpetrator (N) might well also be more vulnerable (V). Similarly, a neighborhood can simultaneously be characterized by high benefit to the perpetrator (H) and lower vulnerability (LV). In such a case, outcomes will be mixed. The allocation of the police efforts is determined by the difference in vulnerability relative to the difference in benefit. When the gap in vulnerability is more substantial, a higher proportion of police activity will be allocated to protect N-V; when the gap in benefits is wider, neighborhood H-LV will garner more protection. Consequently, imposing a harsher sanction might harm or benefit either neighborhood, depending on the values of the relevant parameters.[11]

Consider now the likelihood of apprehension. The preceding discussion has assumed perfect law enforcement when both the police and perpetrator operate in the same neighborhood. However, the model has assumed apprehension of the burglar only in cases in which he actually succeeds in breaking in. As we show, extending the likelihood of apprehension—so that the police may also capture a burglar in a failed attempt— does not affect the analysis.

Suppose that the police can apprehend the burglar regardless of whether he succeeded in breaking in. As demonstrated above, in order to minimize the overall number of victims the police must distribute their efforts so that the net expected utility from burglary is minimized. In equilibrium, the randomization

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[10] It is possible that, in the context of hate crimes, the police objective should be the minimization of bias-motivated crimes (and not the overall level of crime). Such an objective is especially reasonable if the harm experienced by victims is aggravated when a crime is committed with hate. This aspect is debated in the literature. For example, while McDevitt et al. (2001) and Lawrence (1999:161-175) argue that the psychological harm experienced by victims of hate crime are more severe than those experienced by the victims of non-bias-motivated assaults, others challenge this premise (e.g., Kahan, 2001).

[11] Targets may differ in additional aspects. For example, individuals may differ in their "sensitivity"—an illicit activity may inflict a greater harm on some victims than on others. Under such an assumption, the police may see a greater "benefit" in protecting the sensitive targets. The model can be rather easily adjusted to account for such considerations.

of the police, *p*, is set such that the offender's net expected value from burglary is identical in both neighborhoods:

$$(4)\qquad v[(1-p)B]-pS = lvpB-(1-p)S$$

The left-hand side expresses the perpetrator's net expected value from acting in neighborhood V: the perpetrator breaks in with probability *v* and with probability (1–*p*) he is not apprehended and derives a benefit *B*; with probability *p* he is apprehended and bears a sanction *S*. The right-hand side similarly expresses the perpetrator's net expected value from acting in neighborhood LV.

The randomization that the burglar applies is such that the police are indifferent between the two neighborhoods. In equilibrium the burglar randomizes so that the number of break-ins in each neighborhood is identical:

$$(5)\qquad cv = (1-c)lv$$

Equations (4) and (5) yield the following results:

$$(6)\qquad c^* = \frac{lv}{v+lv}\ ;\ p^* = \frac{Bv+S}{(v+lv)B+2S}$$

Just as in the basic example, here the level of sanction does not affect the offender's distribution of efforts, but an increase in *S* does induce the police to shift part of their enforcement efforts from V to LV, since $\frac{\partial p^*}{\partial S} < 0$. Therefore, regardless of the existence of a sanction for incomplete attempts, increased sanctions will primarily serve the less vulnerable targets.

The discussion to this stage has involved effective law enforcement. We now extend the analysis to situations where the likelihood of apprehension is small. We conclude that removing the assumption of effective law enforcement may change some of the model's predictions.

Suppose that the police's enforcement efforts are *less* effective than in our basic example, so that even if both parties operate in the same neighborhood, the police are not always capable of detecting the perpetrator when he breaks in. Rather, assume that the police may detect a burglary with some *probability*, denoted *e*.

