The Impact of Gun Laws:
A Model of Crime and Self-Defense

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Abstract

We develop a model of crime and self-defense that provides a rationale both for the right to bear arms and for regulating this right. It also suggests that a severe punishment for gun crime might best guarantee both the security and freedom of potential victims.

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1. Introduction

Gun-control advocates argue that guns have a “facilitating effect” on crime, because they inevitably end up through loss or theft in the hands of criminals. Gun-rights advocates argue that guns have a “deterrent effect” on crime, because victims may be carrying a concealed weapon.

We propose a simple, strategic model of crime and self-defense. We analyze the impact of gun control on gun use by criminals, hiding and gun carrying by potential victims, and completed gun and non-gun crime. A marginal increase in gun control from a moderate level increases completed non-gun crime, but reduces completed gun crime, and so may on net be desirable. However, with total gun control potential victims always hide, suffering a loss of freedom. The model thus provides a rationale both for a right to bear arms and for regulating this right.

In contrast to full gun control, we show that a severe punishment for committing a crime with a gun leads to no gun crime and no hiding by victims. The gun-crime penalty eliminates gun crime but preserves the threat of armed response, and so may best ensure safety while preserving freedom.

In the large literature on the economics of crime, stemming from the work of Becker [1968] and Ehrlich [1972], few studies model theoretically the connection between guns and crime.\(^2\) There is, though, a growing empirical literature on gun control and crime. Lott and Mustard [1997] argue that allowing concealed handguns has significantly reduced crime across America. Subsequent studies (e.g., Dezhbakhsh and Rubin [1998, 2004], Black and Nagin [1998], Ludwig [1998], Duggan [2001], and Ayres and Donohue [2002]) do not support

\(^2\) One notable exception is Donohue and Levitt [1997], who model the impact of guns on criminals fighting against other criminals for the possession of an external prize. In contrast, our model is about criminals attacking victims for their endowments. In this context, guns also play a role in self-defense.
that finding. The empirical debate lacks a strong theoretical basis to guide it, as evidenced by the failure to distinguish between guns used for self-defense and guns used in crime, the former of which is the real problem. Our result that a harsh penalty for gun crime could eliminate such crime without losing the deterrent effect suggests that empirical research might productively focus on the impact of gun crime sentencing laws.

2. Model

The population is divided into two groups: potential criminals and potential victims. Victims have an endowment $w > 0$. Criminals have no endowment, but can take it from victims, which is a crime. Potential criminals choose not to commit crime ($\neg C$), to commit crime without a gun ($\neg GC$), or to carry a gun, at a cost $g > 0$, and commit crime with it ($GC$). Potential victims choose not to carry a gun ($\neg G$), to carry a gun ($G$) for protection, also at a cost $g$, or to take alternative preventive measures, such as hiding or staying at home at night ($H$), at a cost $h > 0$, which represents the loss of freedom. Agents from each population are paired at random to play the game in Table 1. Let $\alpha_1$ and $\alpha_2$ be the probabilities that the criminal chooses $GC$ and $\neg GC$, respectively, and let $\beta_1$ and $\beta_2$ be the probabilities that the victim chooses $\neg G$ and $G$.

<table>
<thead>
<tr>
<th></th>
<th>$\neg G$</th>
<th>$G$</th>
<th>$H$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\neg C$</td>
<td>$0,w$</td>
<td>$0,w-g$</td>
<td>$0,w-h$</td>
</tr>
<tr>
<td>$\neg GC$</td>
<td>$\frac{1}{2}(w),\frac{1}{2}(w)$</td>
<td>$-d,w-g$</td>
<td>$0,w-h$</td>
</tr>
<tr>
<td>$GC$</td>
<td>$w-g,-d$</td>
<td>$\frac{1}{2}(w-d)-g,\frac{1}{2}(w-d)-g$</td>
<td>$-g,w-h$</td>
</tr>
</tbody>
</table>

Table 1: Normal Form of the Game of Crime and Self-Defense

If an unarmed potential victim meets an armed criminal, the criminal takes the victim’s endowment and possibly shoots the victim in the process, creating an expected cost, $d > 0$. 


