Will gun buyback programs increase the quantity of guns?

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Abstract

Gun buyback programs have become widespread in the United States. This paper offers a model of gun demand in which people make decisions about gun ownership as they would any other durable consumer good. Two insights are generated. First, if the buyback program is unanticipated and never-to-be-repeated, then the buyback program will reduce gun holdings only temporarily, by affecting the timing of consumption. Second, a repeated buyback program, formally analyzed as a permanent buyback program, will actually raise gun holdings, since it permanently lowers ownership costs. Current, repeated buybacks will therefore have the opposite effect of what buyback proponents intend. © 2001 Elsevier Science Inc. All rights reserved.

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1. Introduction

In the wake of a rising toll of gun violence, a growing number of US communities have adopted gun “buyback” or trade-in programs. Sponsored by local governments, businesses, churches, and celebrities, these programs offer to repurchase or “buyback” guns in an effort to reduce the quantity of guns in the hands of the populace. These efforts are likely to continue to
expand as additional communities and sponsors join the buyback bandwagon. Furthermore, there have been several proposals at the federal level to subsidize local buyback programs.学术和政策辩论已经提出了关于买回计划的某些问题。特别是，如果买回计划确实减少了枪支在流通的数量，那将反过来减少与枪械有关的暴力事件吗？买回支持者可能会引用Cook (1982) 和 Zimring (1968, 1972) 的观点，他们认为枪械的可用性增加了暴力死亡的几率。减少枪械数量“将对暴力犯罪的数量影响不大，但它将减少谋杀率。”减少枪械可用性也可能减少意外死亡和自伤死亡（See Sloan et al., 1990）。


这篇文章不就枪械和暴力之间的关系进行评论。相反，它探讨了一个更为根本的问题：买回计划是否能够减少枪械的流通数量？在公共政策辩论中，人们一直认为买回计划将减少枪械数量。但消费者行为的经济直觉暗示相反的结果。这篇文章总结了一个简单的模型，该模型表明买回计划实际上会增加枪械数量。两个洞察力被生成。首先，如果买回计划是不可预见的，而且是一次性的，那么过去购买的决定是沉没的，而且未来购买的决定不受影响，那么买回计划将暂时减少枪械持有量。这与买回支持者所提供的直觉相呼应。其次，然而一个重复的买回计划，作为永久性的买回程序，将实际上提高枪械的持有量，因为它永久降低了拥有成本。重复的枪械买回计划提高了消费者的购买和持有意愿，并且将这可持久的商品重新出售。

这篇文章包含四个附加部分。第二部分草图采购枪械的基本框架，并概述了没有买回计划的市场结果。第三部分检查了两种计划：不可预见的一次性买回，和一个永久的买回计划。尽管这些正式模型是抽象的，但它们都提供了关于买回计划如何影响枪械数量的直觉。第四部分讨论了两模型的现实性和政策相关性，并提出当前计划在长期内将增加枪械库存。因此，买回支持者在他们的目标下犯了错误。

2. Modeling gun purchases

为了预测买回计划对枪械拥有状况的影响，我们需要一个对枪械消费者的购买行为的理论上模型。这个模型将处理枪械和其他耐用消费者商品的购买。第四部分会支持这种方法。
We wish to capture a few features. First, while guns are durable goods, they eventually deteriorate in usefulness and value. Second, just as there are both new and old guns, there are new and old consumers. Third, in order to focus on demand behavior, we will assume a very simple form of gun supply or production behavior. We therefore make the following assumptions.

A new gun is produced at constant unit cost $c$, where $c \in [0,2]$. A gun lasts for two periods, and then disintegrates. A gun in its second period of existence is “used.” The market for guns is perfectly competitive, so new guns are sold at a price of $c$.

There are two equally sized, infinitely lived generations of consumers, with one generation born a period ahead of the other. Individuals have unit demands for possessing a gun, with per period valuation $v$. So once an individual owns one gun, she receives no further utility from owning another gun. The valuation $v$ presumably reflects the consumer’s perceived likelihood of being a crime victim (or perpetrator), willingness to inflict violence, and other characteristics, such as the presence of small children in a household. Since this valuation should vary across consumers, we assume that within each generation, $v$ is distributed uniformly on the interval $[0,1]$. This distributional assumption allows total demand to be easily computed and graphed. It also implies that the total mass of both generations is 2. There is no discounting between periods.

