Self-defense with guns
The consequences

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Abstract

The choices of potential victims and of criminals with respect to weapons were analyzed in an economic game framework. It was found, using *National Crime Victimization Study* data, that victims who have and use guns have both lower losses and lesser injury rates from violent crime. It was also found that the victim's choice of having a gun is not independent of the criminal's choice. Based on these findings, the consequences of having a greater portion of the potential victims being armed were analyzed. It was found that this would reduce both losses and injuries from crime as well as both the criminals' incentives to commit violent crimes and to be armed. © 2000 Elsevier Science Ltd. All rights reserved.

Introduction

The regulation of ownership and carrying of guns is currently a topic which generates a good deal of debate. Some people propose that the private ownership of firearms be prohibited while others advocate that all law-abiding, sane, adults be allowed to own and carry guns. Since both groups are making their proposals with the stated goal of improving personal safety, it is important to ask the question of how personal safety is affected by gun ownership. That is not as simple a question as it may at first seem. Criminals may use guns in order to better attack their victims. The potential victims may, however, also use guns in self-defense. Complicating the analysis is the fact that criminals may obtain their weapons by stealing them from law-abiding citizens.

Much of the analysis which has been done on each side of this debate has been done by partisans of that side. That analysis typically does not include a

model of the behavior of any of the participants nor, frequently, has it been empirically sound. As an example, papers published in the medical literature (which are almost uniformly anti-gun) are often analytically weak[1] (and disconnected from the criminological literature).

Some studies, however, have been done in the economics literature of problems related to this. Becker (1968) looked at the choices made by criminals and by society as essentially a game. The criminals make choices about being in that profession and about the crimes to commit while governments make choices about the resources to devote to catching and punishing the criminals. Ehrlich (1975) analyzed the specific choices about punishment probabilities and severities made by governments and the responses by criminals to those choices. The most relevant study was by Ehrlich and Becker (1972) which analyzes the choices made by potential crime victims for insurance, self-insurance, and self-protection. This study asked the question of how effective are individual responses to the problem of crime and whether current governmental regulations are appropriate in light of the game strategies employed.

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Behavioral model

The criminal and the potential victim may be viewed as participating in a game. The criminal wishes to make as much profit relative to his cost and risk as is feasible. At the same time, the potential victim wishes to minimize his or her (in the following, "he" will refer to the offender while "she" will refer to the victim; both players may be of either sex but this will help to keep the players straight in the text) losses resulting from crime and the fear of crime. The criminal benefits directly from the money and goods stolen from the victim as well as from whatever satisfaction may result if he injures the victim. The latter is more likely to be the case if the assailant knows and dislikes the victim, for whatever reason.

It is sometimes difficult to precisely classify crimes. Some may be primarily for commercial purposes so that any injury to the victim is incidental and, in fact, may be either undesired by or neutral for the criminal. In other cases, the attacker desires to harm the victim (as, for example, rape) and may only take goods or money as a further injury or as incidental benefit to himself. The victim, in this case, may be known to the attacker and may be chosen specifically for the attack because of who she is. In a purely commercial crime, the offender chooses the victim for profitability characteristics; whether the crime can be expected to pay is the overriding consideration. In either case, the offender making the attack weighs the costs and benefits expected for himself in deciding whether to make the attack. This implies that:

$$\text{EU (Value Stolen + Harm to Victim)} \\ - \text{Cost (Criminal Activity)} \\ > \text{EU (Penalties)}$$

is necessary to the decision to make the attack, where EU is expected utility to the offender. The offender will only undertake a crime if the expected value to him of the value of goods and cash stolen plus any utility of the expected harm to the victim less the cost of conducting the criminal activity (in whatever terms he measures his costs) exceeds the expected value of penalties which may be visited upon the offender by either the victim or by society. That is, he must expect to gain by his crime.

On the other side, the potential victim wishes to lose as little as possible from crime, including the losses due to the purchase of insurance or to the taking of self-protection actions. This individual weighs the probability of being attacked by some offender along with the costs and potential benefits of taking some action in deciding on a strategy to be followed. For example, consider having a gun for self-defense purposes:

$$P(\text{Attack}) \cdot P(\text{Able to use Gun|Attack}) \\ \cdot [\text{EU (Loss|No Gun)} - \text{EU (Loss|Gun)}] \\ > \text{EU (Cost of Gun)}$$

would be necessary to induce a potential victim to have a gun. The potential victim looks at the probability of being attacked by some offender, multiplies that by the probability of being able to use the gun given an attack, and further multiplies that by the change in the expected utility of the loss incurred without and with a gun. If that value exceeds the expected utility of the cost of having a gun, the victim will choose to have a gun. Otherwise, she will not.[2]

There have been a number of studies of the probability of an attack for the average person. For robbery, rape, and aggravated assault, the average probability of being attacked in a given year aggregates to about 1.48 percent (from Table 2 in *Criminal Victimization in the United States*, Bureau of Justice Statistics, 1992). Of course, for many age, sex, or ethnic groups, the probabilities differ greatly. The higher the probability, other things being equal, the greater the value of having a gun, assuming it to have defensive value. The second factor is the probability of being able to use the gun if one has it. That may depend on the weapon used by the attacker as well as the competence in gun usage/attack/defense of both the attacker and the victim. A person who had not practiced using her gun would be less able to engage in self-defense but practice involves a cost to the defender,[3] a fixed cost that needs to be incurred before relying on a gun for defense.

The third factor is the difference in expected utility of the losses suffered by the victim who does not or does use a gun in self-defense. This computation has not generally been made by persons other than by potential victims; there has been little research on the outcomes of specific forms of self-defense. An exception is Kleck and DeLone (1993) who found that the use of a gun was effective for the victim in dealing with a robber. The use of a gun in self-defense against various crimes will be the major subject of this study. After all, if there is no difference in the expected losses or the losses are greater for those who have guns, any positive cost of having a gun would induce people not to have self-defense guns. Of course, since some people do in fact have self-defense guns, this implies that they feel that the benefits outweigh the costs. Finally, the expected cost includes the barriers to ownership that may be erected by governments. Since these barriers are mainly for handguns, there may be a move by both potential victims and by criminals to ownership of rifles or shotguns. Of course, for carrying a gun,

there may be a value/cost placed on the inconvenience involved in carrying something that may be bulky or heavy. It appears that relatively few people do carry guns for self-protection.

The decisions by the potential and actual victim are shown in Fig. 1. Initially, she is at choice point 1 and has to decide whether to have a gun or not. Next, she will either be attacked or she will not, at point 2 or point 3. If she is attacked, she is then at either choice point 4 or choice point 5 and has to decide whether to take action. Of course, at choice point 5 it is not possible to use a gun. In either case, the victim will decide either to take some action or not to do so. She then proceeds to outcome 6, 7, 8, or 9, depending on her choices. At each of those outcomes, there is an expected level of losses, L_j, and an expected injury, I_j. The major object of this study is to investigate how the outcomes are related to the decisions made.

Fig. 2 shows the decision from the point of view of the attacker. His initial decision, at point 1, is whether to have a gun, to have some other weapon, or to have no weapon. Then, depending on his decision, he encounters the victim at point 2, 3, or 4. The victim will choose to use a gun, to take some other action, or to take no action. It is undoubtedly the case that the probabilities differ depending on the attacker's choice. The results will be an expected outcome of a through i. The injury to the victim which can be expected will be I_a through I_i. The attacker may be indifferent to this, may want greater injury, or may want less injury; this depends on his motive for making the attack in the first place. Finally, the expected outcome includes losses to the victim of L_a through L_i. The larger the loss, presumably the larger the gain to the attacker so, if the attack is motivated by commercial reasons, he wants larger numbers here. This study is intended to in-
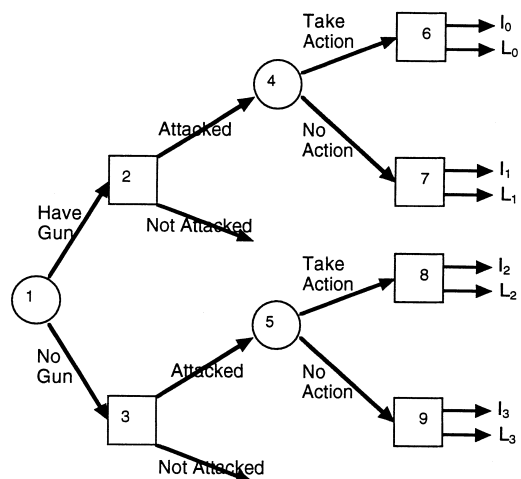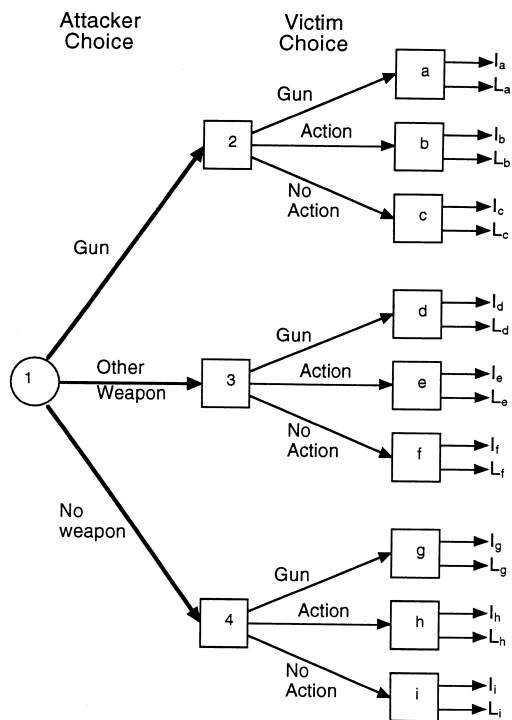