If an armed victim meets an armed criminal, then with equal probability the victim either defends his endowment and possibly shoots the criminal, or loses his endowment and is possibly shot. If an unarmed victim meets an unarmed criminal, then again equal chance determines the outcome, but neither party is shot. An armed potential victim meeting an unarmed criminal defends his endowment and possibly shoots the criminal.

We make the following assumptions about payoffs: (1) \( h > g \), (2) \( 2g > h \), (3) \( w > 2h \), and (4) \( d > w - 2g \). Hiding is costlier than carrying a gun, but there is always the possibility of an accident, so the cost of carrying a gun cannot be too low. The endowment is valuable relative to the cost of hiding, and the disutility from being shot is also high.

Given Assumptions 1-4, the game has a unique, fully-mixed equilibrium:

\[
\alpha_1 = \frac{2(h - g)}{d + w}, \quad \alpha_2 = \frac{2(2g - h)}{w}, \quad \beta_1 = \frac{4gd}{w(3d + w)}, \quad \beta_2 = \frac{2gw}{w(3d + w)}
\]  

(1)

The assumptions ensure that these are well-defined probabilities.

3. The Impact of Marginal Gun Control

Gun control increases the cost of carrying a gun, \( g \), by increasing the risk of legal punishment. It cannot increase \( g \) only for potential criminals because victims can loose their guns or have them stolen, and criminals can then obtain them underground. We are interested in the effect of gun control on the following outcomes: gun carrying by potential victims, \( \beta_2 \), hiding by victims, \( 1 - \beta_1 - \beta_2 \), attempted non-gun crime, \( \alpha_2 \), attempted gun crime, \( \alpha_1 \), completed non-gun crime, \( \alpha_2(\frac{1}{2}\beta_1) \), and completed gun crime, \( \alpha_1(\beta_1 + \frac{1}{2}\beta_2) \), which is possibly the most important element. Let us look at the effect of a marginal increase in \( g \) on equilibrium strategies:

\[
\frac{\partial \alpha_1}{\partial g} = \frac{-2}{d + w} < 0, \quad \frac{\partial \alpha_2}{\partial g} = \frac{4}{w} > 0, \quad \frac{\partial \beta_1}{\partial g} = \frac{4d}{w(3d + w)} > 0, \quad \frac{\partial \beta_2}{\partial g} = \frac{2w}{w(3d + w)} > 0
\]  

(2)
Marginal gun control reduces the incentives of potential criminals to commit gun crime and increases their incentives to commit non-gun crime. Thus potential victims reduce their hiding and increase their gun carrying, by the exact magnitudes that restore criminals’ indifference. Raising $g$ reduces the incentives of victims to carry a gun for protection and increases their incentives to hide. Thus potential criminals commit less gun crime and more non-gun crime, so as to make victims indifferent again. The effects of marginal gun control on completed non-gun and gun crime are:

$$\frac{\partial \alpha_2(\frac{1}{2} \beta_1)}{\partial g} = \alpha_2 \left[ \frac{1}{2} \frac{\partial \beta_1}{\partial g} \right] + \frac{\partial \alpha_2}{\partial g} \left[ \frac{1}{2} \beta_1 \right] = \frac{4d(4g - h)}{w^2(3d + w)} > 0 \quad (3)$$

$$\frac{\partial \alpha_1(\beta_1 + \frac{1}{2} \beta_2)}{\partial g} = \alpha_1 \left[ \frac{\partial \beta_1}{\partial g} + \frac{1}{2} \frac{\partial \beta_2}{\partial g} \right] + \frac{\partial \alpha_1}{\partial g} \left[ \beta_1 + \frac{1}{2} \beta_2 \right] = \frac{2(4d + w)}{w(d + w)(3d + w)}[h - 2g] < 0 \quad (4)$$

Gun control increases attempted non-gun crime and reduces hiding, so it increases completed non-gun crime. Since it reduces attempted gun crime and increases gun carrying by victims, it reduces completed gun crime. Comparing (3) and (4) reveals that the effect on completed non-gun crime is larger, so total completed crime rises. The expected utilities of criminals and victims are unchanged. However, since gun crime may generate more negative externalities (e.g., on family members of shooting victims), and because reducing hiding gives victims more freedom, which may create positive externalities for society, marginal gun control may be beneficial.