Two variables are of interest. The first is the quantity of guns held by the populace in period $t$, $Q_t$. The second is the quantity of guns returned or bought back in period $t$, $R_t$. The respective steady state values are denoted $Q^*$ and $R^*$.

As a benchmark, consider the no buyback (nb) regime, in which a buyback is neither anticipated nor implemented. The market equilibrium is determined by supply and demand. Supply is straightforward. Due to perfect competition, the equilibrium price of a new gun equals its marginal and unit cost $c$. It will be convenient to speak of another price, the rental rate for a gun for one period. There need not be an actual rental market; the implicit rental rate is the consumer’s per period cost of owning a gun. Since a gun lasts two periods and there is no discounting, the equilibrium rental rate for a new or a used gun is $c/2$.

Given these prices, we turn to demand. Any consumer with a valuation above the rental rate $c/2$ receives consumer surplus from owning a gun, and hence purchases one. The population of gun owners is therefore all consumers for whom

$$v + v \geq c \iff v \geq \frac{c}{2}$$

(1)

Each individual who buys a gun holds it for two periods, after which she buys a new gun. Since there are two generations of consumers, in steady state half the guns are new and half are used. Market demand is derived by adding up those consumers who will purchase a gun, that is, those with valuations that meet condition (1). Since $v$ is distributed uniformly over the interval $[0,1]$, the group of consumers with valuations between $c/2$ and 1 will hold guns. The number of such consumers in each generation is represented by the length of the line segment from $c/2$ to 1. So each generation holds $[1 - (c/2)]$ guns. Since this is true for both generations, we have:
Proposition 1  Under no buyback (nb), the quantity of guns held in steady state, $Q^*_{nb}$

\[ Q^*_{nb} = 2 \left( 1 - \frac{c}{2} \right) \]  

As we would expect, the equilibrium quantity of guns is decreasing in the rental rate $c/2$, the per-period cost of ownership.

3. Buyback programs

The buyback program is an offer to buyback any gun at the price $p_t$. The guns received are destroyed.

Within a given period $t$, a consumer first decides whether to purchase a gun or guns, then decides whether to resell any guns, and then receives $v$ in utility if she owns a gun. The quantity of guns owned $Q_t$ is evaluated after the resale decision. This pattern is illustrated in the time line:

<table>
<thead>
<tr>
<th>TIME:</th>
<th>$t + 1/4$</th>
<th>$t + 1/2$</th>
<th>$t + 3/4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase decision:</td>
<td>buy at $c$?</td>
<td>Resale decision:</td>
<td>resell at $p_t$?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Utility: Receive $v$ if own a gun</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$R_t$ evaluated</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$Q_t$ evaluated</td>
<td></td>
</tr>
</tbody>
</table>

3.1. Unanticipated, one-shot buyback

We first consider a type of buyback that would result in a reduction in the quantity of guns, as anticipated by buyback advocates. The simplest way to achieve this outcome is if previous purchase decisions are sunk at the time of the buyback and were not influenced by the prospect of a buyback. Furthermore, future purchase decisions should not be influenced by the prospect of a future buyback. Conceptually similar issues have arisen in other policy arenas, such as tax amnesty programs (see Andreoni, 1991). Following that literature, we formalize the situation by considering an unanticipated, single-period, never-to-be-repeated buyback program in period $\tau$. This is announced at time $\tau + 1/2$, after people have made their purchases for the period.

**Proposition 2** In an unanticipated, one-shot buyback, the quantity of guns returned $R_{\tau}$ is nondecreasing in $p_{\tau}$ and the quantity held $Q_{\tau}$ is nonincreasing in $p_{\tau}$. Moreover, $Q_{\tau} \leq Q^*_{nb}$.

The proof is provided in Appendix A. Intuitively, the announcement of the buyback program transforms gun consumers into (potential) gun suppliers to buyback sponsors. These potential suppliers are holding a fixed stock of guns equal to $Q^*_{nb}$, the steady-state quantity they previously purchased not anticipating a buyback. Because the purchase decision is sunk at the time of the buyback, gun repurchases reduce the quantity of guns outstanding one-for-one. Gun owners’ willingness to supply guns to sponsors rises with the buyback
price, $p_{\tau}$. Put another way, gun repurchases are increasing in $p_{\tau}$, the owner’s opportunity cost of retaining the gun.

This analysis corresponds to the intuition expressed by buyback proponents. A buyback reduces the quantity of guns outstanding, and this efficacy is positively associated with the quantity of guns returned.