For a given level of *e*, the police will allocate their resources between the neighborhoods so that:

$$(7)\qquad v[(1-p)B+p(1-e)B-peS] = lv[pB+(1-p)(1-e)B-(1-p)eS]$$

In this more general case, the perpetrator derives benefits not only when the police patrol the other neighborhood, but also when the police act in the same neighborhood, but fail to apprehend the burglar. As in the basic model, in order to curtail the burglar's level of activity (by minimizing his net expected gain), the police must randomize so that the burglar's net expected utility is identical in each neighborhood. Equation (7) yields that

$$(8) \qquad p^* = \frac{B(v - lv) + lve(B + S)}{e(v + lv)(B + S)}$$

When $e = 1$, as we assumed in the basic example, $p^* < 1$, and an equilibrium in mixed strategies is expected. However, when $e < 1$, equation (8) will yield that p^* is lower than 1 (so that the police allocate part of their efforts to patrol in LV) only if

$$(9) \qquad e > \frac{B(v - lv)}{v(B + S)}$$

Note that when the probability of apprehension is sufficiently low, such that inequality (9) does not hold, $p^* > 1$; in this case, the police cannot divide their efforts so that the burglar's net expected utility would be identical in each neighborhood. In this state of affairs, the perpetrator's net benefit will necessarily be greater in V than in LV, and thus both the perpetrator and the police will apply a "pure" strategy of acting only in neighborhood V.

Our burglary hypothetical can therefore yield two possible results. When law-enforcement is effective, we can expect equilibrium with mixed strategies (where the police act in neighborhood V in probability p^* and the perpetrator acts there in probability c^*). In contrast, where the likelihood of apprehension is small, the gap in targets' vulnerability is substantial, and the applicable sanction is relatively lenient compared to the perpetrator's expected benefit, an equilibrium in which the parties use pure strategies is possible. In the latter case, both the police and the perpetrator will act solely in neighborhood V. To this extent, the model's results concerning the distributional effects of imposing harsher sanctions must be qualified. Where police efforts are sufficiently effective, the imposition of increased sanctions serves principally the *less* vulnerable targets and might even make the vulnerable sector worse off. In contrast, where law enforcement is ineffective, an increase in the level of sanction may benefit the more vulnerable victims.

3. RELEVANCY AND ROBUSTNESS

The preceding analysis makes several assumptions regarding victims' traits and about the behavior and motives of both criminals and the police. Before we move on to discuss some policy implications, we comment on the scope of the analysis and the plausibility of its central assumptions.

3.1. RELEVANCY

Our model refers to a simplified case in which the target sectors are geographically separated, each living in a different "neighborhood." Such a case is plausible as long as "types" of targets are defined by characteristics that might mark neighborhoods, like location or residents' average age. The relevance of our analysis, however, is not limited to such cases. The model applies to all cases in which enforcement efforts can be focused on protecting a distinctive "sector" of targets. For instance, our model can be applied whenever the police can select the level of intensity of their enforcement efforts in response to a report of crime based on the target's "type." The allocation of the "patrols" of the police in our model thus corresponds to any investigative resources the police may apply while differentiating among sectors of victims.

Our analysis assumes that the perpetrator can choose among targets and that the harm to the victim (or at least most of the harm) is avoided whenever the perpetrator is apprehended. Thus, the model fits a large group of crimes which are primarily aimed at achieving pecuniary gains, such as theft, burglary, fraud, or drug trafficking (assuming a client is a "victim").

Finally, our model also applies to perpetrators' selection among different possible illicit activities. Assume, for example, that a perpetrator faces a choice whether to attempt to sell drugs or break in to a house. Assume additionally that the expected benefit from each crime is similar, the sanction for each offense is identical, yet the odds of successfully completing a break-in are higher (or lower) than the odds of successfully selling the drugs. Finally, assume that the police (like the burglar) must decide against which activity (drug trafficking or burglary) to invest its enforcement efforts. The analysis of this case is essentially similar to the analysis we have presented, where the two offenses correspond to the "neighborhoods." An important insight our model suggests, for example, is that elevating sanctions identically for both offenses will alter the police's allocation of enforcement efforts as between these two offenses (but will not alter the allocation of the criminal's efforts).

3.2. ROBUSTNESS AND PLAUSIBILITY

Fully assessing the robustness of our model must await future research directly exploring the connection between the level of sanctions and crime distribution. Nevertheless, existing empirical studies suggest the plausibility of the model's basic assumptions.

