Crime and Moral Hazard: Does More Policing Necessarily Induce Private Negligence?

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Abstract

Even risk-neutral individuals can insure themselves against crimes by combining direct expenditure on security with costly diversification. In such cases – and even when one of these options is infeasible – greater policing often actually *encourages* private precautions.

Keywords : Crime, policing, private precautions, moral hazard, diversification.

JEL Codes : K4, D8.

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1. Introduction

Since Becker (1968)'s pioneering work on crime and punishment, economists recognize that criminals are rational economic agents responsive to costs and benefits. While Becker's work has spawned a rich literature on the economics of crime, our particular focus in this paper is on *private precautions* against crime and their interaction with government expenditure on security.

Becker implicitly assumes that private and public preventive measures are substitutes: if the state spends substantially on crime prevention, individuals need to spend less to achieve a given rate of arrest. This may pose a public choice dilemma along the lines of the Peltzman Effect. Peltzman (1975) argued that safety regulations induce moral hazard causing reckless individual behavior that may ultimately offset the direct effect of the safety regulation. Similarly, Hylton (1996) mentions that individuals under-invest in private precautions simply from a tendency to over-rely on government enforcement. Does government expenditure on crime-prevention then necessarily give rise to moral hazard, discouraging costly private precautions? This is the question we investigate. Private precautions against crime are embedded in day to day life; therefore the question of whether such precautions would be necessarily discouraged by increased public expenditure on security is an important and relevant one.

We allow for two types of private precautions. First, individuals may spend directly on security equipment that increases the probability of foiling a criminal attack (for example, on guns or burglar alarms). Secondly, they – even if risk-neutral – can "insure" themselves against attacks through strategies of costly diversification. These reduce the prize a criminal can seize in a single attempt. We model three cases, one in which both types of precautions can be taken, a second in which only direct security expenses can be incurred (assets being indivisible, ruling out diversification) and a third in which individuals may take precautions through diversification, but cannot take any steps to directly foil crimes, perhaps due to legal restrictions (eg. on private firearms, or noise regulations banning burglar alarms). In all three models, greater policing does not necessarily induce moral hazard. Indeed, there are always conditions where greater policing *encourages* private precautions, while low policing discourages them. Interestingly, while in the model with indivisible assets, this result obtains when policing *enhances* the effectiveness of direct private security equipment, in the more general model where both diversification and direct security expenses are permitted, the result obtains when government policing and private security spending are strongly substitutable, rather than complementary. Thus, it is not the case

that policing encourages private precautions for only a unique technology; different technologies are compatible with a positive relationship between precautions and policing.

Related literature on private precautions includes, besides the papers already mentioned, Shavell (1991), Ehrlich (1981), Lacroix and Marceau (1995), Friedman, Hakim and Spiegel (1987), Ben-Shahar and Harel (1995) and Clements (2003).[3] Shavell (1991), Ben-Shahar and Harel (1995) and Clements (2003) are not concerned with the interaction of private and government security measures, but only with reasons why the equilibrium level of private precautions differs from the socially optimal one. Similarly Leeson (2007) considers a model with private precautions against crime[4], but in a stateless society without government security. Ehrlich (1981) assumes that the government's only role is to set fines for criminals, and that therefore government's actions do not affect private individuals' demand for precautions in the "market for offenses". Friedman et al assume that "private security" is a collectively consumed good and also explicitly postulate that private and public security are substitutes and additively separable. Lacroix and Marceau (1995) model private precautions in a setting of incomplete information.[5] While their focus is not on the interaction between private and government security measures, they find a "moral hazard" type effect in that if public spending is high, people are less likely to take precautions. Thus these papers differ from ours in focus, assumptions and results. Unlike us, none of the above authors explicitly models costly diversification.

In addition to the papers above, ours is also connected to the wider economics literature on crime.[6] Most of this literature studies the causes or effects of organized crime or optimal prevention methods. Some literature has also empirically investigated the effects of greater policing on crime rates; an important example is Levitt (1997); a more recent one is Lin (2009). Many other empirical studies on the subject are surveyed in Cameron (1988).

