Do Guns Cause Crime? Does Crime Cause Guns? A Granger Test

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Sixteen time series measures of crime and deaths from guns are used along with 16 measures of sales and stocks of guns in the U.S. to test for causality using Granger Causality tests. Both per capita and link-relative measures are used. The results indicate that suicide appears to result from the presence of guns and gun accidents are reduced by familiarity with guns but generally neither murder nor other crimes are affected. It appears that more causal relationships are from crimes to gun ownership than from gun ownership to crimes. (JEL K10)

Introduction

This paper looks at the issue of how gun availability affects crime and gun deaths in the U.S. It is alleged by both proponents and opponents of gun control that having more gun availability affects the amount of crime committed. Of course, the two sides differ on the direction of the effect. Gun control advocates believe that reducing gun availability will reduce crime because criminals will have reduced access to a tool of their trade [e.g., Cook, 1990, p. 145]. They also argue that ready gun availability induces otherwise law-abiding people, in moments of strong emotion, to commit criminal acts [e.g., Drinan, 1990, p.61]. Opponents of gun control believe that armed citizens reduce criminals' incentive to commit crimes due to larger potential penalties for crime (being shot) [e.g., Wright and Rossi, 1986, ch. 7]. They also doubt that gun availability causes ordinary people to commit crimes.

Unfortunately, neither side has really done the solid empirical research necessary to determine the direction of the net effect, if there is any such net effect. Instead, each side argues with the fervor of religious conviction that it is correct and that the other side is morally wrong. The objective of this paper is to look empirically at the issue. The study will not be model based; that will await a later paper. Consistency with standard economic theory will, however, be considered throughout.

Guns are preferred tools for many criminals. Victims are more compliant with demands of attackers, stronger potential victims can be attacked, and the average take from a personal crime is greater for the criminal with a gun than for the criminal without [Southwick, 1995]. On the other side of the ledger, the expected sentence for the commission of a crime may be greater for the criminal who has a gun when committing

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a crime than it is for the one who does not. There are not much good data on whether the rate of catching and convicting criminals depends on whether they have guns. However, such crimes are more likely to be reported to the police and, therefore, would plausibly be more susceptible of solution. In any case, making guns more available or less expensive for a given quality will probably induce more criminals to use them. Alternatively, making guns more expensive to obtain will probably reduce criminals' incentive to use them. An important empirical question is, thus, the price elasticity of criminal gun usage.

On the other side is the usage of guns by potential victims to defend themselves. Depending on the source, there are from 80,000[1] to 2,500,000[2] defensive gun uses per year in the U.S. These defensive uses as well as the potential threat posed to criminals by armed victims should reduce the incentive for criminals to commit crimes. The extent of this effect, its elasticity, has not been estimated. In order to ascertain the crime-reducing effect of arming citizens, one needs to determine this effect's magnitude. Then find out how elastic the public's demand is for guns. If guns are made more difficult (expensive) to obtain, to what extent will that reduce the prevalence of gun ownership among potential victims? Further, how would reduced gun ownership by potential victims affect criminals' choices?

For the equilibrium amount of crime to be reduced through making guns more difficult or expensive to obtain, several results must occur. First, criminals must choose to have fewer guns and, either consequently or simultaneously, choose to commit fewer crimes. The latter would seem unlikely in the short run since having fewer guns will reduce the yield to any particular crime. Maintenance of a criminal's standard of living would, therefore, require the commission of more crimes. Over time, this problem would be resolved with fewer persons choosing to enter the crime business. In the short run, however, crimes could be expected to increase.

The second effect is potential victims choosing to have fewer guns as well. This could increase the incentive for the commission of crimes since unarmed victims are more likely to part with their valuables to an attacker than are armed victims. Of course, potential victims would also respond by carrying fewer valuables or by using other self-defense mechanisms. Because there would only be a partial replacement effect, this effect would tend toward an increase in crime and an added inducement for people to enter the crime business. The empirical question is whether the first or the second effect predominates. This is the case both for the short run and for the longer term when entry and exit from the field can occur.

One way to check on these effects is to observe later effects after initial effects on gun ownership have taken place. That is, how is crime affected by the level of gun ownership and how is gun ownership affected by crime? The latter is likely to be at least partially the result of crime. As more crimes or more visible crimes occur, people will tend to feel less safe and will be more likely to arm themselves. Based on that hypothesis, gun ownership will tend to lag the crime level. Of course, gun ownership also has recreational value, as in target shooting or hunting which would induce gun ownership as well.

Criminals would only be able to commit gun-related crimes if they have guns available. Since gun availability for everyone could imply gun availability for criminals as well, the crime level would tend to lag gun ownership. Naturally, it would be desirable to allow noncriminals to have guns while forbidding them to criminals. However, efforts in this direction have been less than successful.

These two hypotheses are not necessarily in conflict. They could both be correct simultaneously. Increased gun availability could result in increased crime which, in turn, could result in more guns being bought by potential victims and, thus, resulting in greater gun availability. Depending on the magnitudes of the effects, this could result in an ever-increasing spiral of guns and crime or it could result in some stable equilibrium level. If this model was correct, introducing an external factor to reduce either the guns or the crime would result in either the lowering of guns and crime in a downward spiral or to a new lower equilibrium level. The advocates of such interventions would seem to have such a model in mind, at least implicitly, as the source of their advocacy.