But this buyback raises the opportunity cost of gun ownership in period $\tau$ only. In periods after the buyback, no future buyback is anticipated or occurs, so the cost of gun ownership returns to its prior level. Consumers therefore purchase guns in the same quantities as they did under the no buyback regime. The steady state gun stock reverts to the level that prevailed without a buyback, $Q_{*}^{nb}$. And this reversion could occur quickly; there might be very little lag in calendar time between when an owner sells to the buyback sponsor and when he buys a replacement gun the following period. The once-and-for-all buyback reduces the gun stock only temporarily, in the period the buyback is offered, by affecting the timing of gun consumption. So a sustained effect would seem to require a sustained program.

In practice, gun buyback programs are repeated, by the same or different sponsors. The WESTLAW newspaper database contained numerous instances of repeated programs in a given locale. Although often repeated on an annual basis, in some cases repetition was more frequent. In Washington, DC, heavyweight boxer Riddick Bowe sponsored a buyback only a week after another program. Moreover, as these programs spread to additional cities, consumers will anticipate the likelihood of a buyback in their home area.

Thus, the assumption of an unanticipated, one-shot buyback fails to capture an important element of real world programs. In modeling a repeated buyback program, I have chosen to focus on one simple form: a permanent program offering a constant price. This modeling choice captures the essential features of a repeated program in a tractable way.

### 3.2. Permanent buyback program

We assume that initially there is no buyback program, and consumers do not anticipate one. In period $\tau$ the permanent buyback (pb) program is announced. This is an offer to buyback any gun at the price $p_{\tau} = p$ at the appropriate juncture within period $\tau$, at time $\tau + 1/2$, and in all future periods. If $p > c$, consumers can make infinite profits by buying and reselling new guns, so we assume $p \leq c$. This assumption is consistent with actual buybacks. The average price over 61 buybacks was $41$, below the price of a new gun. In contrast to the unanticipated one-shot buyback, the decision to purchase a gun will be influenced by the permanent program.

**Proposition 3** Under a permanent buyback (pb) program, the steady state equilibrium is characterized by the following:

- The quantity of guns returned $R_{*}^{pb}$ is nondecreasing in $p$.
- The quantity held $Q_{*}^{pb}$ is nondecreasing in $p$.
- The buyback program is counterproductive: $Q_{*}^{pb} - Q_{*}^{nb}$

\[
= \max\left\{2 \left( p - \frac{c}{2}\right), 0 \right\}
\]  

(3)
3.2.1. Proof of Proposition 3

In steady state, consumers will make decisions anticipating their decisions in later periods and subperiods. So we derive the resale and purchase decisions, and then combine them into equilibrium behavior.

3.2.1.1. Resale decision. We specify the resale decision for three separate situations.

If a consumer owns a single used gun, she will resell it if

\[ v \leq p \]  

(4)

The owner of a single new gun will not resell it this period, since that strategy is always dominated by retaining the gun (thereby receiving \( v \)) this period and reselling it next period as a used gun:

\[ p \leq v + p \]  

(5)

The owner of one new gun and one used gun will resell the used gun this period at any \( p \geq 0 \). Here the assumption that consumers have only unit demands for guns becomes influential. Because the consumer receives no (additional) utility from the second gun, the consumer will be willing to resell one of the guns for any positive price. And from reasoning similar to that in the immediately previous situation, the consumer will resell the used gun.

3.2.1.2. Purchase decision. A person who either anticipates selling her current gun or does not own a gun will buy a new gun if

\[ v + \max\{v, p\} \geq c \]  

(6)

The easiest intuition for condition (6) is to consider an individual who does not currently own a gun. Buying a new gun costs \( c \). This new gun will generate \( v \) in utility in its first period of use. During the gun’s second period, as a used gun, the consumer will be faced with two alternatives. The consumer will choose either to retain the gun, receiving \( v \) in utility that period, or choose to resell it to the buyback sponsor for \( p \). In making the purchase decision this period, the consumer plans and anticipates that she will make the optimal choice next period, so that next period’s gross return from gun ownership is the maximum of \( v \) and \( p \).

Moreover, a consumer who currently owns a single gun but anticipates selling it later in this period, faces and makes the same purchase decision as a consumer who does not currently own a gun. If she does not purchase a new gun she will not have a gun at the end of this period, and therefore not receive \( v \).