The model's first premise is that offenders choose their targets as a function of four parameters: targets' vulnerability, risk of apprehension, expected spoils, and the level of sanctions. Numerous studies have established that the first three elements have a significant effect on offenders' selection of victims. Additionally, a number of studies have shown that criminals invest efforts in obtaining information on their potential victims and choose targets based on such investigations. In the context of property offenses, for example, criminals have been shown to primarily consider their victims' age, wealth, physical fitness and location (Wright and Decker, 1994:62-102). The effect of victims' vulnerability on criminals' targeting choices can also be inferred from studies that show a significant explanatory power of certain characteristics of residents – such as population density, average age and income – on the distribution of crime across regions (Tao, 2005; Reilly and Witt, 1996; Craig and Heikkila, 1989). Similarly, the effect of the risk of apprehension on perpetrators' decisions on where to act is generally undisputed (Tao, 2004; Kovandzic and Sloan, 2002; Marvell and Moody, 1996).

In contrast, the significance of the level of sanctions on perpetrators' activity is hotly debated. A growing volume of empirical research questions the deterrent effect of criminal punishments (e.g., Doob and Webster, 2003; Von Hirsch et al., 1999; Cook, 1980). Some of these studies empirically demonstrate that increasing the level of a sanction does not result in a reduction in crime.[12] These studies, however, have not falsified the assumption important to our model, that the level of sanction affects the perpetrators' choice of *where* (as distinct from *whether*) to commit a crime. In fact, such an effect is evident from studies which show that harsher sanctions in one jurisdiction often result in a substantial migration of relevant criminal activity to adjacent jurisdictions (e.g., Teichman, 2005; Hope, 1994).[13] These studies suggest that offenders are generally aware of and sensitive to the level of sanctions applicable to their planned crimes. Finally, inmate interviews have shown that "professional offenders," when asked about the factors they

[12] In contrast, other studies support the hypothesis that the level of sanction affects deterrence. For a review of such studies see, for example, Lewis (1986 - arguing for a "substantial body of evidence which is largely consistent with the existence of a deterrent effect from longer sentences"); Levitt (2002).

[13] Note that our argument is distinct from that of crime displacement, since we analyze the effect of imposing un-differentiated harsher sanctions.

weighed before committing their crimes, "explicitly spoke of their actions in terms of costs and benefits" (Doob and Webster, 2003:183).

Our model's second premise is that the police aim to minimize the number of victims. This assumption seems intuitively likely, though a few empirical studies have found that other considerations might shape police allocation of resources across victim sectors (Tao, 2004; Behrman and Craig, 1987). Integrating such considerations into the model renders it more complicated but does not affect its main insight as to the distributional effects of criminal sanctions.

The model's last premise relates to the plausibility of the equilibrium concept of mixed strategies. As indicated by David Kreps (1990:409), in cases of monitoring, in which "one player checks on the other…, a policy of random checking is often employed."[14] As far as informed repeated players are concerned, the prediction of mixed strategies forming a Nash equilibrium is generally considered plausible (e.g., Leger, 2000; Mookherjee and Png, 1989; Sherman and Weisburd, 1995). Even in contexts where individuals were observed employing deterministic rules, researchers have found that observed variations in the *aggregate* activities are characterized quite well by the symmetric equilibrium in mixed strategies (Smith and Levin, 2001; Binmore et al., 2001; Erev and Roth, 2002; Rapoport et al., 1998; Malcolm and Lieberman, 1965; Kaufman and Becker, 1961:462).[15]

The prediction concerning the allocation of police efforts can also be challenged as not being "politically viable." According to the model, a mixed strategy by the police results in an unequal distribution of resources. One may plausibly maintain that some sort of "equal protection" constraints might prevent such uneven allocation. If so, police would be required to spread their resources equally across the sectors of targets. We suggest two arguments in response. First, our model shows that where criminal sanctions are insufficient to fully deter, an "equal protection" policy is likely to result in a higher number of victims than would be created by our described equilibrium. Put differently, our analysis highlights the trade-off between the goals of equal protection and efficient crime prevention.[16] Secondly, it is not self-evident what fairness considerations dictate in our case. One may argue, as did Harel and

[14] See also Wittman, 1993. Numerous studies have predicted that parties will randomize in cases of monitoring and zero-sum games. See, e.g., Leger, 2000; Mookherjee and Png, 1989; Sherman and Weisburd, 1995.