Fig. 2. Choices and outcomes for attackers.

vestigate how these outcomes are related to the choices made.

Data

Each year since 1973, a survey has been conducted by the Bureau of the Census of about 100,000 people chosen to be representative of the U.S. population and their recent experiences, if any, with crime. The data set changes each year so this is not a longitudinal study. The title of this study is the *National Crime Victimization Study (NCVS)*. This study asked people about all crimes in which they were victimized, therefore crimes that were not reported to the police are included as well as those that were, if they were reported to the interviewer. The object was to gather a representative sample of all criminal activity that occurs in any given year. Homicides and kidnappings were not included because the sample was too small to give significant results.[4]

Data from a number of these surveys have been combined on a compact disk which is available to the public. This was the source of observations for this study. There were two principal data sets on it which were the most useful for the purposes of this study. They were the data on incidents occurring from 1979 to 1987 and the data on incidents occurring in 1991.

Fig. 1. Choices and outcomes for potential victims.

Table 1
Weapon choices

Criminal choice	Victim choice			
	Gun	Other action	No action	Total
Sample 1979–1987				
Gun	150	2305	1734	4189
Other weapon	163	6113	1656	7932
No weapon	223	18,620	11,837	30,680
Total	536	27,038	15,227	42,801
Sample 1991				
Gun	15	267	248	530
Other weapon	12	446	170	628
No weapon	14	1912	1516	3442
Total	41	2625	1934	4600

Since there were some years left out, the two data sets were not merged for this study; instead, each were considered separately. Also, some comparisons were made over time.[5]

This study looked at the criminal activities which involve direct contact between the principals in the case. The result was that larcenies and burglaries were excluded. Instead, this study looked at rapes, assaults, and robberies. Of course, a burglary that occurs when the victim is at home may involve direct contact if the homeowner is alerted and comes into contact with the attacker. That could change the crime to robbery if the police decide to so categorize it.[6] Of course, only personal attacks were included here. The questionnaire does not distinguish among robbery, aggravated assault, and rape except in the outcomes that are experienced by the victim; the survey later categorizes the crimes. This study does not attempt to separate the crimes into categories since the issue is one of self-defense and the victim does not necessarily know the intentions of the attacker. For example, a robbery may also be accompanied by a rape; how should this crime be categorized?

Choice of gun use

Both the criminal and the potential victim may decide to have a gun available during the crime. Of course, this is simpler for the attacker who only has to be armed at a time of his choosing inasmuch as he picks the time to commit the crime. The potential victim, on the other hand, needs to be armed at any time that she could be victimized since she has no way of knowing when the attacker will act. Thus, unless the potential victim is *always* armed, she cannot be sure of being armed when the criminal acts.

It follows that people who feel themselves to be in greater peril of being attacked by an armed person would be more likely to arm themselves. This can be tested using the actual numbers from the *NCVS* data. Table 1 shows the data for each of the data sets for each case of robbery, rape, and aggravated assault confrontation. As can be seen in Table 1, the very substantial majority of both offenders and victims have apparently chosen not to be armed with guns. At least, they have not used guns during the encounter. This is true for both data sets.[7]

This data set also allows us to ask whether the potential victim's choice of having/using or not having/using a gun is independent of the attacker's choice. This is done by taking appropriate values from Table 1 and treating them as a contingency table. Using the Yates correction for one degree of freedom, the χ^2 value for the 1979–1987 data is 201.50 and for the 1991 data it is 23.07. Since the value for significance at the 1 percent level is 6.64, it is clear that these two categories are not independent. That is, the person who is attacked by an armed person is more likely to be armed with a gun and to use the gun in self-defense than is the person who is attacked by an unarmed person.

There are several possible reasons for this. First, people who are the more lucrative targets because they have more to steal are more likely to be armed in order to protect their possessions. The criminal, realizing this, knows that it is more important to be armed in order to counteract the armed victim. Second, people who are more in harm's way, in that they feel themselves to be more likely to be attacked by armed persons, are more likely to arm themselves.[8] In any case, it is clear that the arming decisions by the attacker and by the victim are *not* independent of each other.

The question can also be asked about the choice of weapon by the attacker since a weapon other than a gun is possible. The data for this, which is a division of the prior data, is again taken from Table 1. As may

be seen, offenders use other weapons about as frequently as they use guns. These other weapons may include knives or other sharp objects as well as clubs or other blunt objects.

By treating this data as a contingency table with two degrees of freedom, χ^2 values of 293.48 and 39.09 are found for the 1979–1987 and 1991 data, respectively. The 1 percent significance level is a χ^2 value of 9.21 so both are highly significant. Thus, again there appears to be a relationship between the criminal's decision to be armed and the victim's decision about having a gun.

It is also feasible to combine the gun category for the attacker with the other weapon category to see if there is a relationship between the attacker's being armed with any weapon and the victim's having a gun. This is not presented as a separate table because it is just a modification of Table 1, but again there is a strong and highly significant correlation. The χ^2 values (with the Yates correction) are 240.37 and 34.19, where 1 percent significance is a value of 6.64. This tends to confirm Cook's proposition (1981, p. 69) that "The economic value of a gun in robbery tends to be greatest against ... well-defended targets." Interestingly, if only the data where the criminal does NOT have a gun is considered, there is still a strong correlation between the attacker's decision to use some other weapon and the victim's decision to be armed.

It is also useful to look at other victim responses to a robber. If the victim does not have a gun, there are still some responses available to her. For example, the criminal may be attacked or threatened either with some other weapon or with no weapon, the victim may attempt to escape, or the victim may verbally engage the attacker. Table 1, in columns 2 and 3, looks at these cases where the victim does not have a gun (or is not able to use it).

It can be seen that the victim who does not have a gun is far more likely to take some form of action if the attacker does not have a gun than if the attacker does have a gun. The χ^2 values for that contingency table are 919.49 and 66.91 as compared to a 1 percent significance figure of 9.21. Again, there is a strong effect. It would seem to follow that the criminal who is seeking to have victims comply with his demands would be well-advised to use a gun. On the other hand, it also appears that victims who are confronted with a weapon other than a gun are more likely to resist in some way than if they are confronted with no weapon. If the cases where the attacker has a gun are compared with those where he has no weapon at all, the χ^2 values are 189.48 and 11.18. They are significant at the 1 percent level, so it can be inferred that unarmed victims are more likely to resist unarmed attackers than they are to resist attackers armed with guns.