3.2.1.3. Equilibrium. These resale and purchase conditions generate the following steady state strategies for consumers, which depend on \( v \):

\[
\begin{align*}
\text{[0} \leq v < c - p] & \quad \text{Will not buy a gun} \\
(c - p \leq v \leq 1] & \quad \text{Will buy a new gun every period} \\
\text{and resell her used gun every period}
\end{align*}
\]
Given these strategies, adding up over the relevant consumer populations yields the steady state quantity of gun holdings: \( Q^{pb}_{*} = \)

\[
Q^{pb}_{*} = 2 \left(1 - \frac{c}{2}\right) \quad \text{if} \quad 0 \leq p < \frac{c}{2}
\]

\[
2 \left(1 - c + p\right) \quad \text{if} \quad \frac{c}{2} \leq p \leq c
\]

(7)

Thus \( Q^{pb}_{*} \) is nondecreasing in \( p \). Furthermore, subtracting \( Q^{nb}_{*} \) from \( Q^{pb}_{*} \) yields Eq. (3). Note that if the buyback price \( p \) is below the competitive rental rate \( c/2 \), the buyback will have no effect on the steady state, resulting in the same quantity of gun holdings as without a buyback. The offer to buyback guns at a price below the rental rate is unattractive, and so is irrelevant to the market outcome.

Similar computations yield the steady state quantity of returned guns: \( R^{pb}_{*} = \)

\[
0 \quad \text{if} \quad 0 \leq p < \frac{c}{2}
\]

\[
2 \left(2p - c\right) \quad \text{if} \quad \frac{c}{2} \leq p \leq c
\]

(8)

So \( R^{pb}_{*} \) is nondecreasing in \( p \).

A comparison of condition (6) with (1) highlights the unintended effect of a permanent buyback. The program raises the value of owning a used gun from \( v \) to \( \max\{v, p\} \). With a permanent buyback, the owner of a used gun may retain it and receive \( v \) in utility, or may exercise the additional choice of reselling the gun for \( p \). The buyback price is a floor underneath the value of a used gun. By raising the value of owning a used gun, the program lowers the rental rate on a new gun from \( c/2 \) to \( c - p \). (An individual can pay \( c \) for a new gun, receive the benefits of one period of ownership, and then resell it used for \( p \). So the consumer’s cost for that one period of use is \( c - p \).) The permanent buyback permanently lowers ownership costs, and so increases the stock of guns. A set of consumers who would not otherwise purchase a gun will buy a new gun every period, hold it for a period, and resell it used for \( p \).

The effect is illustrated in Fig. 1.\(^{10}\) The benefits and costs of gun ownership are graphed as a function of the consumer’s valuation \( v \). Under the no-buyback regime, gun holders are those for whom \( 2v \geq c \). Under the permanent buyback, the benefit of a new gun purchase rises to \( \max\{2v, v + p\} \), which is represented by the thicker line.\(^{11}\) Since the price of a new gun remains fixed at \( c \), the set of gun owners grows. The buyback program is a net addition to consumer demand.

The buyback suffers from a form of adverse selection. The sponsor’s unconditional offer to buy guns is most attractive to those who place a low value on their guns, either because of their personal characteristics (low \( v \)) or the characteristics of their guns (used). This is borne out by experience. Callahan, Rivara and Koepsell (1994) found that in Seattle’s September 1992 buyback, 17% of the guns returned did not fire, an extreme form of adverse selection. Other locales have encountered similar problems.
Critics such as Miron (1993) have charged that buybacks will not reduce crime or violence since “criminals won’t turn in their guns.” If one wishes to associate $v$ with the likelihood of social costs, then this model lends some support to that reasoning. Proponents generally concede that the violent-prone will not reduce their gun holdings, but argue that any reduction in the quantity of guns lowers the likelihood of accident or theft. In terms of the model, this effort is aimed at the “marginal” consumer, who has a valuation just above $c/2$ and hence enjoys only a small surplus from ownership. But as Fig. 1 illustrates, a permanent buyback changes the distribution of gun owners in a particularly striking way. Any gun owner in the no buyback regime remains a gun owner under the permanent buyback. The net increase in gun holdings comes from the “marginal” (non)consumers, those with valuations just below $c/2$. So the change in the distribution of gun holdings is also perverse for buyback proponents.