4. The Impact of Full Gun Control

To examine the effect of full gun control, implemented through a large $g$, we relax Assumption 1 (that $g < h$). If $g > h$, then $G$ is strictly dominated for potential victims. Table 2 shows the resulting game.
Table 2: The Game of Crime and Self-Defense with Full Gun Control

<table>
<thead>
<tr>
<th></th>
<th>(\neg G)</th>
<th>(H)</th>
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<tr>
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</tr>
<tr>
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<td>0,(w-h)</td>
</tr>
<tr>
<td>(GC)</td>
<td>(w-g, -d)</td>
<td>(-g, w-h)</td>
</tr>
</tbody>
</table>

Now no crime is weakly dominated for the potential criminal. There is a continuum of equilibria, in all of which victims hide with probability one, and criminals randomize between no crime and no-gun crime, with probability \(\frac{2h}{w}\) or more on the latter. Expected utilities are unchanged. There is no completed crime, but the threat of crime leads potential victims to always hide and suffer the loss of freedom. The result suggests that some right to bear arms is fundamental to the freedom of potential victims.

5. The Impact of Severe Gun-Crime Punishment

So far, government only plays a role through gun control. In reality, it can also set the punishment for committing crimes. In particular, it could punish gun crime much more severely than non-gun crime. We now introduce a cost \(s > 0\) to the criminal’s payoff for the strategy pairs \((GC, \neg G)\) and \((GC, G)\), representing the expected additional punishment for committing a gun crime. (For simplicity, we set the sentence for non-gun crime to zero.) If \(s\) is high enough, then \(GC\) is dominated for the criminal, so \(H\) is conditionally dominated for victims.

Table 3: The Game of Crime and Self-Defense with a Severe Gun-Crime Penalty

<table>
<thead>
<tr>
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The resulting game, shown in Table 3, has a unique equilibrium: criminals commit non-gun crime with probability $1 - \frac{2g}{w}$, and victims carry guns with probability $\frac{d}{d + \frac{1}{2}w}$. Criminals’ utility is unchanged, but victims’ increases. A harsh punishment for gun crime keeps criminals from using guns, but preserves the threat of an armed response by victims, so that potential victims never hide. In contrast, under the no-gun regime they always hide. The gun-crime penalty is focused on the real problem, which is not guns, but using guns to commit crime.3

6. Conclusion

Our model of crime and self-defense distinguishes between gun crime and non-gun crime, between hiding and carrying guns for self-defense, and between gun crime and gun carrying in self-defense. Our results are that (1) marginal gun control increases non-gun crime, and reduces gun crime, (2) full gun control eliminates gun crime but also reduces the freedom of potential victims, and (3) severe gun-crime punishment eliminates gun crime and preserves freedom. The second result suggests that the Second Amendment’s right to bear arms cannot be revoked without severely threatening individual freedom, while the first result shows that some gun control may also benefit society, by reducing gun crime. The third result suggests that gun-crime punishment could curb gun crime while preserving the gun rights of potential victims. A severe penalty for committing gun crime may be the best way to guarantee both security and freedom.

3 Helsly and O’Sullivan [2001] consider a refundable deposit policy that would encourage law-abiding gun-owners to protect their guns from being stolen by criminals. In terms of our model, that policy would correspond to increasing $g$ only for potential criminals, and so would have a similar effect to independently increasing the punishment for committing crime with a gun.
REFERENCES