[15] Our model assumes the perpetrator bears no costs in changing his distribution of efforts. Otherwise, as demonstrated by Lando and Shavell, 2004, the police may well be better off focusing their efforts in one location. See also Weisburd and Eck, 2004.

[16] Note that the Nash equilibrium in "mixed" strategies seems less politically contentious than the Stackelberg-like equilibrium, since the latter is characterized by absolute inequality in both resource allocation and distribution of crime.

Parchomovsky (1999:509-10), that "victims who are particularly vulnerable to crime may have a legitimate claim on fairness grounds to greater protection against crime." Such an approach provides support to our finding that police *should* allocate greater resources to protect the more vulnerable sector ($p^* > 1-p^*$).

4. POLICY IMPLICATIONS

The distributional effects of criminal sanctions have bearing on various aspects of law enforcement. In this Part, we present three examples, involving victims' compensation, the imposition of enhanced sanctions, and evaluation techniques for police performance. Rather than an exhaustive list, these examples illustrate the relevance of our model for policymaking.

4.1. VICTIMS' COMPENSATION

As illustrated in Part 2, when the police strive to minimize total harm, the distribution of crime among victims is a function of their relative vulnerability. Optimal law enforcement mandates that the police operate in a way which causes some sectors to shoulder a greater portion of the harm than others.

To be sure, policymakers may decide to allocate the efforts of the police as they deem appropriate. An unequal distribution of the harm, however, is inevitable. Where law enforcement is effective, policymakers may choose among three alternatives. If they aim at optimal crime prevention (minimizing the total number of victims), the set of probabilities forming the equilibrium is the strategy that provides the lowest number of instances of unsolved burglaries. Under this strategy, victims would be composed of both vulnerable and less vulnerable individuals. Once the policymakers deviate from this set of probabilities, perpetrators can maximize by adopting a "pure" strategy. Depending on the specific probabilities of the police activity, perpetrators will target one sector exclusively. The set of victims will be comprised entirely of residents of either V or LV, and the overall number of victims will rise. Thus, regardless of the police strategy, some individuals will face a higher risk of crime than others.

This state of affairs suggests that fair-distribution concerns require society to be more directly involved in activities aimed at reallocation. Because an ex ante fair distribution of risk is often infeasible, an ex post approach might be justified. Victims' funds, for example, now run by both the federal government and the fifty states (Nadel, 2005; Greer, 1994), can be extended and used to compensate those sectors whose risk is higher than others.[17] Taxing the sectors

[17] Current compensation under the federal funds provides limited remuneration and restricts compensation to certain groups of victims. Most states, however, expand the coverage of the

that are expected to bear a small part of the harm in favor of the sectors that endure most of this harm is another possibility.

4.2. ENHANCED SANCTIONS

The Federal Sentencing Guidelines, as well as an increasing number of state criminal justice systems, establish enhanced sanctions for offenders who target vulnerable victims.[18] This practice has attracted wide interest in recent years (Hurd and Moore, 2004). As part of a growing attempt to rationalize enhanced sanctions, legal scholarship has suggested ways in which they may in fact increase social welfare. For example, Gan et al. (2004) have analyzed the social disutility likely to result from crimes against vulnerable targets and have demonstrated how enhanced sanctions may reduce this disutility. Dharmapala & Garoupa (2004) have shown that a differential sanctions regime might be necessary to remove vulnerable targets' incentives to invest in avoidance activities. Because such activities only displace crime onto other targets, these investments in avoidance are socially wasteful. Scholars have also suggested non-consequentialist rationales. For example, Harel and Parchomovsky (1999) have advocated enhanced sanctions on egalitarian grounds.[19] The imposition of enhanced sanctions equalizes the protection which the criminal system provides to vulnerable and less-vulnerable targets. This explanation has been recently endorsed by a federal court, holding that "[a]n extra dose of

funds to additional sectors of victims. See the National Association of Crime Victim Compensation Boards, 2005.