A numerical example illustrates the effect. Assume that the unit cost of a new gun, $c$, is 1.00. Absent the buyback program, the implicit rental rate for a new or used gun is $c/2$, or 0.50. Consider an individual with a valuation $v$ of 0.49, who therefore would not buy a gun absent the buyback. Suppose a permanent buyback is announced with buyback price $p$ of 0.60. This individual will now become a permanent gun owner, each period buying a new gun and selling a used gun, receiving a consumer surplus of 0.09 each period ($=0.49 - 1.00 + 0.60$). The buyback program has lowered the rental rate on a new gun to $c - p$, or 0.40, and at this lower cost the individual with a valuation of 0.49 is willing to become a gun owner.

Additional elements of Proposition 3 should be troubling to buyback advocates. The number of guns returned is often employed as a measure of a program’s success. Since this variable is increasing in the buyback price, sponsors can raise the “success” of their program by offering a higher price. But this further increases the guns in circulation, magnifying the counterproductive effect. Returning to the numerical example, if the buyback price was 0.90 rather than 0.60, then even individuals with valuations as low as 0.11 would become both gun owners.

Fig. 1. Effect of Perpetual Buyback on Gun Holdings
owners and buyback participants. The higher the buyback price, the lower is the effective cost of gun ownership, and so the higher the gun stock.\footnote{14}

4. Realism and policy relevance

The claim that buyback programs will increase the quantity of guns is likely to strike one as either an obvious or a far-fetched conclusion. This polarized reaction is due to disagreements concerning the realism and policy relevance of the formal models of buyback programs. Neither model perfectly describes current buyback programs. But the permanent buyback model is best suited to understanding the likely long run effect of current buyback policies. The policy implication is that current buyback policies will increase the gun stock in the long run, and so are counterproductive given their sponsors’ aims. This section defends the permanent buyback model and its policy conclusion.

This paper has assumed that consumer demand for guns should be considered as analytically similar to consumer demand for other durable goods. Thus demand for guns can be analyzed as economically rational. Some gun control advocates take issue with the rationality of gun purchases. They argue that gun purchasers systematically overestimate their chances of being victimized by crime, overestimate the criminal deterrent value of gun ownership, and underestimate the risk of accidental death or injury. Under this view, consumers’ valuations \( v \) are higher than they should be, given all the available data.

Even if these claims are true, however, they are not central to this paper’s analysis of gun demand. What is central is that given consumer’s valuations of gun ownership, consumers respond to prices in the usual manner predicted by consumer theory. In particular, the quantity of guns demanded is decreasing in the cost of gun ownership. Analogously, consumer valuations of another durable good, automobiles, could be skewed by advertising and popular culture, and yet one could still use traditional price theory to assess the impact of an automobile price change. In fact, evidence from buyback episodes suggests that gun consumers do respond to monetary incentives. In one telling example, a priest in the South Bronx offered to exchange a crucifix, but no money, for guns. Although this offer was held open for several months, there were no takers.\footnote{15} And of course buybacks have as their premise that monetary incentives can induce owners to turn in guns.

Admittedly, this paper’s formal specification of demand has presented a simple characterization of the consumer’s utility from gun ownership. A more descriptively accurate model would capture the “option value” of gun ownership. A person who purchases a gun for protection does so in order to have the gun \textit{available} for use. As a result, consumers may purchase a gun, but then no longer want the gun if circumstances change. Since there is some cost to disposing of a gun, the owner may hang onto that gun, absent a buyback, even though it does not serve a current need.

These changes in circumstances play a role in actual buybacks. The study of Seattle buyback participants by Callahan, Rivara and Koepsell (1994) found that 73% of survey respondents listed “safe way to get rid of a gun they no longer wanted” as one of the reasons they had participated in the buyback.\footnote{16} These factors can be captured formally by allowing a consumer’s valuation \( v \) to change from period to period. As illustrated in Appendix B, this
complication does not change the adverse effect of a permanent buyback. A repeated, anticipated buyback still raises the expected liquidation value of a gun, lowers ownership costs, and thereby raises new gun holdings in the steady state. Consider the case of a marginal (non-)consumer who has a particular valuation for a gun today, but recognizes that his valuation for a gun may decline tomorrow. If a permanent buyback is in place, the individual knows that even if his valuation falls to zero tomorrow, he will receive the buyback price tomorrow; the program establishes a floor underneath the realized value of owning a used gun. On the margin, this makes purchasing a gun today more attractive, and so the buyback program increases the set of gun owners in the steady state.\textsuperscript{17}

Analogously, when an individual contemplates buying a new automobile, she recognizes that the value of that car may decline in the future due to depreciation or an accident. An “automobile buyback” program, offering to buy (used) cars for a price above what would otherwise be the market price for used cars, would stimulate new car purchases, and in the long run lead to more cars.\textsuperscript{18} Kleck (1996) makes the analogy between gun buybacks and a hypothetical automobile buyback program, noting that “it is not implausible to suspect that they [the gun industry] secretly favor programs that buy up the older, cheaper civilian gun stock... To have someone reduce a product’s supply without reducing demand is a manufacturer’s dream come true” (p. 31).