The total number of cases where the victim is armed with a gun (and is able to use it) were relatively small compared to the total number of attacks. As seen in the sample in Table 1, there were only 536 armed victims while there were 42,265 victims who were either unarmed or were unable to use their guns in the 1979–1987 sample. That is, 1.25 percent were armed (and able to use their guns). In the 1991 sample, there were 41 armed victims and 4559 who were unarmed, a percent armed of 0.89 percent. These percentages are not significantly different at the 1 percent level, although they do differ at the 5 percent level. It may be that the risk incurred by the attacker that his victim will be armed with a gun is falling over time. If future data show this to be correct, it would follow that a certain increase in the willingness of criminals to commit crimes could be expected since the potential risk to the criminal of harm from the victim would be reduced.[9]

Even if only 1 percent of potential victims can be expected to be armed with guns, that is a real risk to the criminal since he does not generally know *which* people will be armed. According to *Criminal Victimization in the United States* (Bureau of Justice Statistics, 1992, p. 5), there are some 6.6 million crimes of violence each year. That would imply that in from 59,000 to 83,000 cases each year, victims use their guns to fight off attackers. This is lower by a factor of about thirty than the results reported by Kleck and Gertz (1995).[10] It may well be that in numerous cases where a person showed a gun to an apparent attacker, the attacker backed off and the *NCVS* would not show that a crime had been committed. The intended victim might well be unsure that a crime had, in fact, occurred. If the question were asked in a different way, these defensive uses could be more likely to show up. It may be because Kleck and Gertz asked the question differently than the government did that they got the much larger numbers of self-defense uses. They asked specifically whether the respondent had used a gun in self-defense while the *NCVS* asked only what the respondent did without mentioning the possibility of gun use.[11]

The more probable it is that a person will be armed, the greater the likelihood that an attacker will end up being injured or killed by the person he attacks. If it is obvious who is armed as it would be if people openly carried guns, the attacker could simply avoid those who are armed and attack only those who are not. If he does not know who is armed, however, he confronts a risk every time he chooses to make an attack.[12] That risk depends on the proportion of people who carry concealed guns.[13] It can therefore be seen that each person who carries a concealed gun for defensive purposes raises the odds against the

criminal. This confers an external benefit on other potential victims much as a person's vaccination against some communicable disease benefits others who then have reduced exposure to the disease. It follows, if each person only considers her own benefit in carrying a concealed defensive gun, too few people will carry such guns. Of course, this presumes that there are no external costs to carrying a gun.[14]

The odds are generally different in the home of the victim than outside it. This follows from the fact that people are more likely to have a gun available in their homes than they are elsewhere. Some 35.0 percent of rapes, 9.4 percent of robberies, and 11.8 percent of aggravated assaults occur in the home of the victim.[15] Thus, most such crimes take place elsewhere and for guns to be an effective deterrent, it follows that enough potential victims must carry guns with them. Many state and local laws are aimed at deterring just such gun carrying by potential victims.[16]

The above cannot answer the question of whether arming potential victims will deter violent crime. Bayes Theorem implies that the probability of being a victim, given that one has a gun, multiplied by the probability of a potential victim having a gun is equal to the probability of being a victim, multiplied by the probability of having a gun, given that one is a victim. That is;

$$P(\text{Victim}|\text{Gun}) \cdot P(\text{Gun}) = P(\text{Victim}) \cdot P(\text{Gun}|\text{Victim})$$

The probability of being a victim is about 0.0146 (from above) and the probability of having a gun, given that one is a victim (from above), is about 0.0125. Because the attacker should generally not know which potential victims are armed, arming oneself should not affect the probability of being attacked. That would imply that the probability of being attacked, given that one has a gun, would equal the overall probability of being attacked, 0.0146. If that is true, it would follow from Bayes Theorem that the probability of a potential victim having a gun is just 0.0125 (1 in 80). That should not be interpreted as the proportion of the population carrying a gun, however, because the probability of being a victim varies widely.[17] This is somewhat lower than the results given by Cook and Ludwig (1997) who found that about 5 million adults are carrying guns daily (4 million for employment purposes and 1.1 million otherwise). That is about 2.6 percent of all adults. Kleck and Gertz (1998) found about 7.7 million adults carry guns on any given day. That is about 4 percent of all adults. These figures are inconsistent if those who are at greatest risk are more likely to be armed. Some of these people are armed with unconcealed guns such as the

0.6 million police officers; they may be thereby directly made safer since they are obviously more risky to attack. If the percent carrying concealed guns is close to the 1.25 percent computed above, this could be confirming data. On the other hand, the data showing higher percentages of adults carrying guns would seem to imply that the proportion who use guns for self-defense in the *NCVS* is actually too low; there are more self-defense uses than shown there. If 3.3 percent of adults are armed (averaging the two studies cited) and they are armed because they are twice as likely to be attacked, it follows that self-defense uses are more than five times the number estimated by the *NCVS*.

Now look at the number of times the attacker has a gun. In the sample taken in the period from 1979–1987, there were 4,189 attackers with guns, 9.8 percent of all attacks. In the 1991 sample, there were 530 attackers with guns, or 11.5 percent. The χ^2 value is 13.74, which is significant at the 1 percent level; criminals are increasingly using guns in their attacks.

Cash and property losses

An important question in the game played between criminals and victims is in the amount of losses experienced by the victims. Robbers, of course, want to maximize their net gains while the victims desire the minimization of their losses. It would be expected that the choice of actions by each would be intended to bring about the satisfaction of their goals.

With respect to cash and property losses it was presumed that the loss to the victim was related to the gain to the attacker. In the transfer of cash, the values were precisely equal. On the other hand, property losses to the victim may well exceed the gains to the criminal since the robber typically sells that property to another party for less than its value to the victim.

Table 2 shows the cases where the victim experienced cash losses in each of the circumstances for the defensive uses by the victim of gun, other action, or no action and by the attacker of gun, other weapon, or no weapon. In addition, the average losses for those who had cash losses are given. Thus, for example, in the 1979–1987 data set, there were 1,734 cases where the attacker had a gun and the victim took no action (from Table 1). In 33.10 percent of these, or 574 cases, there was a cash loss. It needs to be kept in mind that, in at least some of the cases, the principal objective of the attacker may not have been to take cash; it may have been desired to commit an assault or a rape, for example. Thus, in some of the cases where a

Table 2
Cash losses

Attacker choice	Victim choice			
	Gun	Take action	No action	Total
Sample numbers 1979–1987				
Percent with cash losses				
Gun	2.00	5.99	33.10	17.07
Other weapon	1.23	4.94	23.61	8.76
No weapon	1.79	5.30	28.77	14.33
Total	1.68	5.28	28.70	13.57
Average loss for those with losses				
Gun	213.0	215.4	282.0	268.9
Other weapon	675.0	146.6	134.8	141.5
No weapon	52.0	110.0	115.2	114.0
Total	244.1	127.9	138.9	136.3
Sample numbers 1991				
Percent with cash losses				
Gun	13.3	13.9	45.6	28.7
Other weapon	0.0	10.5	35.3	17.0
No weapon	14.3	12.5	48.9	28.6
Total	9.8	12.3	47.3	27.0
Average loss for those with losses				
Gun	2.5	107.0	300.2	249.3
Other weapon	–	75.0	168.5	127.4
No weapon	225.0	59.2	44.2	48.2
Total	113.8	67.0	84.0	79.6

cash loss was experienced, that may have only been a secondary objective of the attacker.

It is worth testing to see whether there were significant differences in these percentages. That will, presumably, be an important ingredient in both the attacker's choice of weapon and the defender's choice of behavior. One would expect that the prospect of a greater net yield would help to determine the robber's choice of weapon. Of course, the prospect of greater prison time for the use of a weapon would be a disincentive. On the other side, the prospective victim would be interested in minimizing her expected losses. The use of a gun has to be determined beforehand since, if it is not available, it cannot be used. There is a cost to carrying or having a gun available which is larger relative to the cost of a crime since only on rare occasions will a particular victim have occasion and ability to use it. The prospective loss amounts will, however, be a factor on the other side of that decision.

First, consider the possible situations from the attacker's point of view. If the victim has a gun and is able to use it, the probability is very high that the attacker will get no money. This is true for all possible choices by the attacker. The correlations among the three possible attacker choices have been tested by both the normal approximation to the binomial and by the χ^2 contingency table (with Yates Correction) and it has been found in both data sets that there is no significant difference in the outcomes. That is, it does not matter what choices the attacker makes with regard to his own weapon; if the victim has a gun and is able to use it, the probability of actually getting some money from the victim is the same—very low.

Now, do the same thing for the case where the victim does not have a gun, but does take some other action. There are no significant differences among the three outcomes in each data set. It does not matter whether the attacker has a gun, some other weapon, or no weapon; the probability of getting some cash is the same if the victim takes some action even though she does not have a gun. (These could include attacking or threatening the offender, reasoning or arguing with the offender, giving an alarm, or running away.)

The same analysis can be done for the case in which the victim does not resist. There were significant differences at the 1 percent level between the cases for the 1979–1987 data but the only significant difference for the 1991 data was between the non-gun

weapon and no weapon. In both cases, the lowest proportion of victims who actually part with cash do so when the attacker uses a weapon other than a gun. It would follow that the fiscally optimizing attacker would use either a gun or no weapon. Of course, some other factors of interest to the offender in his decision-making have not yet been considered; that will be done later.

