"SMART" GUNS: A TECHNOLOGICAL FIX FOR REGULATING THE SECONDARY MARKET

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A "personalized" or "smart" gun will not fire unless it is being used by an authorized individual. Such guns have the potential to reduce the negative externalities of gun ownership while preserving the benefits. Ongoing efforts to develop practical "smart" designs make it timely to consider regulations that would favor or mandate them in the market for new guns. The likely consequences would depend on the design details, in particular the costs of transferring the "key" to firing such guns. With an "ideal" design, transferring the key would require special equipment that could be monitored by appropriate authorities. The result would be to block thefts and other transfers of such guns in the secondary market and, in the long run, reduce access by individuals who are proscribed from possessing a gun. Personalized guns, therefore, could make existing firearms regulations more effective and reduce the social costs associated with gun misuse. Though personalized guns have advantages relative to standard guns in a wide variety of situations, some of the potential benefits of personalized guns could be captured through alternative policy measures. (JEL K420, L500, D620)

I. INTRODUCTION

There are approximately 200 million firearms in private possession in the United States, including 70 million handguns (Cook and Ludwig, 1996; Kleck, 1997). Approximately 65% of U.S. homicides are committed with firearms, and of these, 80% involve handguns (www.ojp.usdoj.gov/bjs/cvivt_c_tem). Guns, particularly handguns, feature prominently in other violent crimes, too; in 1999, more than half a million crime victims faced an offender armed with a firearm (Zawitz, 1995; U.S. Department of Justice, 2000). The enormous social costs associated with gun violence provide a rationale for regulations on gun commerce.

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Licensed firearms dealers are prohibited from selling handguns to persons less than 21 years of age, for instance. Federal law also proscribes many people from either receiving or possessing firearms. This prohibition includes convicted felons (or those under felony indictment), individuals convicted of domestic violence crimes, drug addicts, and those who have been committed to a mental hospital, among other groups. Youths under the age of 18 cannot legally possess a handgun, except in certain limited circumstances.

This strategy of discriminating among groups (rather than imposing a blanket prohibition) will be effective in reducing gun violence to the extent that perpetrators are concentrated in the proscribed groups and the regulations are enforced effectively. Ideal controls on firearms could be defined as those that are effective at keeping guns out of the hands of high-risk users, while placing few barriers in the way of gun acquisition.

ABBREVIATIONS
ATF: Bureau of Alcohol, Tobacco, and Firearms
FFL: Federal Firearms Licensee

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by purchasers who are by some standard deemed sufficiently law abiding and prudent to be entrusted with this hazardous commodity. Cost is also relevant, of course. One major difficulty is that controls aimed at reducing “blocked exchanges”, such as criminal or juvenile purchase of firearms, can also raise barriers to legitimate firearm transactions (Walzer, 1983, 100–03).

“Personalized” or “smart” guns are a new method for making it more difficult for proscribed users to acquire workable guns (Teret et al., 1998; Teret and Webster, 1999). A personalized gun will not fire unless the internal locking device is released. The “key” to this lock could be any one of a variety of mechanisms, including a magnetized ring worn by the shooter, a wristband that transmits a radio signal to a receiver built into the gun, a unique fingerprint recognized by a computer chip embedded in the gun, a sequence of numbers on a keypad on the handle of the gun, or even a voice that an embedded computer chip is programmed to recognize. (Note that more than one user could be authorized to fire a given personalized gun with any of these devices.) With a personalized gun, the risk of nonconsensual firearm transfer could be greatly reduced, because unless the “key” is also transferred unauthorized people will be unable to fire the gun. In short, an appropriate personalization technology could move handgun regulation closer to the ideal, by helping prevent blocked exchanges without unduly burdening legitimate gun owners.