On the other hand, suppose that only the hypothesis that people buy guns in response to crime is correct and that general gun availability does not affect crime on balance. Since people are unlikely to expend resources on items which do not succeed in their objective, guns must be effective against crime. An external intervention which reduces gun availability will result in increased crime in equilibrium. This results because the crime-reducing effects of guns in the hands of the public will be lowered, crime will become more profitable, and more people will enter the crime business.

Finally, suppose that gun availability only benefits criminals. One would expect no link from crime causing the increased purchase of guns by potential victims since it would do them no good. Greater gun availability would reduce the costs of being a criminal, increase the yields to crime, and induce entry to the profession. An intervention to limit guns would then reduce crime unambiguously.

Data Used

The use of leads and lags to test these potential causalities is the essence of this paper. On the gun availability side, eight time series are used. These are annual sales and total numbers available for each of handguns, rifles, shotguns, and total guns. Another eight series are created. The numbers of guns available in 1945 and the net number sold in the U.S. each year come from the Bureau of Alcohol, Tobacco, and Firearms (BATF) [1994] which collects the data. It can be presumed, as BATF usually does, that guns are nondepreciable (do not wear out). Of course, BATF does not have data on the number of guns made by individuals for their own use or those smuggled into the country. It only has information on licensed manufacturers and legal imports. The stock of guns in any year equals the stock in the prior year plus sales in that year. In this paper, two alternative series are created for each type of gun. These make the presumption that 2 or 5 percent of the existing stock of guns are destroyed or rendered unusable in each year. The stock of guns in each year equals 95 or 98 percent of the prior year's stock plus the

new sales. The result is 16 time series on guns which end in 1993. The stocks series begin in 1945 and sales begin in 1946.

On the crime side, there are also several time series. Some come from the Federal Bureau of Investigation's (FBI) *Crime in the United States* (*Uniform Crime Reports*), the numbers of crimes based on reports to police beginning in their current form in 1960 (except for Murder, which begins in 1957). Others come from the *Criminal Victimization in the United States* series [Bureau of Justice Statistics], a set of surveys beginning in 1973 of victimizations of a representative sample of people. The crimes included are Murder, Rape, Robbery, Aggravated Assault, Burglary, Larceny, and Car Theft. The Larceny series ends in 1992 while the others go through 1993. In addition, Homicide, as reported in *Vital Statistics of the U.S.* from 1945 to 1992, will also be included since the figures differ from the Murder figures presented by the FBI. Also presented there are Suicide and Accidental Gun Deaths. Thus, there are 16 series on the outcomes of interest. This includes the four on deaths by Murder, Homicide, Suicide (1945-91), and Accidental Gun Deaths (1946-91). Then, there are 12 series on nonfatal crime including two on each of the following six crimes: Rape, Robbery, Aggravated Assault, Burglary, Larceny, and Car Theft.[3] Because the population level has changed over the years in question, all of these series have been normalized by population so crimes and numbers of guns are on a per capita basis. Because there are so few deaths, relatively, they are computed per 1,000 population.

The results expected from these tests are the effects of gun availability on crime and the reverse. From them, it should be possible to predict the effects of policies which make guns more or less difficult to obtain. The test used is Granger Causality.

Granger Causality

The first step in testing for Granger Causality is to take the dependent time series as a function of lagged versions of itself. Since the periodicity of the time series which are available is annual, this is the only periodicity available for testing. The variable is initially run against its lagged version as, for example:

$$X_t = a_0 + a_1 X_{t-1} . \tag{1}$$

Then, the variable is regressed against two lagged versions as:

$$X_t = a_0 + a_1 X_{t-1} + a_2 X_{t-2} . \tag{2}$$

The choice is made between these two equations depending on some criterion. The criterion used here is the Akaike Information Criterion which asks whether the second equation adds information to the first [Judge et al., 1985, pp. 870-1].[4] Next, if the second equation is preferred by that criterion to the first, another lag is added. That is:

$$X_t = a_0 + a_1 X_{t-1} + a_2 X_{t-2} + a_3 X_{t-3} \quad (3)$$

is run and again is tested. In this paper, these tests are run for lags of up to five periods. That allows the result to be an equation including from one to five lagged versions of the series. This was first done for each of the 16 series on guns and the 16 series on deaths and crime.

It is often considered to be better to detrend each series before doing the foregoing. In this case, that is done by taking the link relatives of each series. If X_t is the original series, let $Z_t = X_t / X_{t-1}$. The link relative equals one plus the fractional change from year to year. The coefficient from a regression then is the elasticity. This method is used to create another series for each of the 32 series named above. Thus, there are ultimately 64 time series with 32 on guns and 32 on deaths and crimes.

The second step in the Granger Causality test is to take the equation estimated earlier for each of the time series and add the lagged version of the series for which the causality is in question. If this adds information according to the Akaike Criterion, the question is next asked whether the coefficient is significant and, if it is, whether it is positive or negative. Suppose, for example, that the equation for the original series was as in (1) with one lag. The new estimate is done as:

$$X_t = a_0 + a_1 X_{t-1} + b_1 Y_{t-1} . \quad (4)$$

If there is no information added by the term $b_1 Y_{t-1}$, it is an indication that there is no causality from Y to X. If the coefficient b_1 is not significant, the causality will not be considered significant [Judge et al., 1988, pp. 767-70].