Now, turn to the decisions by the victim. The first case to be examined is where the offender has a gun. Generally, the proportion of victims who lose money did not differ significantly between those victims who have a gun and those who do not but take some other action. The results were significantly different for those victims who take no action; they were much more likely to have monetary losses. This was true for both data sets.

Now, suppose that the attacker has some weapon other than a gun. The person who takes no action is more likely to lose money than is the person who either takes action or who has a gun. The difference between the cases of having a gun and taking some other action is either significant at the 1 percent level or close to it, depending on the statistical test chosen. In any event, there was again a clear increase in the probability of having a cash loss if one takes no action against an attacker armed with a weapon other than a gun.

Finally, consider the offender who is unarmed. The results were similar to the previous case. There was a significant difference between the victim who does not take any action and the one who does take action; the former were much more likely to lose cash. The difference between the use of a gun and the taking of some other action was generally not significant at the 1 percent level. Thus, in all cases, no matter what weapon the attacker has or even if he has no weapon at all, the taking of some action will significantly reduce the probability that the victim will lose some money. Having a gun generally does not reduce the probability significantly more than does taking some other action.

Since it does not depend very much on the opponent's actions for either party in terms of probability of a cash loss, the author looked at that decision using aggregated data. The first case was for the offender. From his point of view, there was very little difference in the proportion of successful robberies between having a gun and having no weapon although the difference was significant in the case of the 1979–1987 data. Having some other weapon, however, significantly reduces the proportion of people who actually lose cash. Based solely on this, his choice would be between having a gun and having no weapon. As noted above, other factors may also enter the decision.

What about the victim? In the 1979–1987 data, all of the choices differ significantly with some non-gun action reducing the probability of loss and having a gun reducing it further. In the 1991 data, the probability of suffering a cash loss was significantly reduced by taking action. Having a gun did not significantly further reduce the probability (this was due to the small data set—it did seem to reduce the probability somewhat).

It is also interesting to ask whether the probability of having a cash loss has changed over the years. This can also be tested by a contingency table. The result was highly significant; the proportion of victims who reported losing cash has increased from the 1979–1987 period to the 1991 period. It is unclear why this should be the case unless people are feeling more secure and are carrying more cash. That could well be the case inasmuch as the *NCVS* has reported that the rates of these types of crimes have been decreasing over the survey period.[18]

Next, look at the sizes of the cash losses which occur. For each of the decisions made by offender and victim, only for those cases where there are losses, the results are also shown in Table 2. The average losses are given for each group.

It is feasible to test for the significance of the differences between the groups in terms of their losses since the data computed also have the standard deviations of losses, although this is not shown in the table. It turns out that the sample size (especially for the victims with guns who lose money) was small enough that there was no significant difference (at the 0.01 level) between the losses suffered by victims in terms of their actions. If the victims take action, they reduce the probability of having a cash loss enough that there is little residual difference in the cash lost by those who still lose cash. Their savings come about through not having any cash loss rather than by reducing the amount of the loss.

On the other hand, the robber will get significantly (at the 0.01 level) more money if he uses a gun than if he uses no weapon. This was the case for both samples. It was also the case that in the 1991 sample, there was a significant gain in using a weapon of any kind. There was significance at the 0.02 level in the 1979–1987 data for the use of a gun over other weapons. When these results are combined with the results on the proportion of victims who actually lose cash, it becomes clear that the use of a gun is the most lucrative choice for the attacker.

Property losses

The next issue is on property losses other than cash. The data, it must be remembered, were self-

reported so the values given may well be more inaccurate than the values given for cash losses. In addition, the value to the person who steals the property is likely to be less than the value to the person who loses it since the robber will probably fence it for a fraction of its market value. This also neglects any sentimental value that may be placed on the property by the victim. Again, most of the victims do not lose any property. The results showing the proportion of victims who lost property is shown in Table 3.

From the offender's view, the probability of getting property from the victim is the lowest with a weapon other than a gun. This was significantly lower than either other choice and this was true for both samples. The use of a gun was significantly more effective than using no weapon only in the first sample. Note that this result is very similar to the result on cash.

Now consider the victim's point of view. She is significantly less likely to lose property if she takes some action or has a gun than if she does nothing. She is also significantly less likely to lose property if she uses a gun rather than taking some other action in the first sample, although this difference was not significant in the second sample. This, too, is in keeping with the results from the data on cash losses.

The next step is to look at the value of property losses for those victims who have such property losses. These data are also given in Table 3. Look first at the victim's choices. The only apparent significant effect was that the property losses were greater for victims who take some action other than with a gun in the first sample. Perhaps the reason for the victim taking the action is because the property she is protecting is more valuable. It cannot be known with certainty why this effect occurs.

There is, however, a set of strong results with regard to the criminal's choices. The amount of property loss increases as the instruments used by the attacker increase in effectiveness. The difference was significant at the 1 percent level in every case except in the move from no weapon to a weapon other than a gun in the second sample. This is an effect that should be expected since the cost to the criminal of the instrument used increases and necessitates the choice of more lucrative targets. Since the marginal target chosen was more remunerative, the average result computed here will be higher as well. This gives an incentive for the robber to use other weapons or a gun, but there may be other costs that reduce the utility of doing so. Since the gun or other weapon may not

Table 3
Property losses

Attacker choice	Victim choice			
	Gun	Take action	No action	Total
Sample numbers 1979–1987				
Percent with property losses				
Gun	4.67	8.07	23.01	14.13
Other weapon	4.91	6.94	20.23	9.67
No weapon	7.17	10.13	40.94	21.99
Total	5.78	9.23	36.65	18.94
Average loss for those with losses				
Gun	162.0	1567.0	1118.0	1247.8
Other weapon	1539.0	558.0	1114.0	811.1
No weapon	113.0	392.0	274.0	306.6
Total	492.1	507.8	384.8	423.1
Sample numbers 1991				
Percent with property losses				
Gun	13.33	9.36	26.21	17.36
Other weapon	0.00	6.28	19.41	9.71
No weapon	7.14	9.68	34.89	20.77
Total	7.32	9.07	32.42	18.87
Average loss for those with losses				
Gun	504.0	464.0	1396.7	1123.8
Other weapon	–	618.5	321.7	457.9
No weapon	500.0	383.3	437.0	423.2
Total	502.7	419.4	530.4	499.9

increase the probability of getting property, that also has to be taken into consideration. These results are very similar to the results for the cash losses. Again, it has to be kept in mind that, even though the figures for property losses are generally larger than the corresponding figures for the cash losses, the benefits to the attackers may be much smaller than the loss to the victim.

Table 4 gives the average losses including both cash and property for each strategy by attacker and victim. In this table, the average losses are for *all* victims rather than just for those who have losses. The results are, of course, much like the results from the earlier separate analyses. Looking first at the victim, it can be seen that there was a significantly (at the 1 percent level) lower expected loss if one takes action than if one does not. The loss was also reduced from the case of taking no action to having a gun in the earlier sample; the sample was too small to generate a significant result in the later data. There was no significant difference in the expected loss between taking a non-gun action and defending oneself with a gun.

Next, look at the attacker's decision. He will gain significantly more through the use of a gun than by either of the other methods. The use of a weapon other than a gun has an expected gain that was lower than the other two methods. (The difference was not significant between other weapon and no weapon in the later sample.) Other things being equal, therefore, it would seem that the offender would be more likely to want to use a gun while the victim would want to take some action, either with a gun or in some other way.

Injuries

An important consideration for both parties to these transactions is the issue of injuries. The victim wishes to avoid injuries for the obvious reason that she suffers the loss from them. The attacker may, if the attack is motivated by commercial reasons, wish to avoid injuries as well since the penalties, if he is caught, may be increased as the result of injuries to the victim. Further, the police may be more highly motivated to capture the offender if the victim has injuries and therefore increase the probability of capture. Either would increase the expected cost to the offender and thus reduce the expected net value. Of course, since these data include assaults and rapes, those particular injuries may be the actual motivation for the attacker; he gains utility from harming the victim.