[18] Section 3A1.1(b)(1) of the Federal Sentencing Guidelines holds that "[i]f the defendant knew or should have known that a victim of the offense was a vulnerable victim," the court may increase the judgment "by two levels." For similar state provisions, see, for example: Alaska Stat. § 12.55.155(c)(5) (empowering the courts to impose enhanced sanctions when "the defendant knew or reasonably should have known that the victim of the offense was particularly vulnerable or incapable of resistance"). For a comprehensive review, see Bremer, 2004. The actual enhancement imposed on criminals targeting vulnerable victims depends on the type of the offense. While in some contexts the imposition of enhanced sanctions may add only a few months in jail, in other contexts an offender who targets a defenseless victim is likely to spend a substantially longer time in prison. See Gary (1993 - concluding that the "[a]pplication of section 3A1.1 can increase the available sentencing range from as little as two months to as much as seventy-eight months, depending upon the base sentencing range").

[19] In a recent paper, Dharmapala et al. (2006) have shown that disproportionate victimization of certain sectors may increase the volume of crime in the long run. They thus show that Harel and Parchomovsky's argument in favor of enhanced sanctions may have important economic implications.

punishment removes the criminal's incentive to facilitate his crime by selecting victims against whom he actually will enjoy a high probability of success."[20]

These explanations focus on the effects that enhanced sanctions have on the behavior of perpetrators and vulnerable targets. Their underlying assumption is that the imposition of enhanced sanctions reduces the risk to vulnerable targets of victimization. These explanations, however, disregard the possible effect such a regime may have on the operation of the *police*. As our model shows, higher sanctions make vulnerable victims less attractive. Consequently, the police—to the extent that their objective is to minimize the number of victims—would reallocate their efforts from the vulnerable to the less vulnerable targets. Therefore, if the police's shift is large enough, the vulnerable victims may suffer a greater harm under enhanced sanctions than they would under the non-differential sanction regime.

From the perspective of the vulnerable targets, a harsher sanction only for burglaries committed in neighborhood V might be worse than the uniform application of the same sanction. Consider first the police behavior under either regime. Recall that the police, aiming to minimize the number of victims, must equalize the net expected value from burglary in both neighborhoods. As demonstrated in Part 2, a uniformly augmented sanction decreases the expected value from burglary more substantially in neighborhood V than in neighborhood LV. Imposing the harsh sanction only for burglaries committed against vulnerable targets increases the gap in the expected values even further. The differential regime, therefore, induces a more significant shift in police efforts from neighborhood V to LV, as compared to the shift required when the harsh sanction is imposed uniformly. Additionally, the overall deterrent effect under the differential regime is lower, given that the sanction in LV is not enhanced. It is thus especially likely that, under the differential regime, the decrease in police protection would more than offset the vulnerable sector's benefit from the reduction in crime. Put differently, the likelihood that the more vulnerable victims will end up worse off is ironically greater under a regime that aims to improve their position than under the non-differential regime.

For illustration, consider again the numerical example analyzed in section 2.2 above, but this time under a regime of differential sanctions. Assume that the

[20] *United States v. Zatz*, 298 F.3d 182, 188 (3rd Cir., 2002); see also, *United States v. Stover*, 93 F.3d 1379, 1387 (8th Cir., 1996) ("[T]he victims to whom § 3A1.1 applies are those who are in need for greater societal protection."). For similar explanations in legal scholarship, see Harel and Parchomovsky, 1999:509-10, who argue that "victims who are particularly vulnerable to crime may have a legitimate claim on fairness grounds to greater protection against crime," and that enhanced sanctions are one of the primary tools the legal system applies to provide such protection.

sanction for a break-in committed in neighborhood LV is \$20, while the sanction for a burglary in neighborhood V is \$75.

Recall that under the uniform regime in which the sanction is \$20, the burglar invests 1/11 of his efforts in neighborhood V (and 10/11 of his efforts in LV); the police patrol neighborhood V 8/10 of the time (and LV 2/10 of the time); the net expected value from burglary in each neighborhood is \$10; and the burglar acts twice a day $(\frac{10}{5} = 2)$.