Another assumption that might be challenged is that the repeated buyback program is specified as a permanent buyback. Actual buyback programs are repeated, although not permanent. Nevertheless, the intuition from a model of a permanent buyback carries over to a model of a repeated, even a randomly-repeated, buyback program. The expectation of a potential buyback tomorrow encourages gun purchases today. In practice, consumers should expect buybacks to be repeated, since they have been repeated in several locales, and they are spreading to an increasing number of cities. Indeed, Boston established a program which solicits donations of funds to support periodic buybacks.\textsuperscript{19}

There is also the issue of consumer expectations, foresight and planning. In the permanent buyback model, consumers make decisions anticipating their future actions. In particular, individuals who buy a new gun this period plan on selling it to buyback sponsors the following period. Buyback proponents might argue that some gun consumers make decisions impulsively, born of fear or passion. These consumers may seem likely to make their purchase decisions myopically, without regard to the prospects of future resale. But even if a sizable fraction of consumers act myopically, market forces would still make the permanent buyback counterproductive. Under such a permanent buyback program, there would be a profit opportunity for forward-looking “buyback entrepreneurs” to buy and rent out new guns and subsequently sell the used guns to the buyback sponsor. This entrepreneurial activity would drive down the rental rate on a new gun to $c - p$, raising gun holdings. A myopic consumer would merely react to this lower rental rate.

In fact, at least some consumers are forward-looking. Some individuals have purchased a used gun and immediately turned it in at a buyback.\textsuperscript{20} Absent contrary evidence, it seems reasonable to assume that gun consumers (or entrepreneurs) will take into account future buybacks in making purchase decisions.

Finally, a buyback program will increase gun holdings in the long run even if there is an accumulated stock of past purchases. In the permanent buyback model, the adverse incentive
effects come from lowering the cost of gun ownership and so influencing future gun purchases. But US households own an estimated 150 million to 200 million guns. This stock vastly exceeds the flow of new purchases, which averaged 4.5 million per year in the 1980s.

Presumably some share of these 200 million guns are not of current use to their owners due to changes in the owner’s circumstances. If this share is high enough, then buyback programs may reduce gun holdings in the short run, by drawing down this stock of past purchases. In the long run, however, the stimulus given to new purchases would offset and then overwhelm the short run reduction.

5. Conclusion

This paper advances a simple model of consumer behavior in which a buyback program increases the quantity of guns in circulation, directly counter to the professed goals of buyback advocates. Admittedly, gun buyback sponsors may have other goals besides directly reducing the number of guns in circulation. They may be conducting a symbolic exercise to gather publicity and support for a political agenda. Indeed, Rosenfeld (1996) has argued that buybacks programs have no effect on crime, but should instead be evaluated as a form of community mobilization.

Whatever the various goals of buyback programs, this paper indicates that programs will have unintended consequences directly contrary to organizers’ goal of reducing the quantity of guns. At current funding levels, these effects may prove small. Yet even at current levels the programs seem to have generated consumer responses consistent with the model. The long run effects of these programs will not be measurable for several years; buybacks, and their repetition, did not become prevalent until the 1990s. This paper suggests that buyback sponsors should abandon their efforts, and channel their resources into raising the cost of gun ownership, if they are serious about reducing gun ownership.

This paper illustrates a classic lesson about economic incentives. As Daniel Polsby of Northwestern University School of Law indicates, “Government programs to buy up surplus cheese cause more cheese to be produced without affecting the availability of cheese to people who want to buy it. So it is with guns.” In fact, this lesson has even older roots. “One should not just think about the first incentive to come to mind. To do so means to risk the fate of the poor little town of Abruzzi, Italy. The city was plagued by vipers, and the city fathers determined to solve the problem by offering a reward for any viper killed. Alas, the supply of vipers increased. Townspeople had started breeding them in their basements.”