Table 4
Total losses property and cash

Attacker choice	Victim choice			
	Gun	Take action	No action	Total
Sample numbers 1979–1987				
Percent of category with losses				
Gun	5.33	10.33	39.85	22.37
Other weapon	4.91	9.24	31.28	13.75
No weapon	8.07	12.06	54.44	28.38
Total	6.34	11.27	50.26	25.08
Average total loss for all in category				
Gun	11.8	139.4	350.6	222.3
Other weapon	84.0	45.9	120.0	62.2
No weapon	9.0	45.6	145.2	83.8
Total	32.6	53.7	165.8	93.3
Sample numbers 1991				
Percent of category with losses				
Gun	13.33	13.86	45.56	28.68
Other weapon	0.00	10.54	35.29	17.04
No weapon	14.29	12.50	49.08	28.62
Total	9.76	12.30	47.41	27.04
Average total loss for all in category				
Gun	67.5	58.3	502.9	266.6
Other weapon	–	46.7	121.9	66.2
No weapon	67.9	44.4	174.2	101.7
Total	47.9	46.2	211.8	115.8

Table 5
Injuries

Attacker choice	Victim choice			
	Gun	Take action	No action	Total
Sample numbers 1979–1987				
Numbers injured[a]				
Gun	6	145	116	267
Other weapon	6	628	241	875
No weapon	5	611	251	867
Total	17	1384	608	2009
Percent injured				
Gun	4.00	6.29	6.69	6.37
Other weapon	3.68	10.27	14.55	11.03
No weapon	2.24	3.28	2.12	2.83
Total	3.17	5.12	3.99	4.69
Sample numbers 1991				
Numbers injured[a]				
Gun	1	19	21	41
Other Weapon	–	74	19	93
No Weapon	–	74	27	101
Total	1	167	67	235
Percent injured				
Gun	6.67	7.12	8.47	7.74
Other weapon	0.00	16.59	11.18	14.81
No weapon	0.00	3.87	1.78	2.93
Total	2.44	6.36	3.46	5.11

[a] Injuries included here are rape, knife wound, bullet wound, broken bones, internal injuries, and knocked unconscious.

Table 5 presents the data from both samples for certain injuries.[19] These specific injuries include rapes, knife wounds, bullet wounds, broken bones, internal injuries, and being knocked unconscious. While they are not medically defined inasmuch as the survey respondents are not qualified to give such definitions, they do appear to be serious injuries. Both the numbers of injuries and the percent of victims in each category who receive them are given. The results were very similar to those found by Cook (1980) using earlier data, although he did not analyze the defensive use of guns.

First, consider the issue from the point of view of the attacker. There were significant (at the 1 percent level) differences in each of his choices for both data sets. He is least likely to injure the victim if he is unarmed and most likely to injure the victim if he is armed with a weapon other than a gun. Unless his objective is to injure the victim, he would be generally better off using either a gun or no weapon at all. The use of a gun was significantly more likely to result in injury than was an unarmed attack.[20] Kleck and McElrath (1991, p. 685) found, on the other hand, that the use of a gun by the (stranger) attacker was significantly less likely to result in victim injury than was either an unarmed attack or an attack with some other weapon. Their result, using more variables in a regression framework, takes more factors into consideration than does this study.[21] It turns out, however, there was a cost to using a gun but the financial gain to using a gun may outweigh that cost in the mind of the attacker.

On the side of the victim, the choice most likely to result in injury is to take action without a gun. This probability was significantly higher than the probability of injury when no action is taken. There was not the same significance between using a gun defensively versus taking some other action because the sample size was too small. The use of a gun versus not having a gun also results in no significant difference because of the small sample size.

Each of the choices available to the victim who has been attacked can also be studied. At that point, she knows what choice of weapons has been made by the offender. First, suppose that the attacker has a gun. Based on the data, there is no significant difference in the injury outcomes whether the victim

Table 6
Men and women defensive choices, sample 1979–1987

	Gun	Take action	No action	Total
Number making choice				
Men	456	15,696	7836	23,988
Women	80	11,342	7391	18,813
Percent making choice				
Men	1.90	65.43	32.67	
Women	0.43	60.29	39.29	
Number with injury				
Men	16	816	380	1212
Women	1	568	228	797
Percent with injury				
Men	3.51	5.20	4.85	5.05
Women	1.25	5.01	3.08	4.24

chooses to use her gun, take some other action, or to take no action.

If, however, the attacker has some other weapon, there were significant differences in the outcomes depending on the victim's response. The use of a gun by the victim significantly reduces her likelihood of being injured. This result was also found by Kleck and DeLone (1993). There was not as significant a difference between taking no action and taking some action other than gun usage. This may be important to the case where the attacker is doing so for the specific purpose of harming the victim as through rape or aggravated assault. Finally, if the attacker has no weapon, there were no significant differences in injury rates between the responses made by the victim.

One question that arises is whether victims who have guns are more likely to be shot during the commission of a crime. In the 1979–1987 sample, 121 victims were shot; of these, five had guns. In the 1991 sample, twenty victims were shot; of these, one had a gun. The difference was significant in the earlier sample only at the 5 percent level, but the greater level of gunshot wounds is more than offset by the reduced number of other injuries. The difference is not significant in the 1991 sample.[22]

It is often argued that the victim who is confronted with potential deadly physical force should cooperate with the attacker (see, for example, Zimring & Zuehl, 1986, p. 30). The use of a gun for self-defense, however, appears to reduce injury. Thus, it may well be that the choice of some potential victims to arm themselves does improve their safety. While Cook (1986, p. 417) points out that resistance may either result in greater or lesser harm to the victim, the results

above show that having a gun (and being able to use it) reduces harm to the victim.

Male and female victims

It is interesting to look at the ways in which male and female victims respond to their attackers. Table 6 shows the results for the 1979–1987 sample. Women were significantly less likely to have a gun than were men. They were also significantly less likely to take some positive action against their attackers.

Table 6 also reports the number of serious injuries received by those who choose each set of actions. The only significant difference here is in the likelihood of receiving an injury if one takes no action. Doing nothing, men were more likely to be injured than were women. This may account for some of the lower propensity either to have a gun or to take some other action among women; they may (accurately) view safety as being more achievable through inaction than do men. It may also be conjectured that the attacker, knowing that women are less likely to be a threat to them, will injure a man more readily so as to reduce a potential threat to themselves.[23] Either the use of a gun or taking some other action results in the same probability of injury to both sexes.

Table 7 is created to look at the differences in losses of cash and property suffered by men and women. Defensive gun usage results in a likelihood of loss that was significantly greater for men than for women. (The confidence level for this as well as for following statements was 1 percent). This was also true for taking some other action. Taking no action results in a likelihood of loss that was significantly greater for women

Table 7
Total losses property and cash, sample 1979–1987

Attacker choice	Victim choice			
	Gun	Take action	No action	Total
Men				
Percent of category with losses				
Gun	3.68	8.94	42.92	22.41
Other weapon	4.14	7.90	33.55	12.85
No weapon	6.29	9.54	46.42	22.75
Total	4.82	9.03	44.10	20.41
Average total loss for all in category				
Gun	10.6	113.4	275.0	173.7
Other weapon	84.6	39.7	120.4	56.8
No weapon	9.1	28.4	127.6	63.8
Total	33.6	39.9	148.0	75.1
Women				
Percent of category with losses				
Gun	21.43	13.12	34.00	22.29
Other weapon	11.11	12.54	26.80	15.91
No weapon	14.58	14.86	61.64	34.19
Total	15.00	14.38	56.79	31.04
Average total loss for all in category				
Gun	23.2	192.0	494.5	321.8
Other weapon	77.8	61.1	119.1	75.0
No weapon	8.9	64.7	160.9	104.3
Total	26.9	72.7	184.7	116.5

than for men. It was generally the case that the amounts lost are significantly greater for women than for men.

Next, consider the specific confrontations that may result. When the defender has a gun and the attacker has a gun, has some other weapon, or has no weapon, there was no significant difference between the injury probability or the loss probability between men and women. It would appear that having a gun really does result in equalizing a woman with a man.[24]

When the attacker has a gun and the defender does not, either taking action or not taking action results in women having a significantly lower probability than men of having a loss but no significant difference in the probability of being injured. This may help to account for the fact that fewer women than men have guns available.

When the attacker has some other weapon, taking action results in a significantly greater probability of loss for women than it does for men while taking no action results in a significantly greater probability of loss for men than for women. The probability of injury did not significantly differ by sex.

Finally, when the attacker has no weapon, women are at significantly greater risk of having a loss than are men, whatever they choose to do. Women, however, had a significantly greater probability of injury than men if they take action. This may be due to the

fact that, generally, women are physically less strong than men and would lose more physical confrontations with their attackers.

The game[25]

It is now useful to recap these results so that it can be seen how the actors are making their choices in this game. Prior to their encounter, the attacker has to decide what weapon to use, if any. Also, the potential victim has to decide whether to have a gun available because, if it is not available when the encounter takes place, it will not be possible to use that response.