2. A Model of Private Precautions and Government Expenditure on Policing

2.1 Framework

A criminal attempts to acquire a loot of value L. Criminals seize any opportunity for crime that promises an expected income exceeding their outside option (which we normalize to zero). All

[3] See Garoupa (2002) for a comprehensive survey of post-Beckerian literature on the economics of crime.
[4] Taken by farmers expecting bandit attacks.
[5] This is in contrast to our paper, which assumes common knowledge of all parameters and variables.
[6] Including Stigler (1970), Schelling (1971), Anderson (1979), Reuter (1983,1987), Jennings (1984), Arlacki (1986), Jankowski (1991), Dick (1995), Konrad and Skaperdas (1998), Garoupa (2000), Skaperdas (2001), Chang, Lu and Chen (2005) and Miceli (2010).

agents are risk-neutral and have complete information. During an attack, a criminal faces a probability p of being caught, where p is an increasing function of government expenditure on crime prevention, G, as well as of private expenditure on security, x:

$$p = p(G, x) \tag{1}$$

such that $p_G > 0$, $p_{GG} < 0$, $p_x > 0$, $p_{xx} < 0$. The sign of p_{xG} is not obvious and depends on the specific nature of the security equipment. $p_{xG} > 0$ if x and G are complementary (eg. private spending on burglar alarms and government spending on rapid police response); $p_{xG} < 0$ if they are substitutable (eg. private expenditure on guns may be more effective in deterring crime when the police are ill-armed).

Let S be the penalty or "sentence" that a criminal receives if caught. He then expects to gain loot L with probability 1-p, and to be subjected to S with probability p. He knows the values of x and G – and therefore of p; he also knows L and S. He attacks iff $(1 – p)L – pS > 0$

$$\text{Or } L > pS/(1 – p) = \underline{L} \tag{2}$$

The prize must be large enough to risk capture and punishment for it. $\underline{L}$ is increasing in p –

$$d\underline{L}/dp = S/(1-p)^2 > 0 \tag{3}$$

and therefore also in x and G.

Besides direct expenses on security x, an individual can take costly private precautions of a different nature; these involve "diversification" or "not putting all one's eggs in one basket". These measures reduce cash or assets "on hand" so that a criminal can only seize a limited amount at one attempt. They include hiding one's cash and valuables in many different places (in different homes, if one has more than one, in different banks, going out with but little cash to discourage mugging, maintaining many different credit cards, each with small balances, etc). In particular, if an individual can divide his assets into enough lots as to make each too small for a criminal to risk capture for, he could insure himself against crime. However, such a measure is costly: the person incurs a fixed transaction cost A of operating each lot. In terms of our model, diversification entails reducing each lot to a maximum of $\underline{L}$. The threshold $\underline{L}$ – and hence the number of required lots – varies with p, and therefore with x and G. Higher x and G reduce the cost of diversification: a given wealth L need now be divided into fewer lots to deter crime.

We consider three cases below. In the first an individual has divisible assets he may diversify and/or spend on direct security measures (x). In the second, assets are indivisible (eg. an Old Master) and diversification is impossible though one may incur x on direct security.

Third, assets may be divisible and permit diversification, but private security expenditure may be banned (eg, bans on private gun ownership or noise regulations prohibiting burglar alarms). For each case, we show that a high level of policing can *encourage* private precautions.