Personalized guns would help prevent use by unauthorized people. How much prevention such guns would offer depends on the circumstances and the nature of the personalization technology. Any personalization mechanism would offer protection during a confrontation over possession of a gun, as, for example, between a law-enforcement officer and a suspect that he or she is attempting to arrest. Any such technology would also offer protection against gun accidents involving young children who get their hands on the family gun. For adolescents who might “borrow” a gun with the thought of using it to show off to their friends or to commit suicide, the mechanism by which the gun is personalized matters: they may be able to obtain the ring or combination that releases the lock at the same time they take the gun, whereas they would not be able to use the gun if the owner’s fingerprint or voiceprint were required. The value of a personalized gun to a thief will depend on the cost of overcoming that mechanism. Finally, there is the important matter of whether it would be feasible, and at what cost, for the owner to voluntarily transfer the key. Perhaps the ideal technology would allow such voluntary transfers but only by use of specialized equipment that could effectively be reserved for licensed dealers.

The purpose of this article is to examine the potential impact of personalized handguns on the firearms market and on the misuse of guns by proscribed users. We consider two scenarios: first, where such guns make up the entire market, and a second, more realistic scenario, in which there remains a substantial portion of guns that do not possess the personalization technology. We identify those factors that are most relevant to the impact of personalization on the market for guns and project the results of policies to encourage or require the use of personalized handguns.

Two strands of economic literature are relevant to the personalization issue. One concerns the effects of limiting or destroying the resale market for consumer durables (e.g., Benjamin and Kormendi [1974]; Miller [1974]; Hendel and Lazzeri [1999]). A second examines the bundling of commodities (McAfee et al., 1989; Wallner, 1998). Many health and safety regulations, such as shields on power saws and lawn mowers or childproof caps on medicine bottles, take the form of mandated safety features bundled with potentially dangerous products. The focus within both of these strands of literature, however, is on the incentives facing sellers (typically a monopoly supplier) with respect to bundling or elimination of the resale market. We are more interested in how personalization will affect the extent and distribution of handgun demand, while the interests of gun manufacturers in pursuing personalization are more directly

1. For a summary of some personalization technologies, see Appendix B of Center for Gun Policy and Research (2000). Other information concerning personalization can be found online at www.smartlock.com and at www.handguncontrol.org/legalaction/dockets/A3/a3background.htm.
addressed by these existing economic literatures. We also examine the potential gap between social and private incentives to acquire personalized guns.

The discussion presented herein is quite speculative. Personalized guns have yet to be marketed widely; prototypes have been developed, and there remains disagreement over such fundamental issues as the most advantageous personalization technology. Furthermore, many of the effects of personalization will depend on the reaction of the illegal market for guns. Almost by definition, information on the illegal market is limited, and predictions of how the illegal market will respond to changed circumstances are necessarily marked by a substantial amount of uncertainty (Leitzel, 2000). The impact of personalization will further depend on the extent and enforcement of complementary government regulations on the formal and informal markets for guns. We offer our analysis, then, as a preliminary exploration into the complex terrain of firearm personalization—a terrain on which the United States appears to be poised to traverse—while recognizing that large parts of the landscape remain terra incognita.

The remainder of the article is organized as follows. Section II reviews the existing evidence on the acquisition of guns by high-risk users in the United States. Section III examines the impact of personalization on firearm transfer, and section IV extends this analysis by focusing on best-case personalization. In section V, three specific policies concerned with encouraging personalized weapons are more closely examined. Section VI revisits the analysis, taking into consideration the possibility that the personalization technology may be defective. Section VII discusses some issues regarding personalization of other commodities, and conclusions appear in section VIII.

II. THE ACQUISITION OF GUNS BY HIGH-RISK USERS

The market for handguns in the United States can be considered to be made up of two segments, a primary and a secondary market, where the primary market consists of sales (of either new or used guns) by official dealers, known as federal firearms licensees (FFLs) (Cook et al., 1995). More than half (60–70%) of all gun transactions take place through FFLs (Cook and Ludwig, 1996). The rest take place in the secondary market, which consists of a host of informal methods of transferring guns, ranging from transfers between family members or friends to sales via classified ads or at gun shows to theft. Secondary market transactions typically involve used firearms, though some new guns may be diverted into the secondary market before formal sale by an FFL. Most U.S. gun transactions, whether in the primary or the secondary market, are legitimate. Many prescribed handgun users, however, find it relatively easy to acquire guns illegally, typically on the secondary market.