The attacker may have either of two objectives, or some combination of them. Either his objective is commercial and he wants to gain as much profit from the encounters as possible or his objective is to harm the victim, perhaps as revenge for some other act or to gain pleasure from that action. Suppose first that his object is personal profit. Then, he will want to choose either to be armed with a gun or to have no weapon at all. The former has some additional costs for him; he may run a risk of greater penalties by using a gun as well as having the direct cost of having the gun in the first place.

Table 8
Clearance rates

	1980 (%)[a]	1991 (%)[b]	1991/1980 (%)
Robbery			
Gun	22.80	19.90	87.28
Other weapon	24.46	26.08	106.63
No weapon	24.60	27.40	111.38
Aggravated assault			
Gun	54.30	45.40	83.61
Other weapon	57.87	57.84	99.94
No weapon	64.30	64.60	100.47

[a] Data from 1980 Uniform Crime Reports, p. 185.
[b] Data from 1991 Uniform Crime Reports, p. 208.

Consider Table 8. This shows the probability of the offender being caught in two specific years; the first is one year after the start of the first data set and the second is the year of the second data set. This table shows that the probability of a robber or assaulter who uses a gun being caught has declined by 12.7 percent and 16.4 percent, respectively. At the same time, the robber or assaulter who uses no weapon now has a greater chance of being caught. This fact, along with the greater yield to robbers who use guns, will tend to induce an increase in the proportion of offenders who use guns. From Table 1, it can be seen that the proportion has increased from 9.8 percent to 11.5 percent over the period covered by the two samples. The difference was significant at the 1 percent level.

Using data from several tables, the ratio of gun-using attackers to those who use no weapons has risen from 13.65 percent in the earlier data to 15.40 percent in the later sample. At the same time, the ratio of the yields in the two cases to the attacker in terms of property and cash lost by the victim was, in the earlier sample, 2.653. That fell modestly in the second sample to 2.621. This result seems to imply that the marginal benefit to the offender of using a gun has remained relatively stable relative to the marginal benefit of using no weapon. This may, in part, be due to the fact that fewer of the victims have guns or take other actions in the later sample.

Now, take a look at the strategy for the potential victim. It is not appropriate to make the assumption that the choice of action or whether to have a gun is independent of the potential loss since that is clearly not the case. As found earlier, those people who are more likely to be attacked by people with guns are themselves more likely to be armed in self-defense. This can be seen to be a reasonable response to a higher probability of attack since (a) the probability of a loss is lower if the victim has a gun, (b) the expected loss is lower if the victim has a gun, and (c) the probability of serious injury is lower if the victim has a gun. These conclusions are all based on an attack by a person who has a gun.

What about the case where the victim is attacked by a person who does not have a gun but has some other weapon? While having a gun seems to reduce the probability of having a fiscal loss, the average loss is higher for victims who have a gun than for those who take some other action. As noted above, it cannot be known whether this is due to the probable fact that people who have more to be stolen may well be more likely to have guns for defensive purposes. The other consideration is injuries; the victim is less likely to be harmed if she has a gun than if she takes some other action. It would seem, therefore, that having a gun would dominate the choices available to a potential victim in this case.

The final case is where the attacker has no weapon. This is referred to as "strong-arm" in the case of robbery; it may refer to purse snatching or similar type of robbery by threat or strength or it may involve more prolonged contact as in simply beating up the victim by dint of strength or skill in martial arts. The proportion of injuries is significantly lower for victims who have and are able to use guns. Again, it would seem that the best choice for the victim is to have a gun available.

The foregoing does not apply any cost to the victim's having a gun. In this costless situation, it would be expected that most of the victims would be armed. Yet this is not the case; in fact, most victims apparently do not have guns.[26] It should be noted that the having of a gun is self-reported; if it is illegal for the victim to have a gun, she will be less likely to report having had one during the incident. This point is noted as well by Kleck and Gertz (1998) who report that many of the people who actually carry guns are not licensed to do so. Further, if a victim has a gun but is unable to use it, it might be expected that the victim would class this as a case where no self-defense use of a gun was made.

A person is not a victim until she is attacked. The probability of any individual being attacked is fairly low and, according to the *NCVS*, falling. Given the fact that there is at least some nuisance cost to having a gun available, especially when out of one's home, it would be expected that not all people would choose to have a gun available for self-defense. Further, there are legal barriers to having a self-defense firearm available in many jurisdictions.

Another factor of importance in the availability of a gun is whether the victim is at home or not. In most cases it is easier to have a gun available at home both because it does not have to be carried on one's person and because the laws governing possession are generally less restrictive at home. At home, a person is more likely to have a long gun (rifle or shotgun)

available than they would away from home because of the difficulty associated with carrying it. In terms of both ease of use and safety in self-defense use, since the attacker has a more difficult time in taking it from the victim, the handgun is probably more effective, although the long guns are more deadly. State and local laws tend to be much more restrictive in regard both to handgun ownership and to carrying of handguns. The result is that the cost of the handgun to the defender is increased.

Another cost of having a gun available is in its potential for misuse which brings harm on the family which owns it. In 1994, there were 1356 accidental deaths from gunshot (see Table 137 in the 1997 *Statistical Abstract*). At the same time, there were some 95,988,000 households in the U.S. (see Table 73 in the 1997 *Statistical Abstract*). Of these households, some 41 percent had guns (see Table 2.75 in the 1996 *Sourcebook of Criminal Justice Statistics* of the Bureau of Justice Statistics (a)). It follows that the probability of an accidental death from a gun is 0.0000345. According to Kleck (1991, pp. 271–274), some 17.7 percent of these deaths are actually misclassified suicides and homicides. Correcting for these would reduce the probability to 0.0000287. The relationship of total injuries to deaths in shootings may be as high as 7 to 1.[27] That would imply a probability of injury by accident of 0.0002. Compare this with the probability of being a victim of a violent crime, which, as noted earlier, is about 0.0148 or about seventy-four times as high. The probability of reduction in serious injuries from crime can be computed as 0.000228 in the 1979–1987 sample and 0.0004 in the 1991 sample. Thus, there is still a substantial *net* reduction in injury probability for the average person.[28]

Of course, those who are less likely to be attacked than the average will gain less protection and would be less likely to desire to carry guns.

At the same time, the handgun is also more utilitarian to the attacker since he will usually not be in his own home and will need to carry his weapon of choice with him to the encounter. Thus, it might be expected that the legal restrictions would also increase his costs; to the extent that he takes the probability of being caught and punished into account and to the extent that the expected punishment increases with his use of an illegal firearm (it would be foolish to use a licensed handgun which would increase the probability of being caught), this would be a cost he would/should be expected to consider.

Table 9 is created for the purpose of computing the added risks to the offender of having a gun with respect to expected punishments. The data in this table are from around 1990 and show the expected sentences for various crimes. The number of weapons crimes was computed by multiplying the numbers of each crime by the percentage which are done with a gun, resulting in an inferred 1,000,295 gun crimes. The expected maximum sentence for each crime was computed as the arrests per crime times convictions per arrest times percent incarcerated times the average maximum sentence. Then, this was further multiplied by the average percent of the sentence that was served. The result for the gun crime is an expected incarceration of 0.20 month. If it is further presumed that half of the cases have the sentence for the weapons charge served concurrently with another charge, this would reduce the expected sentence to 0.10 month per gun offense, or about three days.

The difference in expected gain to an attacker with a gun compared to one with no weapon is $138.50 in

Table 9
Prison risks to criminal

Crime	Rape	Robbery	Aggravated assault	Weapons
Crimes[a]	130,260	1,149,710	1,600,670	
% Guns[b]	48.3	40.6	29.4	1,000,295
Arrests[c]	39,160	167,990	475,330	221,200
% Arrest/crimes	30.1	14.6	29.7	22.1
Convictions[d]	18,024	47,446	53,860	20,733
% Convictions/arrests	46.0	28.2	11.3	9.4
% Incarcerated[d]	86.0	90.0	72.0	62.0
Average maximum sentence[d]	128	97	52	34
Average % time served[e]	55.6	46.3	47.5	46.7
Expected sentence	8.46	1.67	0.60	0.20

[a] *Sourcebook of Criminal Justice Statistics 1991* (Bureau of Justice Statistics, p. 266).
[b] *Sourcebook of Criminal Justice Statistics 1991* (Bureau of Justice Statistics, p. 308).
[c] *Crime in the U.S. 1990* (Federal Bureau of Investigation, p. 174).
[d] *Sourcebook of Criminal Justice Statistics 1993* (Bureau of Justice Statistics, pp. 536–537).
[e] *Prison Sentences and Time Served For Violence* (Greenfield, 1995, p. 1, BJS).

the earlier sample and $164.90 in the later sample. As long as the opportunity cost of time to the offender is under about $46 per day in the earlier time period and $55 per day in the later time period, it makes sense for him to use a gun. Of course, it is necessary to factor in the cost of the gun as well. If a gun has a street price of $100, it can be expected to be used for about four times before the user is caught. Suppose that results in a 60 percent probability of losing the gun. Then the per use cost of the gun is about $15. That will not affect the decision very much. It would in this case reduce the needed opportunity cost of time for the offender to $31 per day in the earlier sample and $40 per day in the later sample.[29] It needs to be stressed that these figures were only approximate and there should be little confidence placed in their precise values; the method, however, is valid and with better data could result in more precise estimates.