2.2 Divisible Assets, Direct Private Security Expenses Permitted

In this environment, an individual who owns assets of value L can insure himself against crimes by dividing his wealth into n lots, each of size L/n, where n is an integer, and (through his choice of x) adjusting p to p_n such that

$$\underline{L}(p_n) = L/n \tag{4}$$

Given G, a high enough choice of x increases p to the point p_n such that the size of each lot is too small to tempt criminals to risk capture and punishment. Through these measures, an individual can deter all attacks. From (2) and (4), $(1-p_n)L/n = p_nS$

$$\text{Or } p_n = L/(L+nS) \tag{5}$$

Now consider any integer m. As the number of lots increases from m to m+1, the level of p required to deter criminals falls from p_m to p_{m+1} with

$$p_m - p_{m+1} = LS/\{(L+mS)(L+(m+1)S)\} \tag{6}$$

from (5). Clearly this difference is decreasing in m. Therefore,

$$p_m - p_{m+1} > p_{m+1} - p_{m+2} \tag{7}$$

The fall in p from p_m to p_{m+1} reflects a fall in x (given G) from x_m to x_{m+1}. Now rewrite (1) as

$$x = x(G, p) \tag{8}$$

where $x_G = \partial x/\partial G$ (with p constant) < 0, $x_p = \partial x/\partial p$ (with G constant) $= 1/p_x > 0$, $x_{pp} = -p_{xx}/p_x^2 > 0$. The concavity of p(G, x) in x implies the convexity of x(G, p) in p. Now we state our first result.

Proposition 1: If direct private expenditure on security is permitted, and assets are divisible, an individual's likelihood of insuring himself completely against crime is *increasing* in government expenditure against crime G if p_{xG} is strongly negative, specifically, iff $p_{xx}p_G - p_{xG}p_x > 0$.

Proof: This proof proceeds in two steps, first deriving the necessary and sufficient condition for diversification, then assessing the effect of G on this condition.

Step 1: Let p assume successively the values p_m, $(p_m + p_{m+2})/2$, p_{m+2}. From the convexity of x in p, we then have

$$x(G, p_m)/2 + x(G, p_{m+2})/2 > x(G, (p_m + p_{m+2})/2)$$

$$\text{or } x(G, p_m) - x(G, (p_m + p_{m+2})/2) > x(G, (p_m + p_{m+2})/2) - x(G, p_{m+2}). \tag{9}$$

From (7), we have

$$(p_m+p_{m+2})/2 > p_{m+1} \quad (7')$$

As x is increasing in p, it follows from (7') that

$$x(G, (p_m + p_{m+2})/2) > x(G, p_{m+1}). \quad (10)$$

Using (9) and (10), we then obtain a series of inequalities: $x(G, p_m) - x(G, p_{m+1}) > x(G, p_m) - x(G, (p_m + p_{m+2})/2) > x(G, (p_m + p_{m+2})/2) - x(G, p_{m+2}) > x(G, p_{m+1}) - x(G, p_{m+2})$. Consecutive increments in m reflect consecutively smaller reductions in x. However, each increase in m implies a constant increase in transaction cost A (the cost of operating one extra lot). Then, iff $x(G, p_1) - x(G, p_2) > A$, so that division into at least two lots is worthwhile, there exists some $\underline{m}$ such that $x(G, p_{\underline{m}-1}) - x(G, p_{\underline{m}}) > A$ and $x(G, p_{\underline{m}}) - x(G, p_{\underline{m}+1}) < A$. $\underline{m} > 1$ is thus the optimal number of lots. The necessary and sufficient condition for diversification is, therefore,

$$x(G, p_1) - x(G, p_2) > A \quad (11)$$

$$\text{or } x(G, L/(L + S)) - x(G, L/(L + 2S)) > A. \quad (11')$$

Intuitively, diversifying into more than one lot entails a transaction cost of A. However, it also implies lower x than without diversification; if lots are not too large, p – and so x – need not be very high to discourage criminals. Under (11'), the reduction in direct security expenditure outweighs the increase in diversification costs, and diversification becomes economical.