When the sanction for a burglary in V is enhanced to \$75, the police's randomization will change. If the police do not alter their behavior, the burglar will operate exclusively in LV, where his net expected benefit still equals \$10, which now exceeds his net expected benefit in V.[21] To minimize the number of victims and keep the burglar's expected utility at the lowest possible level, the police must increase their presence in LV. Specifically, the net expected benefit from crime is equalized in both places if the police patrol neighborhood V only 6/10 of the time (in contrast to 8/10 under the non-differential regime). The net expected benefit that the perpetrator derives from burglary is reduced from \$10 to \$7, and he will thus reduce the overall number of attempts to break in from 2 per day to only 1.4. Table 3 summarizes the results for a period of 110 days, under both regimes.

Table 3

	B = \$130; S = \$20		B = \$130; S_V = \$75; S_{LV} = \$20	
	Neighborhood V (v = 1)	Neighborhood LV (lv = 0.1)	Neighborhood V (v = 1)	Neighborhood LV (lv = 0.1)
Days in which Burglar Operates	10 days (1/11)	100 days (10/11)	10 days (1/11)	100 days (10/11)
Number of Burglaries	20	20	14	14
Days in which Police Operate	88 days (8/10 of the time)	22 days (2/10 of the time)	66 (6/10 of the time)	44 (4/10 of the time)
Solved Burglaries	16 (0.8 of all burglaries)	4 (0.2 of all burglaries)	8.4 (0.6 of all burglaries)	5.6 (0.4 of all burglaries)
Unsolved Burglaries	4	16	5.6	8.4

[21] If police continue to patrol in neighborhood V 80% of the time, the burglar's net expected benefit in V is (\$130 × 0.2 – \$75 × 0.8) = -\$34.

As Table 3 shows, imposing an enhanced sanction for burglaries committed in neighborhood V reduces the total number of break-ins from 20 to 14. Police reallocation of enforcement efforts from neighborhood V to LV, however, makes targets in V worse off. Under the uniform, mild sanction of $20, the number of victims in V is 4, but under the differential regime this number increases to 5.6.

As indicated above, police can make residents of V better off under the differential regime by avoiding re-allocating enforcement efforts to LV. The analysis thus indicates that if policymakers wish to provide more intensive protection to defenseless targets, a rule of enhanced sanctions for offenders who target vulnerable victims is not sufficient. The police must be directed to avoid optimally adjusting the distribution of their enforcement efforts in response to the change in the incentive schemes that the perpetrators face. Stated differently, the police must be directed to give up the aim of minimizing total crime. In our numerical example, to insure that the more vulnerable victims are better off, the police must allocate more than 60% of their efforts toward protecting neighborhood V. Such a strategy, however, not only diverts all the harm to LV, but also does not minimize the net expected value the perpetrator derives from burglary. It thus results in a higher volume of crime.

4.3. MINIMIZING CRIME AND MAXIMIZING APPREHENSION

High apprehension levels—both in absolute numbers and as a fraction of committed crimes—are perceived as an important measure of police performance. High rates of solved crimes and apprehended offenders seem to indicate successful law enforcement. Analysis of possible police strategies, however, shows that apprehension rates can be misleading. As our model demonstrates, the police can artificially increase the number of apprehensions by inducing the perpetrators to commit crimes against the more vulnerable victims. Such a policy would result in a greater number of apprehensions, but also in a *higher* number of unsolved burglaries.

This reasoning is demonstrated through our basic numerical example, analyzed in section 2.2 above. The analysis has shown that if the police aim to minimize crime, 40 burglaries are expected during a period of 110 days, 20 in each neighborhood. Of these burglaries, police apprehend the perpetrator 16 times in neighborhood V, in contrast to only 4 such instances in LV. Thus a total of 20 burglaries do not lead to apprehensions.