Murder and Homicide

This is usually the major focus of any look at crime and guns, probably because it is the most feared crime. There are four sets of regressions with the FBI's Murder series and the Vital Statistics' Homicide series both in per capita and link-relative forms on one side and the 16 measures of gun availability on the other in per capita and link-relative terms.[5] Of course, per capita series are matched with per capita series and link-relative series are matched with link-relative series. The causalities are tested in both directions, from guns to deaths and from deaths to guns. There are, therefore, 128 regressions in this set.

The first results are for FBI Murder as dependent on Guns. In none of the per capita regressions does the addition of any Gun variable add information to the regression according to the Akaike Criterion. Thus, Guns, by any of 16 measures, have no effect on Murder. The time series for Murder contains all of the information which is included in both series. Next, the same is done for Murder as a link relative as a function of Guns as a link relative. In none of the 16 regressions does the Gun variable add any

information to the equation. Thus, in both tests, there is no causal relationship found from Guns to Murder.

Next, let Homicide be the dependent variable. There are 16 regressions with Homicide as a function of Guns. In only five of these is significant information added by the Gun variable. These are: Handgun Sales (+ significance at the 10 percent level); Rifle Stock 5 percent depreciation(- significance at the 5 percent level); Shotgun Stock (+ significance at the 5 percent level); Shotgun Stock 2 percent depreciation (+ significance at the 10 percent level); and Shotgun Stock 5 percent depreciation (- significance at the 10 percent level). Three are positive and two are negative. The fourth set of 16 regressions is of the link relative of Homicide as the dependent variable. In none of these is information added by the Gun variable. There is no effect of Guns here on Homicide.

In the other direction, consider the effect of Murder or Homicide on the level of Gun availability. First, look at the effects of Murder on Guns. Of the 16 regressions, eight add information and have significant coefficients, all in the positive direction. These include: Rifle Stock, 1 percent level; Rifle Stock 2 percent depreciation, 1 percent level; Rifle Stock 5 percent depreciation, 1 percent level; Shotgun Stock, 10 percent level; Shotgun Stock 2 percent depreciation, 5 percent level; Gun Stock, 5 percent level; Gun Stock 2 percent depreciation, 1 percent level; and Gun Stock 5 percent depreciation, 1 percent level. It appears that the risk of Murder is an inducement to own long guns (rifles and shotguns) but apparently the effect on hand gun ownership is not significant.[6] Next, look at the same variables as link relatives. There are only two out of the 16 regressions where there is a significant effect. These positive effects are Rifle Stock at the 10 percent level and Rifle Stock 2 percent depreciation at the 5 percent level. These are less powerful results than the ones above but are more likely to be valid since the time trend has been removed through the use of the link relative.

The second set of variables has the Gun level as a function of the Homicide Rate. In the case of the per capita regressions, 14 are significantly positive out of the 16 regressions. Significant at the 5 percent level are the following: Hand Gun Sales; Hand Gun Stock; Hand Gun Stock 2 percent depreciation; Hand Gun Stock 5 percent depreciation; Rifles Sold; and Guns Sold. Significant at the 1 percent level are: Rifle Stock; Rifle Stock 2 percent depreciation; Rifle Stock 5 percent depreciation; Shotgun Stock; Shotgun Stock 2 percent depreciation; Gun Stock; Gun Stock 2 percent depreciation; and Gun Stock 5 percent depreciation. These results strongly suggest an effect from Homicide to Gun ownership.

Finally, the same set of variables, taken as link relatives, are again regressed. In 11 of the 16 regressions, the effect is significantly positive. Significant at the 5 percent level are: Hand Gun Stock; Hand Gun Stock 5 percent depreciation; Rifles Sold; Guns Sold; Gun Stock; Gun Stock 2 percent depreciation; and Gun Stock 5 percent depreciation. Significant at the 1 percent level are: Hand Gun Stock 2 percent depreciation; Rifle Stock; Rifle Stock 2 percent depreciation; and Rifle Stock 5 percent depreciation.

Overall, in the regressions from Murder and Homicide to Gun ownership, the results are significantly positive in 35 out of 64 possible cases. While not conclusive, this does seem to point to an effect of Murder or Homicide on Gun ownership. At the same time,

the regressions from Gun ownership to Murder or Homicide were significant in only five out of 64 possible cases and two of these were negative effects. There appears to be no effect from Guns to Murder or Homicide.

If people buy more guns in response to increased risk, they must expect their ownership of guns to help protect them. However, there is no significant effect flowing from the guns to reducing Murder and Homicide. How can that be squared with a rational expectation for people buying guns? There are two possible answers. The first is that there are two simultaneous effects. First, some people acquire guns for criminal purposes while other people acquire guns for self-protection. Both the criminal uses and the self-defense uses must work. Apparently, however, these effects just about cancel each other out, resulting in no net effect. The second possible answer is that increased gun ownership does work to protect those who own the guns. However, criminals turn from those who are protected to those who are not. The latter have increased risk as the result of others being safer. If the latter rationale is correct, potential victims who acquire guns are safer and those who do not have more risk. Then, those who do not want guns for self-defense wish to limit the ownership of guns for all people to make themselves safer. Those owning guns oppose such limitations since they gain safety from their ownership.