Arming potential victims

Suppose that more of the victims had guns. What would the effects of this be on crime? In order to answer this question, suppose that 10 percent of the victims who were not armed but took some action and 10 percent of the victims who took no action were all armed with guns and were able to use them in self-defense. (The 10 percent is simply an arbitrary figure). It will be assumed that each of these persons will carry the same amount of valuables that those who were already armed with guns carried. Since people who do not currently carry guns probably carry smaller amounts of cash and property with them as a form of self-insurance, this would imply that they would carry more when they are armed. Consequently, this may result in an over-estimation of the losses that these people would suffer if they were to be armed with guns.[30] The means by which more potential victims would be armed could be due to lower governmentally imposed costs such as registrations, purchase delays, taxes, or regulatory costs passed on to the consumer. Then, those who are next most likely to be attacked after those who are currently armed would be the incremental ones to arm themselves. This would not be a random sample of citizens, of course. It would be necessary to have the proportion of citizens who are armed be substantially less than 10 percent in order to have 10 percent of the victims be armed. It would also be necessary to increase the number of people who carry guns by more than 10 percent, however, to accomplish this result.

Tables 1 and 4 can be used to compute how the losses would be changed under the posited changed circumstances.[31] These results are given in Table

Table 10
Losses and injuries if more victims were armed

Attacker choice	Actual	More armed	Difference
Sample 1979–1987			
Average total loss			
Gun	222.26	201.21	(21.04)
Other weapon	62.15	64.34	2.18
No weapon	83.76	76.29	(7.48)
Total	93.31	86.30	(7.01)
Percent with injuries			
Gun	6.37	6.14	−3.72
Other weapon	11.03	10.30	−6.66
No weapon	2.83	2.77	−2.07
Total	4.69	4.54	−3.24
Sample 1991			
Average total loss			
Gun	237.21	220.23	(16.97)
Other weapon	33.00	29.70	(3.30)
No weapon	77.01	76.10	(0.92)
Total	89.46	86.37	(3.09)
Percent with injuries			
Gun	7.74	7.63	−1.38
Other weapon	14.81	13.33	−10.00
No weapon	2.93	2.64	−10.00
Total	5.11	4.84	−5.23

10. The "Actual" column of Table 10 is the same loss results given in Table 4 for the actual samples. The "More Armed" column is what the results for those samples would have been if 10 percent of those victims who did not actually have guns were to have had guns.[32]

First, consider the choice of the individual who is considering committing a criminal act. The average yield in the earlier sample would have dropped from $93.30 to $86.30, a drop of 7.5 percent. In the 1991 sample, the drop is from $115.80 to $110.10, or 4.9 percent. This means that criminal activity generally would be less lucrative so there would be less incentive to commit criminal acts.[33] This should not be strictly compared to the presence/absence of guns among attackers as considered above; rather it is a productivity measure to the attackers. There are other incentives not to be armed among attackers, such as added prison terms. This simply reduces the gain to a gun and thereby reduces the number of criminals who would rationally choose to be armed.

Second, consider the choice of a criminal who is unarmed as to whether or not to have a gun. The current benefit in the 1979–1987 sample is $138.50, the difference between the yield if he has a gun and the yield if he is unarmed. With more of the victims having guns, the net yield falls to $124.90, a drop of 9.8 percent. In the 1991 sample, the actual yield was

$164.90. It would have fallen, had more victims been armed, to $148.40, a drop of 10.0 percent.

The result of this is that, if more victims have guns, the incentive for a criminal to have a gun falls as well. This is contrary to the standard perception that if more victims are armed, more criminals will also be armed. The fact is that it would not be to their financial benefit to do so. The gain of $138.50 did not induce all criminals to have guns in the 1979–1987 sample so there must have been other costs associated with having a gun. The reduced incentive due to the smaller gain assumes that these other costs would not be reduced.

It needs to be noted in this context that there is no data on injuries to the criminal attackers. Of course, any such injuries are generally valued negatively neither by the victims nor by society generally (except in paying any hospitalization costs). The criminal, however, may well be concerned about this and it may affect his decision about having a gun.[34] If it were the case that having more of the potential victims armed had no effect on the probability of injury to the criminal (which seems unlikely), it would then be the case that this factor would have no effect and criminals' incentives to be armed would be reduced if more victims were armed.[35]

Another question relative to the arming of potential victims is how it would affect their injury rates. Using the same set of serious injuries as in Table 5 and the same presumption that 10 percent of the actual unarmed victims were to have guns, this is analyzed and presented in Table 10. The proportion of victims with serious injuries would have fallen in the 1979–1987 data set from 4.69 percent to 4.54 percent, a drop of 3.24 percent. In the 1991 data, the proportion would have fallen from 5.11 percent to 4.84 percent, a drop of 5.23 percent. It may be conjectured that a factor causing the higher actual rate of serious injury in the 1991 data set is that fewer of the victims had guns than in the earlier data set.[36]

It follows that there is a social gain to having more of the potential victims possessing guns. This gain is not fully captured by the individual since the reduced level of crime and the lower likelihood of criminals being armed will also benefit those potential victims who do not choose to have guns. Lott and Mustard (1997) also find that increased arming of potential victims reduces the incentive to commit crimes.

Of course, people are currently making individually optimal choices of whether to be armed or not. Their choice factors include not only their potential injuries and losses but also the costs they face. Since many states impose substantial costs on the possession of guns (for example, it takes over eight months to receive a handgun permit in New York

State as well as requiring the expenditure of over $200), fewer people will choose to be armed. Recently, several states have reduced these barriers (costs) with the result that more potential victims, ceteris paribus, will choose to be armed.

Conclusion

This study has looked at the decisions by potential victims and by criminal offenders about the use of guns for attack and for defense, as well as the use of other weapons by offenders and the taking of other actions by defenders. It was found that gun usage by defenders is correlated with gun use by offenders. This is to be expected since those with more to lose or a greater risk of being attacked would be more likely to arm themselves and their attackers, knowing this, might similarly be inclined to be armed.

The cash losses and property losses by victims of crime were analyzed and it was found that either the victim's taking other actions or having a gun reduced the probability of actually suffering a loss. This was found to be independent of the choice of weapon for the attacker for the probability of cash losses but the amount of loss suffered by the victim was higher if the attacker used a gun. Similar analyses were done for property losses with similar results. Guns or other actions acted to reduce victim loss probabilities but the amounts of losses were more affected by the choices made by the attacker. Overall, either taking some other action or using a gun worked best for the victim in reducing losses. For the attacker, the optimum commercial choices would be either no weapon or the use of a gun. Other weapons may be preferred if the object is to inflict injury without killing the victim.

The next step was to look at the serious injuries which occurred. Victims received more injuries if they took some other action than if they used a gun or did nothing. Their attackers caused the lowest rate of injury if they did not use a weapon but caused the highest rate of injury if they used a weapon other than a gun. Thus, it followed that the best choice for the victim is to use a gun and for the money-motivated attacker is either to use a gun or to use no weapon.

The differences between men and women in their reactions to being attacked were also analyzed. Women are less likely to have guns but, if they do, will have the same probability of injury or probability of loss that men do. If they do not have guns, women are less likely to take some action than are men and this appears to be a rational choice given the relative likelihoods of injury and financial loss.[37]

The next stage in the analysis was to look at this game with the additional factors of the cost to both

the offender and the potential victim of carrying a gun. Since there is such a cost for both, the choice for the potential victim may be optimally found as any of the three strategies. It may be worthwhile to carry a gun if the probability of being a victim is large enough or the potential loss is sufficiently large. Given that many people will still choose not to carry a gun, the reduction in the expected loss accompanied by the increase in the probability of injury may induce victims to choose either to take some other action or not, depending on their own utility functions. The attacker will, if he is optimi-zing his receipts, choose either to use a gun or no weapon, depending on his weighing of the apparent likelihood of extra prison time for gun usage against the extra payoff for having a gun. The attacker who is interested in harming his victim will tend to choose a weapon other than a gun. It appears that the opportunity costs of the criminal's time are about what would be expected, given the actual choices made.