Assume now that the police aim to maximize the *number of apprehensions*. The best strategy for the police under this alternative goal is to induce the perpetrator to act exclusively in neighborhood V. Such a strategy would increase the number of burglaries, since the likelihood of success against this sector is substantially higher. It would also enable the police to maximize the number of apprehensions. This goal can be achieved by slightly reducing the level of enforcement in the vulnerable sector. For instance, in the above numerical example, assume that the police slightly reduce their presence in neighborhood V from 0.8 to 0.79. Under this distribution of police efforts, the perpetrator's net expected value in neighborhood V exceeds his expected value in neighborhood LV; the expected value from a burglary attempted in V is \$11.50 (and only \$9.85 in LV).[22] The perpetrator is therefore expected to act exclusively in neighborhood V and increase the volume of his activity from 2 attempts per day to 2.3 $(\frac{11.5}{5} = 2.3)$. Since the perpetrator is certain to break-in in neighborhood V, in the period of 110 days he will commit 253 (110 × 2.3) burglaries. Given the strategy of the police, he will be apprehended in 0.79 of these cases, or nearly 200 times.

Such an apprehension rate might be perceived as a substantial improvement in law enforcement efforts. The absolute number of apprehensions is increased from 20 to 200, and the rate of apprehensions from all burglaries increases from 0.5 (20 out of 40) to 0.79 (200 out of 253). Such a policy, however, is socially detrimental. This increase comes at the expense of a greater number of victims. In our example, the total number of unsolved burglaries increases from 20 to 53.[23]

More generally, police can always increase apprehensions, both in absolute numbers and as a portion of committed crimes, by deviating from the strategy that minimizes total crime.[24] Such a deviation, however, necessarily results in an increase in the number of unsolved burglaries.[25] Data indicating that the police have increased the apprehension rate, therefore, do not necessarily signify better law enforcement. While it may sometimes be indicative, the ability of the police to manipulate the number of apprehensions at the expense of increasing crime mandates caution in using this measurement.

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[22] V: \$130 × 0.21 – \$20 × 0.79 = \$11.50; LV: \$130 × 0.1 × 0.79 – \$20 × 0.1 × 0.21 = \$9.85.

[23] Assuming the applicable sanction for burglary is jail rather than a fine, high apprehension rates may decrease crime due to incapacitation. Some empirical studies, however, suggest that incapacitation has rather limited effects in the context of crimes committed for pecuniary gains. New offenders replace the incapacitated criminals. See Zimring and Hawkins, 1995:114-22; Kleiman, 1992:122-23, 143-45.

[24] Denote p^* and c^* as the equilibrium activity levels in V of the police and perpetrator, respectively. If the police deviate and randomize at p', where $p' = p^* - \varepsilon$, the perpetrator will act exclusively in V. The number of unsolved burglaries under p' exceeds the number under p^* if $p'v > c^*v$. This condition holds, since $p^* > c^*$ (given that $v > lv$) and since p' can be set close to p.

[25] The number of unsolved burglaries under p' exceeds the number under p^* if $(1 - p')v > c^*v$. This condition holds since $(1 - p^*) > c^*$, and p' can be set close to p.

5. CONCLUSION

The optimal allocation of enforcement efforts is subject to intensive debate. Police crackdowns that target particularly troublesome locations and hot-spots policing are some of the strategies that have been suggested in the criminology literature (Weisburd and Eck, 2004; Kury and Fuchs, 2003; Bayley, 1994). Our analysis indicates that, given the assumptions of the model, the optimal strategy of the police is to randomize across the neighborhoods (or sectors of potential victims). This randomization should be determined by the characteristics of the neighborhoods (such as their relative vulnerability) and the level of sanction. Evidence of a high level of crime in one place or against a certain sector of victims does not necessarily justify reallocation of enforcement efforts.

The model presented in this article can be expanded to investigate other factors relevant to the criminal context. In our analysis, for example, we have assumed that targets' vulnerability is exogenous. In some cases, however, potential victims may invest in precautions to increase their ability to resist victimization. The game-theoretic analysis presented in this paper suggests that such investment will not only affect the behavior of the perpetrators, but will also affect that of the police. Because the police invest more in the protection of the more vulnerable sector, individuals making such investments might, in some cases, be worse off. This insight might explain why efficient precautions are not always installed, or may suggest the need for subsidies of such precautions. As this example illustrates, an extended analysis—one that accounts not only for deterrence but also for the distribution of crime—is required to address the intricacies of law enforcement.

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