Suicide and Accident

The next area is deaths due to suicide. Clarke and Lester [1989] found some substitution of alternative methods if a method of suicide is removed. If so, the removal of guns could reduce gun suicides but increase other suicides. Thus, the interest here is in the total number of suicides rather than only the gun suicides. Data on Suicides are presented in *Vital Statistics of the U.S.*. The first step is to see the effect of Guns on Suicide, measured on a per capita basis. Out of 16 regressions, 11 are significant in the positive direction. Significant at the 10 percent level are: Hand Gun Stock; Hand Gun Stock 2 percent depreciation; Rifle Sales; Rifle Stock; Shotgun Stock; Shotgun Stock 2 percent depreciation; Gun Stock; and Gun Stock 2 percent depreciation. Significant at the 5 percent level are Hand Gun Stock 5 percent depreciation and Gun Sales. Finally, significant at the 1 percent level is Hand Gun Sales. There does appear to be an effect of Gun availability on Suicide.

Next, the 16 link-relative regressions are run. Only three of the Gun variables add information and are significant. These are all at the 10 percent level in the positive direction and are all measures of the stock of hand guns: Hand Gun Stock, Hand Gun Stock 2 percent depreciation, and Hand Gun Stock 5 percent depreciation. Overall, this makes the picture much less clear. It does appear that Hand Gun availability leads to increased Suicide. However, the other Gun variables are less well-linked, having only seven significant coefficients out of 24 possible.

On the other side, one can ask whether increased Suicide leads to alterations in Gun availability. On a per capita basis there are eight coefficients which are significant in the positive direction and eight which do not add information or are not significant. Those significant at the 10 percent level are: Hand Gun Stock 5 percent depreciation; Rifle Stock

5 percent depreciation; Shotgun Stock 5 percent depreciation; and Gun Stock 2 percent depreciation. The two significant at the 5 percent level are Rifle Stock 2 percent depreciation and Shotgun Stock. The two significant at the 1 percent level are Shotgun Stock 2 percent depreciation and Gun Stock 5 percent depreciation. This seems odd since one might expect Suicides to induce a desire for people to reduce the lethal instruments available in their homes while exactly the opposite apparently happens. The better measure, as before argued, is the link relative since it has been detrended. In this case, out of 16 regressions, none adds information with a significant coefficient. That tends to indicate that Suicides do not influence people's decisions about having Guns.

The other issue in this section is Gun Accidental deaths. The data are from *Vital Statistics of the U.S.*. On a per capita basis, in 12 of 16 possible cases, the result is a significant negative effect. In none of the measures of sales of Guns does the variable add information. In the cases of the Rifle Stock 5 percent depreciation and the Shotgun Stock 5 percent depreciation, the coefficients are significant at the 5 percent level. In the other 10 cases, the coefficients are significant at the 1 percent level. It appears that having Guns available increases the familiarity with them and *reduces* their risk. However, consider the results from using the link relatives. Out of 16 regressions, only four add significant information. These four all are positive. Significant at the 5 percent level are Hand Gun Sales and Rifle Sales, while Shotgun Sales and Gun sales are both significant at the 1 percent level. None of the stock variables adds significant information. Apparently, it is new buyers of Guns who are most at risk for accidents, perhaps because of their unfamiliarity with Guns. These two sets of results can lead to the inference that Gun safety is a function of the owner's familiarity with Guns. It suggests the possibility that more and improved education of new or future Gun buyers would make them safer.

Now consider the effect Gun Accidents have on Gun availability. It might be thought that news of Gun Accidents would induce people to think twice about Gun ownership. First are 16 regressions using per capita measures. In only two cases do the coefficients add significantly to the information available. In the case of Rifle Stock 2 percent depreciation, the coefficient is significantly negative at the 5 percent level, while, in the case of Shotgun Stock, the coefficient is significantly positive at the 5 percent level. Overall, there is little apparent effect. This may be similar to the experience with car ownership, where each person feels himself to be a safer driver than are other people. Finally, look at the effect Gun Accidents have on Gun availability with both sets of variables as link relatives. Of the 16 coefficients, nine are positive and significant. These include, at the 10 percent level, Hand Gun Sales and Shotgun Sales. At the 5 percent level are Hand Gun Stock 2 percent depreciation and Gun Sales. Significant at the 1 percent level are: Hand Gun Stock; Hand Gun Stock 5 percent depreciation; Gun Stock; Gun Stock 2 percent depreciation; and Gun Stock 5 percent depreciation. Why Gun Accidents would lead to increased Gun purchases or ownership is difficult to explain.

Rape

Next, consider the serious, nonfatal crimes. First is Rape, widely regarded as the most serious crime after Murder. There are two measures of the number of Rapes, a crime which is often not reported to authorities by victims. The first measure is those known to authorities, as reported annually by the FBI in *Crime in the United States*. The first set of 16 regressions has Rape dependent on Guns on a per capita basis. Out of 16 coefficients, six add information and are significant, all in the positive direction. Significant at the 10 percent level is Gun Stock 5 percent depreciation, while four coefficients are significant at the 5 percent level: Hand Gun Stock 5 percent depreciation; Shotgun Stock 2 percent depreciation; Shotgun Stock 5 percent depreciation; and Gun Stock 2 percent depreciation. Shotgun Stock is significant at the 1 percent level. This is relatively weak evidence of a positive causality. Next are the same variables, recomputed as link relatives. There are no coefficients which add significant information. That suggests there is no causal relationship from Guns to Rape.