Notes

1. In February 1994 then Senator Robert Dole proposed legislation to provide $30 million over two years to states and localities which match the federal contributions for buying back guns. That same month a separate bill was introduced to provide increased tax breaks for companies that donate goods for “guns for goods” programs.

3. Later work by Black and Nagin (1998) and Dezhbakhsh and Rubin (1998) suggests that the Lott-Mustard results may not be robust. Ludwig (1998) offers results that suggest that concealed weapons laws increase adult homicide rates. This remains a subject of debate.

4. In reality, some consumers own multiple guns. The advantage of assuming unit demands is that it simplifies the derivation and exposition of the market equilibrium.

   A more general form of demand would specify that consumers can derive utility from owning more than one gun, but with diminishing marginal valuations for additional guns purchased. So a shopowner might have one valuation for a gun for his store, and have a lower valuation for a second gun, for his home. This more general form of demand would not change the results significantly. A permanent buyback would still subsidize demand by lowering the rental rate on a new gun, raising the number of guns in circulation. Some consumers would buy a second gun who would otherwise have only owned one gun.

5. In practice, many programs repurchase guns with gift certificates in lieu of or in addition to cash. For these cases, \( p_t \) is the total cash value of goods offered by sponsors.

6. As elsewhere in this paper, this assumes away any income effects of the buyback.

7. It also raises the question of the buyback sponsor’s credibility in pledging never to repeat the buyback. Consideration of that issue is beyond the scope of this paper.


10. For Fig. 1, I have assumed that \( p > c/2 \), which is required for the permanent buyback program to have an effect on the steady state.

11. If the consumer holds the gun for two periods, he receives a total of \( 2v \). If he holds the gun for one period and then sells it the next period for \( p \), he receives a total of \( v + p \). Since the consumer will make the optimal decision the next period, the value of owning a new gun is the greater of these two payoffs.

12. These are the consumers for whom \( [c/2 < v \leq 1] \).

13. These are the consumers for whom \( [c - p \leq v < c/2] \). This region is shaded on the \( x \) axis of Fig. 1.

14. Note that we still assume \( p \leq c \).


17. This holds even if there is a positive cost of disposing of a gun. Consider gun owners who have low valuations \( v \) (below the current competitive rental rate), but who are not willing to bear the disposal cost \( d > 0 \) (i.e., because \( v > -d \)). In response to a buyback offer at price \( p > v + d \), such consumers will sell the gun and not buy a replacement. Thus in the short run a buyback will reduce gun holdings of these consumers. But in the long run the repeated buyback program still fosters gun ownership by raising the value of having a used gun from \( v \) to \( p - d \).
18. This assumes that the buyback price is below the cost of a new car.
20. “One man who turned in a used handgun to police in Norwalk, Conn., for a $100 toy certificate last week had a receipt showing that he had just paid $40 for it.” St. Louis Post Dispatch, January 6, 1994, 5B.
22. Ibid, 12.
23. My conjecture is that this tradeoff between short and long run effects could be accommodated by altering the model of changing consumer valuations offered in Appendix B. That model contains two relevant differences from the permanent buyback model offered in the text. First, consumers live for only two periods, rather than infinitely long. Second, consumers’ valuations for guns change over their life-cycle. In order to capture the tradeoff between short run and long run effects, one could assume that both guns and people have longer, although finite, lives. In practice, guns are extremely durable, and assuming that guns last more than two periods allows one to capture an equilibrium before buybacks in which new purchases in a period are small relative to the total number of guns outstanding.

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Appendix A

Proof of Proposition 2

An owner of a used gun will be willing to resell if $v < p_\gamma$, since by turning in the gun the owner foregoes $v$ in consumption value but gains $p_\gamma$ in income. Likewise, an owner of a new gun will be willing to resell if $v < p_\gamma - (c/2)$, where $c/2$ is the rental rate for the second period of the gun’s life. The owner of a new gun who resells it foregoes $v$ this period and $c/2$ next period, but receives $p_\gamma$ in exchange.

Total guns resold therefore depends on the distribution of $v$ among those who own guns. We integrate over these conditions given the condition for gun ownership: $[(c/2) \leq v \leq 1]$. Summing the resulting offer functions for used and new guns yields $R_\gamma$.

In an unanticipated, one-shot buyback, the precise form of $R_\gamma$ depends on $c$. Assume $[0 \leq c \leq 1]$. 