How are guns that are used in crime acquired? First, many people who misuse guns are adults without a previous felony conviction; therefore, in the absence of any other prohibiting conditions, they can acquire a firearm legally. However, the vast majority of gun criminals do not acquire their guns directly through legal purchases from FFLs (Wright and Rossi, 1986; Cook and Braga, 2001).

Illegal methods of obtaining firearms abound. Over half a million guns are stolen each year in the United States (Cook and Ludwig, 1996), which (unlike Britain, for instance) has no safe storage requirement except in a handful of states. More than half of the guns that are stolen are handguns (Zawitz, 1995). A second channel for diversion from the legal stream is through illegitimate, off-the-books sales by FFLs or by nominally legitimate sales to “straw” purchasers, who quickly transfer the firearms to prohibited buyers. In some states, local straw purchases are a major channel of gun supply for prohibited users (Cook and Braga, 2001; U.S. Department of Treasury, 2000a, b). Small-scale gun-runners provide a third source of supply to the secondary market. These illicit dealers make multiple purchases in states with relatively lax controls and sell the guns in more restrictive states. Furthermore, informal transfers are arranged through gun shows, classified advertisements, word of mouth, and myriad other

2. In the mid-1990s the National Institute of Justice sponsored an investigation by the Sandia National Laboratories to identify the most promising personalization technology for police handguns. The radio frequency technology that Sandia favored is the basis for the development of a personalized gun by the Colt Manufacturing Company.
devices. Drug dealers sometimes diversify their underground economic activity by trading in guns. Thus there are a variety of channels through which prohibited users can acquire guns—even when the users lack a clear intention of becoming armed. One interview study of juvenile gun crime offenders in metropolitan Atlanta found that the majority had come into possession of their first gun in a passive manner, without planning to do so (Ash et al., 1996).

III. PERSONALIZATION AND GUN TRANSFER

A handgun may be characterized along several dimensions relevant to the potential for misuse, such as caliber, magazine capacity, and size. For the purposes of examining personalization, we will consider only one characteristic, the “key” that allows the gun to be fired. For standard, nonpersonalized guns, anyone who acquires the gun also acquires the key—which is usually just the knowledge required to release the manual safety—and vice versa.

With a personalized gun, it is no longer true that the possessor of the gun necessarily has the key. A personalized gun can be transferred in the usual ways, through sale, trade, gift, loan, or theft. But how is the key exchanged? The answer depends on the technology employed in personalizing the gun. If the key entails a wristband or ring worn by the owner, that can be transferred readily enough, though a thief might steal such a gun without the key. If the gun has a combination lock built in, then the key is knowledge of the combination, which could be easily transferred if the original owner is willing. If the personalization technology relies on electronic recognition of a thumbprint, then transferring the key will require reprogramming. Presumably such reprogramming will necessitate special equipment—if it is feasible at all.

Personalization raises the transaction costs associated with blocked exchanges. Some notation will be helpful. Let $CI$ represent the transaction cost of an involuntary transfer (through theft or unsanctioned borrowing) of a gun and its key. That is, $CI$ is the cost to the thief of taking the gun and “repersonalizing” it, without the cooperation of the originally authorized user. $CI$ can be influenced by standard antitheft devices, including safe storage.

More important for the present discussion, however, $CI$ can also be raised via personalization technology.