The second measure of Rape is from *Criminal Victimization in the United States*, annual since 1973 [Bureau of Justice Statistics]. This survey asks randomly selected people whether they have been the victim of a crime and particulars about any crimes in which they have been victimized. It is hoped that people will be more forthcoming about crimes perpetrated upon them in this survey than they are in reporting to the police. This is, however, still a government survey so there may still be some reluctance to report fully. The first use of this measure of Rape is on a per capita basis. Out of 16 coefficients, only the four on Sales measures are significant, all in the positive direction. Hand Gun Sales and Shotgun Sales are significant at the 10 percent level, while Rifle Sales and Gun Sales are significant at the 5 percent level. Next, the same variables are recomputed as link relatives. Again, the Sales measures are all positively significant but Stock measures add no information. Hand Gun Sales is significant at the 5 percent level, while Rifle Sales, Shotgun Sales, and Gun Sales are all significant at the 1 percent level.

It is difficult to explain why Sales of Guns appear to increase the incidence of Rape when the Stocks of Guns has no effect. It is also difficult to reconcile the FBI measure results with the victimization survey results. The former indicates some influence from the Stock of Guns, while the latter only has an effect from the Sales of Guns. Inasmuch as rapists use firearms in only about 4 percent of all cases and no weapon is used in over 80 percent of cases [U.S. Department of Justice, *Sourcebook of Criminal Justice Statistics*, 1994, Table 3.13], the presence or ownership of guns would seem to be helpful, in general, primarily to potential victims. Of course, if the victim cannot use the gun, it will not be helpful to have it.

From the above, one would not expect to see much effect of Rape on the purchase or ownership of Guns since they appear to exert little influence on preventing Rapes. However, look first at the per capita measure of Rapes from the FBI data. Some six of 16 coefficients are significant and add information; all six are positive. These include Rifle Stock at the 5 percent level and, at the 1 percent level: Hand Gun Stock 5 percent depreciation; Rifle Stock 2 percent depreciation; Rifle Stock 5 percent depreciation; Gun

Stock 2 percent depreciation; and Gun Stock 5 percent depreciation. Next, the same variables' link relatives are used. In none of 16 regressions is there a significant addition of information due to the Rape variable.

The next step is to again compute the per capita regressions using the victimization measure for Rape. The results of the 16 regressions show only Shotgun Stock 2 percent depreciation with a significant (positive) effect at the 10 percent level. When the link relatives of these variables are used, there are only two out of 16 results which are significant, both negative. These are Hand Gun Sales at the 10 percent level and Hand Gun Stock at the 5 percent level. Overall, out of 64 regressions with Gun measures as a function of Rape measures, nine are significant, seven of which are positive and two are negative. This hardly is a strong indication that Rape has an effect on Gun availability or ownership.

Robbery

The next crime is Robbery, the attempted taking of something of value by force or threat of force. It involves personal confrontation between criminal and victim. There may or may not be an intention to physically harm the victim but that possibility or threat is a part of the robbery.

First, look at the effect of Guns on the occurrence of Robbery on a per capita basis using the FBI data for Robbery. In all 16 regressions, there is no case where there is any information added by the Gun variable. The second test set uses link relatives on the same data and, again, there is none of the 16 regressions which adds information. Third, look at the data from the Crime Victimization Survey on a per capita basis. Once again, in the 16 regressions, there is none which adds significant information. Finally, using the data in link-relative form, the same 16 regressions are run, again with no significant information added by Gun variables in any of the regressions.

It must be concluded that Robbery is not affected, on balance, by Gun availability. Of course, it may be that increased arms for criminals are just balanced by increased arms for victims. In turn, that would imply that laws intended to keep increased Guns from going to criminals are doing no better now than they have in the past. The best protection in most cases of Robbery on the street is a Hand Gun since other types of Gun are more difficult to carry for defense purposes. At home or in a business, other types of Guns are more readily used.

Then look at the effect of Robbery on Guns. Even if there is no net effect of Guns on Robbery, it does not mean that in individual cases there is no incentive to acquire a Gun. Both criminals and potential victims may desire them. First, look at the per capita effect of Guns on Robbery. In four of the 16 regressions there are significant effects, all in the positive direction. At the 5 percent level are Rifle Stock and Gun Stock 5 percent depreciation. At the 1 percent level are Rifle Stock 2 percent depreciation and Rifle Stock 5 percent depreciation. These seem to suggest that people may own more Rifles as the result of increased Robbery. The same data can also be used with the detrended link

relatives. The results of these 16 regressions are that no significant information is added by the Robbery variable.

Next is the Criminal Victimization data on a per capita basis. In 16 regressions, there is none in which Robbery adds significant information to the Gun variable. Finally, consider the same variables on a link-relative basis. In these 16 variables, only one has a significant effect. That is a positive effect on Hand Gun Sales, significant at the 10 percent level. Overall, it appears that there is little effect of Robbery on any of the Gun variables. Only five of the 64 regressions have a significant effect (all in the positive direction). This tends to indicate that potential victims do not perceive arming themselves to be an effective option to reduce their likelihood of being robbed. After all, what are the odds that a person who sometimes chooses to be armed will, during that time, be attacked by a robber?