Then $R_\tau =$

\[
egin{align*}
0 & \quad \text{if} \quad 0 \leq p_\tau \leq \frac{c}{2} \\
\frac{p_\tau - c}{2} & \quad \text{if} \quad \frac{c}{2} \leq p_\tau \leq c \\
2p_\tau - \frac{3c}{2} & \quad \text{if} \quad c \leq p_\tau \leq 1 \\
1 + p_\tau - \frac{3c}{2} & \quad \text{if} \quad 1 \leq p_\tau \leq 1 + \frac{c}{2} \\
2\left(1 - \frac{c}{2}\right) & \quad \text{if} \quad 1 + \frac{c}{2} \leq p_\tau 
\end{align*}
\]  

(9)

A qualitatively similar result obtains if $[1 \leq c \leq 2]$. By inspection, $R_\tau$ is nondecreasing in $p_\tau$. The quantity of guns held $Q_\tau$

\[
Q_\tau = Q_{n2}^{*} - R_\tau = 2\left(1 - \frac{c}{2}\right) - R_\tau
\]

(10)

Therefore $Q_\tau$ is nonincreasing in $p_\tau$, and $Q_\tau \leq Q_{n2}^{*}$.

Appendix B

Model with changing valuations

The basic model involved infinitely lived consumers who in every period place the same value $v$ on owning a gun. In practice, there are several reasons why $v$ might change over time, including an individual’s life cycle.

In formalizing this more complicated consumer purchase decision, we retain a number of assumptions from the basic model. A new gun is produced at constant unit cost $c$, where $c \in [0,2]$. A gun lasts for two periods, and then disintegrates. A gun in its second period of existence is “used.” The market for guns is perfectly competitive.

We change consumer time horizons. Consumers live only two periods. Consumers have unit demands for a gun within a period, with valuation $v_i$ for period $i$. The index $i (i = 1,2)$ refers to the period of the consumer’s life, not the gun’s life. A new generation of consumers is born each period. The total mass of all consumers at any one time is 2, equally divided between young and old generations. There is no discounting. Consumers can sign contracts to be executed at their deaths.

The life cycle of a consumer’s valuation is formalized by the following. The “young” valuation $v_1$ is distributed uniformly on the interval $[0,1]$. The “old” valuation $v_2$ is a random variable described by a conditional density and a well-defined associated conditional expectation: $E[v_2 | v_1]$. This setup allows valuations within a given generation to evolve over time either randomly or deterministically. The expected distribution of valuations in the total
population remains unchanged over time, however, due to the overlapping generations of consumers.

Decisions are governed by the following time line:

<table>
<thead>
<tr>
<th>TIME:</th>
<th>$t$</th>
<th>$t + 1/4$</th>
<th>$t + 1/2$</th>
<th>$t + 3/4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learn $v$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase decision:</td>
<td>buy at $c$?</td>
<td>resell at $p$?</td>
<td>own a gun</td>
<td></td>
</tr>
<tr>
<td>Resale decision:</td>
<td>$R$, evaluated</td>
<td>$Q$, evaluated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility: Receive $v$ if own a gun</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The comparison of outcomes between the no-buyback and permanent buyback regimes is very similar to that in the basic model. Absent a specific distributional assumption on “old” valuations, we cannot derive a closed form solution. We are able to show that parallel conditions to the basic model will hold, and that a permanent buyback will therefore raise gun holdings. Without a buyback program, the population of gun owners in any period is characterized by conditions similar to condition (1):

$$ v_1 \geq \frac{c}{2} \quad (11) $$

$$ v_2 \geq \frac{c}{2} \quad (12) $$

Under a permanent buyback program, the population of gun owners in any period is characterized by conditions similar to condition (6):

$$ v_1 + \mathbb{E}[\max\{v_2, p\}|v_1] \geq c \quad (13) $$

$$ v_2 \geq c - p \quad (14) $$

For the buyback to have an effect, it must be that $p \geq (c/2)$ and so the permanent buyback enlarges the set of gun owners. With this setup, there will be an active resale market for guns. The buyback program raises the minimum price for used guns to $p$. But since the program is permanent, this lowers the rental price for a new gun from $c/2$ to $c - p$. This second price becomes the effective rental price for both generations. The young can buy a new gun for $c$ knowing they will be able resell it next period for $p$. The old can rent a new gun for $c - p$ by signing a contract that transfers possession of the gun at their death.

References