The final step in the analysis was to look at what the results in terms of both losses and injuries would have been in both data sets if more of the victims had been armed. It was found that potential victims who choose to carry guns provide an external benefit to the class of potential victims. They reduce the probability that the attacker will get anything from a particular crime and therefore reduce the attractiveness of that crime to the criminal. Further, they reduce the amount of gain that can be expected from that crime. Since there are costs to the potential victim in carrying a gun, it follows that too few guns will be carried for a social optimum.

Acknowledgments

Notes

1. See, for example, Loftin et al. (1991) and Kellerman et al. (1993). Their statistical procedures are invalid. Kellerman et al. purport to create a control group which, it turns out, differs in many important (and biased) respects from their sample population while Loftin et al. compared results from two states with the District of Columbia while neglecting factors in which they differ in numerous uncontrolled ways. See Kates et al. (1995) for the analysis of numerous such medical studies.

2. Of course, this does not apply to having a gun for recreational purposes. Generally, long guns are for recreation while handguns are for self-protection, although there are overlaps in both directions. The ownership of a gun does not imply that it is for self-defense, although it may sometimes be useful in such a situation.

3. Of course, some people find practice with a gun gives them a positive utility.

4. Also, other sources have substantially accurate data on these crimes. Further, homicide victims cannot be interviewed.

5. There are some minor differences in the format of the questionnaire, as filled out by the interviewer, across the two periods. For our purposes, the only substantive difference is in the question regarding defensive use of a weapon. In the earlier sample, the question was whether a gun was "used or brandished" against the attacker, while in the second sample the question was whether the offender was "attacked or threatened" with a gun. It seems unlikely that this made a difference in how the form was filled out. The actual question asked of the victim was "What did you do?" which did not change. It is possible, however, that differences in results do occur as a result of this interviewer difference, so changes over the two time periods should be interpreted with caution.

6. The choice of how to categorize a crime is highly arbitrary. If an assault is accompanied by a robbery, is it primarily an assault or primarily a robbery? The true answer depends on the motive of the attacker, which can only be inferred by the person doing the categorization. In the attacks studied in this study, it is only the attack and consequences which matter rather than the crime category. The report is made by the victim and the categorization is made by the researcher.

7. The data are the actual sample results. As a result, they may not be a random sample accurately reflecting the overall population; they would have to be weighted to accomplish that. The objective here, however, is to see what happened to a set of people who were attacked and who chose different responses to the attack. It is also the case that interviewees who may have been armed but who did not use their guns in response to the attack are not counted as users of guns in self-defense.

8. This can be thought of as having a rational expectations basis where it is expectations which govern decisions.

9. Kleck (1988, p. 17) argues that gun ownership among potential victims has a substantial inhibiting effect on criminals' willingness to commit crimes.

10. Possibly, people are reluctant to tell a government interviewer about gun use. Kleck (1991, p. 106) earlier had estimated about 1 million defensive uses of guns annually. Cook and Ludwig (1997, p. 9) found as many as 4.7 million defensive uses annually, although they believe there are actually fewer such uses. Mauser (1996) estimates about 750,000 such uses and finds the Canadian rate to be somewhat smaller but in the same range. See Kleck and Gertz (1995) for more extensive discussion of the differences with the NCVS.

11. Even in Kleck's surveys, it is probable that self-defense uses of guns are underreported, especially by people who do not legally carry the guns. It may mean the safety improvement found in this study is understated if there is under-reporting in the data used since the question at issue is the results of such defensive gun uses. Unreported uses are likely to have been even more successful than those reported since they would have less in losses and fewer injuries for the defender.

12. Alternatively, the attacker could exercise more caution in making the attack. Either way, the attack is more costly in his own terms if the victim has a higher probability of being armed.

13. If the attacker knows the potential victim, he may know as well whether the potential victim is armed and therefore may make a decision on his attack based on that information.

14. It is sometimes argued that armed civilians are more likely to attack others in a momentary fit of anger, but the evidence on licensed gun carrying does not support this.

15. Data from *Sourcebook of Criminal Justice Statistics, 1991* (Bureau of Justice Statistics (b), p. 264).

16. While a number of states have laws which allow the concealed carrying of guns, there are others which do not as well as localities even in the former states which restrict it severely.

17. It is also the case that the survey results are subject to bias, given that it may be illegal for some defenders to carry guns.

18. Rape has declined from 1.8 to 1.0 per 1000 population from 1979 to 1990, Robbery declined from 6.3 to 5.7, and Aggravated Assault declined from 9.9 to 8.4, *Criminal Victimization in the U.S.: 1973–90 Trends,* (Bureau of Justice Statistics, 1992, pp. 19, 25, 39).

19. Cook (1985, p. 94) argues that the number of bullet wounds is understated in the surveys. This may also be true for other injuries or bullet wounds may be deliberately misclassified as other injuries but there is no reason to believe that there is a systematic bias that will affect the results herein.

20. Cook (1987) notes that gun robberies are also more likely to result in the victim's death than are non-gun robberies. On the other hand, he uses FBI data rather than *NCVS* data and also does not analyze injuries as done here.

21. They also report on a number of other studies that appear to show that the use of weapons by attackers result generally in reduced injury to the victim. These other studies also show, as does this one, that the use of a gun results in lower injury than does the use of some other weapon.

22. It is the case that people who were killed by an attacker are not included in the sample. Generally, the ratio of people injured but not killed by gunshot to the number killed is about 3.3 (see Table 3.144 in the *1995 Sourcebook* (Bureau of Justice Statistics (b)). That would suggest that two people should be added to the injuries list over the two periods. At the same time, about thirty-five other people who did not use guns for defense would also have died. These figures would not change the conclusion.

23. Zimring and Zuehl (1986, p. 17) find, using a different sample, that females are less likely to be killed in a robbery than are males, which may be seen as added confirmation of this point.

24. The sample of women who are attacked and have guns is too small to test for a significant difference in the probability of being raped. The average probability of rape, given an attack on a woman, is about 1 in 80. In the sample only eighty women with guns were attacked and one was raped. If none had been raped, the difference would still not be significant.

25. Taylor (1995) has formally developed a game theoretic model that comes to many of the same conclusions theoretically as are found empirically in this study.

26. Because the defensive gun use is reported only if the victim reports it, those victims who have guns but do not use them either because they are unable to do so or because they are unwilling to do so will not be included as having guns

for defensive purposes; they are treated by this study as though they were unarmed.

27. See Wintemute and Wright (1992, p. 556). Mercy and Houk (1988) argue for 5 to 1. The *1995 Sourcebook of Criminal Justice Statistics* (Bureau of Justice Statistics (b)), Table 3.144, gives a ratio of 4.4 to 1, but does not include gunshots which are not treated at a hospital.

28. The effect on the probability of death is less clear. Generally, based on the relative likelihood of serious injury, it also appears that having a gun also reduces the net (average) probability of death.

29. Raising the street price of the gun would also reduce the incentive to use a gun, although that has been unsuccessfully tried already.

30. Note that the population of people who are currently armed differs from the general population in the likelihood of being attacked by an armed robber and, therefore, probably in the amount of expected losses.

31. These results make the assumption that the loss of cash and property to the victim is equal to the gain to the criminal.

32. More than a 10 percent increase in the number armed would be necessary. Further, because the people who are currently armed for self-defense are generally those who have more to lose, the reduction in losses would be greater than is assumed in this analysis. Thus, this section results in an underestimate of the effects to be expected.

33. Kleck (1986, p. 47) argues that increased gun ownership among potential victims reduces the incentive of criminals to commit crimes due to an increased probability of being harmed; this has not been considered in the present study.

34. Cook (1979, p. 755) notes that "the fear of some victims' ability to defend themselves should be considered when analyzing deterrents to robbery."

35. Since it is usually illegal for the victim to use deadly physical force when she is not in imminent danger, it may be optimal for a criminal who faces or expects to face armed victims to be unarmed so as to reduce the threat to himself.

36. Kleck and Sayles (1990) and Kleck and DeLone (1993) also found that victim resistance using guns reduced injuries among victims.

37. It might be possible to look at age and income as other factors affecting outcomes since both are related to gun ownership, although non-linearly. (See *Sourcebook of Criminal Justice Statistics, 1994* (Bureau of Justice Statistics (b)), Table 2.64). It is difficult, however, to determine the age and income of the person to whom the incident happened so this was not done.

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