Aggravated Assault

The next crime is Aggravated Assault, the most serious category of Assault. This is an attack by one person on another for the purpose of inflicting bodily injury. The attacker presumably gains utility from the injury to the other person. In some cases, the attack may be a by-product of Robbery or another crime. A Robbery may also be a by-product of an Assault. The concern here is to ascertain whether the presence of Guns increases the number of Aggravated Assaults and whether Aggravated Assaults lead to increased Gun possession.

The first test is 16 regressions from the FBI's data on a per capita basis. In none does the Gun variable add significant information to the regression. Using link relatives of these data yields 16 more regressions with the same result; no information is added. The third set of regressions uses the Crime Victimization data on a per capita basis. There is only one case with a significant coefficient and added information. That is Shotgun Stock 5 percent depreciation, which is negatively significant at the 10 percent level. Finally, using these data on a link-relative basis yields three cases with significant coefficients and added information. Significantly positive at the 5 percent level is Gun Sales, while Rifle Sales and Shotgun Sales are positively significant at the 1 percent level. Overall, there are four significant results out of a possible 64. Of these, three are positive and one is negative. It would seem, therefore, that there is no significant effect of Guns on Aggravated Assault. This makes sense inasmuch as this crime is typically committed with personal weapons (fists, feet, and the like) or blunt instruments rather than guns.[7]

Next, look at the effect of this crime on the choice to have Guns. A person may reasonably believe that a Gun will help in defense against a person who is attacking with personal weapons. Usually, however, the potential victim is concerned about attack from specific persons rather than about the general level of Aggravated Assault. First, consider the FBI data on a per capita basis. Out of 16 coefficients, four add information and are significant, all in the positive direction. These include, at the 5 percent level, Gun Stock 2 percent depreciation and, at the 1 percent level, Rifle Stock, Rifle Stock 2 percent depreciation, and Rifle Stock 5 percent depreciation. Using the same data on a link-

relative basis yields no significant coefficients with added information out of 16 regressions.

Next, is the Crime Victimization data, first on a per capita basis. Again, out of 16 regressions, there is no significant information added. The final set of 16 regressions uses these same data on a link-relative basis and, again, there are no significant coefficients with added information. The end result here is that Aggravated Assault results in no apparent increases in Guns. There were only four significant coefficients, all positive, out of a possible 64.

Burglary

Burglary is a crime of stealth, the illegal entry of a structure to commit a theft. The burglar does not intend to confront the victim but rather to steal the victim's property. The usual purpose is a gain for the burglar; the victim's loss is incidental. The most likely reason for more Guns to affect Burglary is if criminals switch operations from Robbery to Burglary. They might do so if there is a greater likelihood of being shot by armed victims due to the increase in Guns. However, armed homeowners might be a disincentive if the burglar does not know with certainty that the home is unoccupied.

First, consider Burglary as measured by the FBI on a per capita basis. Of 16 regressions, 14 add information and have significant coefficients. Four are significant in the positive direction, including Gun Sales at the 10 percent level, Rifle Sales and Shotgun Stock 5 percent depreciation at the 5 percent level, and Shotgun Sales at the 1 percent level. In the negative direction, Rifle Stock 5 percent depreciation is significant at the 10 percent level. Also in the negative direction at the 5 percent level are: Hand Gun Stock; Hand Gun Stock 2 percent depreciation; Hand Gun Stock 5 percent depreciation; Rifle Stock; Rifle Stock 2 percent depreciation; Shotgun Stock; Gun Stock; Gun Stock 2 percent depreciation; and Gun Stock 5 percent depreciation.

It appears that Gun Stocks negatively influence Burglaries, although Gun Sales may positively influence them. Using the same variables with link relatives results in no cases out of 16 regressions where information is added. The third step is per capita data from the Crime Victimization Survey. Out of 16 regressions, 12 add significant information, three of which are positive and nine are negative. Positively significant at the 5 percent level are Shotgun Sales and Gun Sales, while Rifle Sales is significant at the 1 percent level. Significantly negative at the 10 percent level are Rifle Stock, Rifle Stock 2 percent depreciation, Shotgun Stock, and Gun Stock 5 percent depreciation. Significantly negative at the 5 percent level are: Hand Gun Stock; Hand Gun Stock 2 percent depreciation; Hand Gun Stock 5 percent depreciation; Gun Stock; and Gun Stock 2 percent depreciation. Again, as in the case of the FBI data on a per capita basis, the sales seem to increase Burglary while stocks decrease Burglary. Finally, using the same variables on a link-relative basis results in no cases out of 16 regressions where significant coefficients resulted with information being added. Since it seems likely that the link relatives are better measures due to their detrending, it would seem that there is little evidence of any substantial effect of Guns on Burglary.

Now turn to the effect of Burglary on the level of Guns. First, using the FBI data on a per capita basis, of 16 regressions there is none which adds information and is significant. When the link relatives are used instead, there are two out of 16 regressions with significant results. These are positively significant at the 5 percent level, Rifle Stock and Rifle Stock 2 percent depreciation. Next is Victimization data, first on a per capita basis. Again, none of 16 regressions adds information with a significant coefficient. The same is true of the same variables on a link-relative basis. Overall, since only two out of 64 regressions indicate significance, it would seem that there is no causal relationship between Burglary and Guns. That makes sense if people do not expect Guns to deter Burglary, an apparently realistic expectation.