The transaction costs associated with voluntary trades require a further distinction based on whether the trades are legally sanctioned. Let voluntary and legal transfers be designated by the term “entitled,” to indicate that such transfers receive governmental imprimatur (i.e., they are not “blocked exchanges”). Illegal voluntary transfers, such as the transfers following a straw purchase, are “unentitled.” The corresponding transaction costs are denoted by $CVE$—the cost of voluntarily transferring a gun to an entitled user, and repersonalizing the gun for the new user—and by $CVU$, the cost of a voluntary transfer of a gun and its key to an unentitled user.

An ideal circumstance for enforcing selective prohibitions on gun possession would be one that leads to small $CVE$, but high $CI$ and $CVU$. In a standard nonpersonalized gun $CVE$ would typically be small. Nevertheless, some gun controls, such as waiting periods and background checks, impose costs on transferring guns to entitled users. Other policies, such as fining individuals who are found guilty of knowingly transferring guns to unentitled users, can be used to drive up $CVU$, the transaction costs of exchanging a working gun to a proscribed user.

$CI$ for a standard gun depends on how the gun is stored and the penalties for theft. Personalized guns are intended to raise $CI$, but in doing so, may also make voluntary transfers of the firing authorization more costly. Some personalization technologies, such as magnetic rings or radio-transmitting wristbands, do little to raise $CVE$ and $CVU$ relative to standard guns, though such technologies do raise $CI$ in many circumstances.

Personalization per se does not distinguish between entitled and unentitled users. Whatever technological process is necessary to repersonalize a gun for a new owner applies to legitimate and illicit users alike. Personalization combined with government monitoring, however, can drive a wedge between $CVE$ and $CVU$. If transferring the key (repersonalization) requires specialized equipment, for instance, then the government could operate or monitor the transfer technology. Through this monitoring, the government could raise $CVU$, eliminating or at least
significantly restricting voluntary but illegal transfers. If the key is a magnetic ring, then CVU would be no higher than with a standard gun. The opportunity for personalization to directly limit illicit secondary market transfers without posing a substantial barrier to legal transfers, therefore, requires the combination of a suitable government policy (monitoring of voluntary transfers) with an appropriate technology.

IV. BEST-CASE PERSONALIZATION

Consider first a best-case scenario for personalization, where the personalization technology eliminates nonconsensual transfer of the key, so that CI approaches infinity. Such a personalized gun can be stolen, but cannot be fired by the new possessor. Furthermore, suppose that the key cannot easily be transferred even in voluntary exchanges, so that government monitoring can make CVU essentially infinite, as well. Voluntary trade to an entitled user, however, would allow for inexpensive reprogramming (CVE is low), once the new user is identified as legitimate by the monitor. Biometric methods of personalization, involving fingerprints, for instance, apparently have the potential to implement something close to the best-case scenario, when combined with government oversight over transactions.³

Finally, suppose for now that personalization involves no increase in the costs of production, and consider the impact of this best-case personalization if it were suddenly applied to the entire existing stock of guns, as well as to newly produced guns. In sum, this personalization technology implements what was characterized in the introduction as an ideal gun control: proscribed users would be prevented from obtaining a (working) gun, whereas legitimate purchasers would have little problem acquiring one.

³ The possibility that personalization will lead to a substantial rise in CVE is a frequently expressed concern of those who urge caution in pursuing public policies mandating personalization. The Beretta USA Corporation, for instance, notes that “such a device [i.e., a biometric personalization method] would require the purchaser to travel to the manufacturing site in order to have the gun personally programmed” (www.berettausa.com/smugun.htm). It should be noted that sale and resale of other dangerous commodities such as dynamite and hazardous chemicals are subject to screening and close monitoring. The elevated transactions costs are justified by public concern over the deadly consequences of misuse.