Step 2: Now consider the effect of G on condition (11). It is easy to see that a high level of G, while leaving the RHS of (11) unchanged, increases its LHS, thus making diversification more likely, iff $x_{pG}>0$. Now note that $x_{pG} = \partial x_p/\partial G$ with p constant. Constant p implies, from (1),

$$p_G.dG + p_x dx = 0$$

$$\text{or } dG/dx = -p_x/p_G \quad (12)$$

$$\text{Now } x_{pG} = \partial x_p/\partial G = \partial[1/p_x]/\partial G = -[p_{xG}+p_{xx}dx/dG]/p_x^2 \quad (13)$$

$$\text{From (12) and (13), } x_{pG} = -[p_{xG}-p_{xx}p_G/p_x]/p_x^2$$

$$\text{Or } \operatorname{sgn}(x_{pG}) = \operatorname{sgn}[p_{xx}p_G - p_{xG}p_x] \quad (14)$$

Thus the condition $x_{pG} > 0$ is equivalent to the condition

$$p_{xx}p_G - p_{xG}p_x > 0. \quad (15)$$

Since $p_{xx} < 0$, $p_x > 0$, $p_G > 0$, a necessary condition for (15) is $p_{xG} < 0$. Therefore, higher policing increases the likelihood of private precautions through costly diversification if policing reduces the marginal efficacy of direct private security measures by a sufficient amount. *QED*

The intuition is as follows. The benefit of not diversifying is the saving in transaction cost A, its cost is the higher expenditure on raising p enough to discourage criminals. Specifically, one spends $x(G, p_1) > x(G, p_2)$ (which is what one spends if diversifying into 2 lots). If more policing reduces the marginal efficacy of x in raising p, this implies that x must be raised by a large amount to raise p from p_2 to p_1. If, therefore, p_{xG} is sufficiently negative, the cost of *not diversifying* exceeds its benefit, and the individual diversifies.

Further, an increase in policing also entails an opposite effect. When policing increases, less x is needed to achieve the same p. Lower x implies a higher marginal efficacy of x in raising p (higher p_x), given $p_{xx} < 0$, thereby reducing the increase in x required to achieve a given rise in p. Hence this effect lowers the cost of not diversifying, opposing the previous effect. The first effect dominates when (15) holds, that is, when p_{xG} is sufficiently strongly negative.

2.3 Divisible Assets, Direct Private Security Expenses Not Permitted

Now consider an environment where the individual cannot directly influence p via x (due, say, to bans on private gun ownership, noise regulations prohibiting burglar alarms etc) so that p = p(G). For a given G, therefore, the "safe" threshold $\underline{L}$ is uniquely determined by (2). Individuals whose wealth is less are safe from criminal attacks, and need no precautions. An individual with $L > \underline{L}$ may still take private precautions through diversification. He can divide his wealth L into n+1 lots, n of size $\underline{L}$, and one of size $B = L - n\underline{L} < \underline{L}$. Those who do not take these measures avoid the fixed costs (A per lot) on the n extra lots; but risk losing all their wealth to a successful criminal attack (which happens with probability 1 – p). Individuals split their wealth into lots iff their extra transaction costs, nA, fall short of their expected loss from criminal attack, (1 – p)L, ie, if

$$nA < (1 - p)L \tag{16}$$

Proposition 2: If assets are divisible, but individuals cannot directly affect p, then individuals with wealth $L > \underline{L}$ *always* self-insure through costly diversification if policing is high enough such that $p(G) > A/S$, or equivalently, $G > p^{-1}[A/S]$. Such individuals *never* self-insure in the above sense if $p < nA/(n + 1)S$, or – equivalently – if $G < p^{-1}[nA/(n + 1)S]$.

Proof: *Step 1:* If $p > A/S$, $npS > nA$ – or from (2),

$$n(1 - p)\underline{L} > nA \tag{17}$$

Now by definition, $L > n\underline{L}$. Therefore (17) implies (16):$(1 - p)L > nA$. Hence, wealthy individuals self-insure through diversification if policing – or penalties, S – are high enough. Far from causing moral hazard, increasing government effort encourages such costly self-insurance.