Larceny

Larceny is the theft, generally by stealth, of goods, presumably to benefit the thief. There is no force or violence used. Again, there are two measures, from the FBI and from the Victimization Survey. There seems little reason to expect any effect of or on Guns.

First are per capita effects from the FBI data. Out of 16 regressions, four add information and are significant, all in the positive direction. At 10 percent significance are Rifle Sales and Gun Sales, while at 5 percent significance are Shotgun Sales and Shotgun Stock 2 percent depreciation. Using the same variables in a link-relative format yields 10 out of 16 coefficients which add information and are significant, all positive effects. Significant at the 10 percent level are: Hand Gun Stock 5 percent depreciation; Rifle Stock; Gun Stock 2 percent depreciation; and Gun Stock 5 percent depreciation. Significant at the 5 percent level are: Hand Gun Stock; Hand Gun Stock 2 percent depreciation; Shotgun Stock 2 percent depreciation; Shotgun Stock 5 percent depreciation; and Gun Stock. Finally, Shotgun Stock is significant at the 1 percent level. Overall, it appears that increases in the availability of guns result in increases in the amount of theft. That may well represent a turning from Robbery to Larceny as a rational choice on the part of the criminal who wishes to avoid being harmed by armed victims.

Next are the data collected by the Victimization Survey. The results for 16 regressions on a per capita basis are nine significant coefficients, one of which is positive while the other eight are negative. Positively significant at the 10 percent level is Rifle Sales, while negatively significant at the 10 percent level is Rifle Stock 2 percent depreciation. Significant at the 5 percent level, all negative, are: Hand Gun Stock 5 percent depreciation; Rifle Stock; Shotgun Stock; Gun Stock; and Gun Stock 2 percent depreciation. Negative significance at the 1 percent level is found for Hand Gun Stock and Hand Gun Stock 2 percent depreciation. Using the same data in link-relative format yields no information added in any of 16 regressions. Overall, if there is greater confidence in the link relatives, it would appear that there are no strong results. Since some of the data yield results in one direction while the other data yield some results in the other, it is difficult to conclude very much as to the effect, if any, of Guns on

Larceny. However, there may be some positive effect as criminals change to less risky crimes.

What about the effect of Larceny on Guns? It would seem that, since little or no effect is found the other way and since Guns are probably ineffective against most Larcenies, little effect would be expected. First, using the FBI data on a per capita basis, of 16 coefficients, only one adds significant information. Shotgun Sales is negatively significant at the 10 percent level. Using the FBI data on a link-relative basis results in none of 16 coefficients adding significant information. Using the Victimization data on a per capita basis results in only one out of 16 coefficients adding significantly. Shotgun Stock 2 percent depreciation is positive at the 1 percent level. On a link-relative basis, none of the 16 coefficients adds information and is significant. Overall, it would appear that there is no effect of Larceny on Guns.

Auto Theft

This category includes the theft or attempted theft of a motor vehicle. Auto Theft is not included in Larceny. Usually those who engage in Auto Theft for commercial reasons differ from those who engage in Robbery since the skills differ somewhat, especially in converting the stolen objects into cash. Thus, there would seem to be little spillover from any effects of Guns on Robbery to an effect on Motor Vehicle Theft.

Begin with the FBI data on a per capita basis. There are seven out of 16 coefficients which add data and are significant, all positive at the 10 percent level. They are: Hand Gun Stock; Hand Gun Stock 2 percent depreciation; Hand Gun Stock 5 percent depreciation; Rifle Stock; Shotgun Stock; Gun Stock; and Gun Stock 2 percent depreciation. With the same data on a link-relative basis, none of the 16 coefficients adds information. Using the Victimization data, only one out of 16 coefficients adds significant data. Shotgun Stock 5 percent depreciation is negatively significant at the 10 percent level. With the same data on a link-relative basis, none of the 16 coefficients adds information and is significant. Overall, there would seem to be little evidence of an effect of Guns on Motor Vehicle Theft.

Looking at the opposite effect, there would seem to be little reason to expect much effect. Out of 64 regressions tried, there are only five significant coefficients. These are Rifle Stock 2 percent depreciation and Rifle Stock 5 percent depreciation, both from FBI per capita data and both positive at the 5 percent level. From the Victimization per capita data, Shotgun Stock 2 percent depreciation is significantly negative at the 5 percent level, Gun Stock is significantly positive at the 5 percent level, and Gun Stock 2 percent depreciation is significantly positive at the 10 percent level. None of the link-relative coefficients adds significant information. The conclusion is that there seems to be no effect of Motor Vehicle Theft on Guns.

Summary

Using significance at the 10 percent level (two-tailed tests), the above results can be summarized in tabular form. Looking only at measures of Gun Sales yields Table 1. In each cell there are four possible positive or negative results, indicating that information was added by the relevant variable and that the coefficient which resulted was significant in the positive or negative direction. In terms of outcomes being caused by Gun Sales, there are 29 positive results out of a possible 128. The most likely influences are on Suicide (three positive out of eight possible), Gun Accident (four positive out of eight possible), Rape (eight positive out of 16 possible), Aggravated Assault (three positive out of 16 possible), Burglary (six positive out of 16 possible), and Larceny (four positive out of 16 possible).[8] In the other direction, where deaths or crimes cause gun sales, there are 12 significant results, 10 positive and two negative, out of a possible 128. The most likely influences are Murder or Homicide (five positive out of 16 possible) and Accidents (three positive out of eight possible).

TABLE 1
Sales

	Per Capita		Link Relative	
	Guns Cause	Cause Guns	Guns Cause	Cause Guns
Murder	0	0	0	0
Homicide	1+	3+	0	2+
Suicide	3+	0	0	0
Accident	0	0	4+	3+
Rape	0	0	0	0
Rape Victim	4+	0	4+	1-
Robbery	0	0	0	0
Robbery Victim	0	0	0	1+
Aggravated Assault	0	0	0	0
Aggravated Assault Victim	0	0	3+	0
Burglary	3+	0	0	1+
Burglary Victim	3+	0	0	0
Larceny	3+	1-	0	0
Larceny Victim	1+	0	0	0
Auto Theft	0	0	0	0
Auto Theft Victim	0	0	0	0

Table 2 summarizes the results where the variables of interest are gun stocks of one measure or another. Each cell in Table 2 has the possibility of having up to 12 significant coefficients. In terms of outcomes being caused by Gun Stocks, there are 38 positive results and 43 negative results, a total of 81 significant results out of a possible 384. The most likely influences are on Suicide (11 positive out of 24 possible), Gun Accident (12 negative out of 24 possible), and Burglary (one positive and 19 negative out of 48 possible). Larceny has mixed results (11 positive and eight negative out of 48 possible). In the other direction, where crimes or deaths cause stocks of guns, there are 67 positive and three negative results out of a possible 384. The most likely influences seem to be of Murder or Homicide (30 positive out of 48 possible), Suicide (eight positive out of 24 possible), Accident (seven positive and one negative out of 24 possible), and Rape (seven positive and one negative out of 48 possible).

TABLE 2
Stocks

	Per Capita		Link Relative	
	Guns Cause	Cause Guns	Guns Cause	Cause Guns
Murder	0	8+	0	2+
Homicide	2+/2-	11+	0	9+
Suicide	8+	8+	3+	0
Accident	12-	1+/1-	0	6+
Rape	6+	6+	0	0
Rape Victim	0	1+	0	1-
Robbery	0	4+	0	0
Robbery Victim	0	0	0	0
Aggravated Assault	0	4+	0	0
Aggravated Assault Victim	1-	0	0	0
Burglary	1+/10-	0	0	2+
Burglary Victim	9-	0	0	0
Larceny	1+	0	10+	0
Larceny Victim	8-	1+	0	0
Auto Theft	7+	2+	0	0
Auto Theft Victim	1-	2+/1-	0	0

The summary of all regressions is done in Table 3. The numbers here are just the totals from Tables 1 and 2. There are a total of 190 significant results out of a possible 1,024. This includes 67 positive and 43 negative effects of guns on deaths and crimes and 75 positive and three negative effects of deaths and crimes on guns. On balance, it would appear that there are more net positive causal relations from crimes and deaths to guns, 72, than from guns to crime and deaths, 24. Therefore, it would seem to be a more reasonable conclusion that crime causes guns than that guns cause crime. People have guns as a response to crime rather than crime being a result of people having guns. This is, of course, based on averages and should not be interpreted to have bearing on specific cases.

TABLE 3
All Equations

	Per Capita		Link Relative	
	Guns Cause	Cause Guns	Guns Cause	Cause Guns
Murder	0	8+	0	2+
Homicide	3+/2-	14+	0	11+
Suicide	11+	8+	3+	0
Accident	12-	1+/1-	4+	9+
Rape	6+	6+	0	0
Rape Victim	4+	1+	4+	2-
Robbery	0	4+	0	0
Robbery Victim	0	0	0	1+
Aggravated Assault	0	4+	0	0
Aggravated Assault Victim	1-	0	3+	0
Burglary	4+/10-	0	0	2+
Burglary Victim	3+/9-	0	0	0
Larceny	4+	1-	10+	0
Larceny Victim	1+/8-	1+	0	0
Auto Theft	7+	2+	0	0
Auto Theft Victim	1-	2+/1-	0	0

Footnotes

1. From the National Crime Victimization study, a government survey to which many people may have hesitancy in answering about defensive gun usage, especially if they are uncertain about the legality of their ownership or actions.
2. From a survey by Kleck and Gertz [1995].
3. Many of the data are also found in the *Sourcebook of Criminal Justice Statistics* [U.S. National Center for Health Statistics, annual] for various years.
4. The results so obtained are almost exactly the same as would occur if the Amemiya Probability Criterion was used instead.
5. Of course, the link relatives are of per capita variables.
6. This lack of effect may be due to legal obstacles in purchasing handguns.
7. Sometimes sharpened instruments such as knives are also used.
8. Using the 10 percent significance level criterion might seem to indicate that 12.8 of the results could have been caused by chance. However, the Akaike Criterion also has to be met and significance, if random, should average positive and negative equally.

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