Step 2: $p < nA/(n + 1)S$ implies $(n + 1)pS < nA$ – which, using (2) is equivalent to

$$(n + 1)(1 - p)\underline{L} < nA \tag{18}$$

Now $L < (n + 1)\underline{L}$ by definition. Therefore (18) implies

$$(1 - p)L < nA$$

which from (16) implies that individuals never self-insure. Therefore, *low* rather than high state investment on security and policing induces a neglect of costly self-insurance. *QED*

Intuitively, the reason for Proposition 2 is that a rise in G and hence in p pushes up the threshold $\underline{L}$ below which criminals do not find crime worthwhile. By doing so, it reduces the transaction costs, or diseconomies of scale, associated with this form of diversification; fewer lots are now required to keep one's wealth safe from criminals. Conversely, low policing implies that it is also very expensive to split one's property into enough "lots" to be safe from criminals because the threshold for safety is very small.

2.4 Indivisible Assets, Direct Private Security Expenses Permitted

If the individual's assets are indivisible, the costly diversification described above is not feasible. However, he is free to incur x, thereby raising p. Such an individual has two options:

(a) He could choose x to minimize expected losses – his expenses on security x plus expected loss from a successful crime(in which event he loses L with probability 1 – p).The individual's optimization exercise is

$$\min_x \{(1 - p(x))L + x\}$$

This yields the first order condition

$$p_x(G, \underline{x}) = 1/L \tag{19}$$

which is sufficient for minimization since $p_{xx} < 0$. Thus $\underline{x}$ is the optimal x.

(b) Alternatively, he could raise x to the level where p rises enough so that – even without diversification – he raises $\underline{L}$ all the way to L, deterring a criminal attack. The target p is given by $(1 - p)L = pS$ or $p = L/(L + S)$. The x required to reach this target p is given by

$$p(G, \tilde{x}) = L/(L + S). \tag{20}$$

which may be rewritten as

$$\tilde{x} = \tilde{x}(G, L, S) \tag{21}$$

where $\tilde{x}$ is increasing in L and decreasing in G and S.

The individual chooses between options (a) and (b) depending on which option entails lower expected costs. Thus he chooses option (a) iff

$$(1\text{-}p(\underline{x}))L + \underline{x} \leq \tilde{x}(G, L, S) \qquad (22)$$

– i.e. if, for given G and L, $S \leq S^*$ where (22) holds as an equation for $S = S^*$.

Proposition 3: If assets are indivisible, but private expenditure on security is permitted, then greater policing increases private precautions iff (i) $p_{xG} > 0$, and (ii) penalties for captured criminals, S, are not too heavy.

Proof: Option (a) is chosen if $S \leq S^*$ So condition (19) holds. Totally differentiating (19),

$$d\underline{x}/dG = - p_{xG}/p_{xx} \qquad (22)$$

Since $p_{xx} < 0$, $d\underline{x}/dG$ has the same sign as p_{xG}. Hence if $p_{xG} > 0$, that is, if government spending enhances the efficacy of private spending on security (as can happen with rapid police response and burglar alarms), private precautions increase optimally with G. *QED*

Intuitively, without extremely heavy penalties, the owner of a valuable but indivisible asset is unlikely to be able to deter criminals unless he incurs uneconomically high expenses on security. He therefore opts for incomplete deterrence by choosing a lower x and incurring some risk of theft. However, if government spending raises the efficacy of private measures in combating crime, greater policing could *encourage* private spending on security.

3. Conclusion

Conventional wisdom focuses on the direct effect of greater policing in reducing the probability of a successful crime. It suggests that greater policing causes moral hazard, inducing neglect of costly private precautions. This is in line with the Peltzman effect as well as with Becker's assumption of substitutability between private and public expenditure on security. We have examined three models; in one, people can undertake costly diversification, as well as additional expenditure that directly reduces the probability of a successful attack. In each of the other models, one of these options is withdrawn; the asset may be indivisible and diversification impossible; alternatively, it may be possible to diversify but not to directly reduce the probability of a criminal's success. In all three models, we derive conditions to show that greater policing need not cause negligence. More policing can, on the contrary, encourage private precautions.

Acknowledgements: The authors would like to thank Madhav Aney and an anonymous referee.

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