For durable goods such as firearms, the demand for acquisition of the good can be distinguished from the demand for possession of the good. For example, in the U.S. handgun market, the current demand for possession is reflected in the stock of about 70 million handguns, with several million transactions each year (Cook and Ludwig, 1996; U.S. Department of the Treasury, 2000c). How would best-case personalization influence this demand? Overall, the demand to possess would begin to fall as a result of the fact that new cohorts of youths and felons would be kept out. Demand would drop still more rapidly if the arms-race dynamic worked in reverse; as the prevalence of gun possession by proscribed people declined, the motive by entitled people to own a firearm might decline as well. On the other hand, the value of a gun would be enhanced because it would no longer have to be secured or insured against theft, and there would be no danger of its being misused by another member of the household.⁴ Whether the net result of these countervailing forces would be to increase or decrease demand for gun possession is not clear.

The analysis above assumes that the personalization technology could be added to a handgun at no extra cost. In fact, the personalization of firearms involves a more costly production process for new guns. Because used guns are close substitutes for new guns, the price increase for new guns would be passed on to the secondhand market (Cook and Leitzel, 1996). Our best guess is that across-the-board price increases would reduce the overall quantity demanded, because the increase in price would be greater than the increase in value placed on having a safer gun. (Under the current regime, demand for enhanced safety in handguns appears muted at best.) The higher price may also be conducive to differentially screening out high-risk users who are not proscribed by law. A large proportion of high-risk users are young and poor, and it is reasonable to suppose that as a group

⁴ In other words, the expected future stream of benefits to an authorized user associated with possession of a perfectly personalized gun would increase relative to a standard gun. In itself, this “present value effect” (Benjamin and Kornendi, 1974) should result in an increase in the demand to possess a gun.
they have a relatively high price elasticity of demand (Cook, 1981).

Ideal personalization offers yet another advantage associated with solving crimes. When police recover a crime gun, currently they can trace it to the first retail customer by use of the serial number and other information about the gun. The problem is that the first customer has usually transferred it to another in an off-the-books transaction (Cook and Braga, 2001). If such secondary-market transactions were effectively blocked, and all gun transfers were through a licensed dealer or government official, then tracing the gun to its true owner would become much easier. Personalization, therefore, would increase the efficiency of gun traces. The advantage is even more pronounced with personalization methods, such as fingerprint detectors, that would allow the police, in possession of a firearm used in a crime, to identify the authorized user. As only the authorized user would have been able to shoot the gun, there would be a strong prima facie case that that person is the culprit. Hence the introduction of personalized guns would complement law enforcement efforts, and knowing that, owners of such guns may be deterred from misusing them.

V. POLICY ALTERNATIVES

Three alternative policies to promote firearm personalization are of interest: a (differential) tax on the sale of standard guns; a ban on the sale of new standard guns; and a ban on the sale of standard guns, whether they be new or used. We conduct the baseline analysis under the assumption that personalization works well, in the sense that a personalized gun has a high CI and a low CVE.

A. Additional Tax on the Sale of Standard Guns

One measure that can promote a transition to personalized guns would be to invoke a differential tax on the sale of new standard guns, modifying the current uniform federal excise tax on handguns of 10%. If the tax were sufficiently high, then the tax would become equivalent to a ban on the sale of new standard guns. But nonprohibitory taxes would still provide a spur to the penetration of personalized firearms into the overall firearms stock.

What would be the “socially efficient” size of such a tax? With the help of some heroic assumptions, a rough order-of-magnitude estimate can be divined. Note first, that as we are looking for a tax differential between personalized and standard guns, we needn’t quantify the private or external benefits of gun possession, as these are presumably similar (on a per-gun basis) for both types of guns. Personalization, however, should lead to a decline in gun accidents, suicides, and crime.

What would be the average, per-gun benefit if the entire U.S. handgun stock were suddenly converted into ideally personalized guns, with CI and CVU infinite and CVE small? Consider the diminution in homicides that would be associated with perfect personalization. In 1998, there were 8,816 handgun homicides in the United States (Fox and Zawitz, 2000). Many of these were committed by entitled users, however, who would not be disarmed by an ideal personalization scheme. Interpretations of the existing evidence differ rather widely. Kates et al. (1997, 32), based on FBI statistics, note that 67% to 78% of arrested murderers have prior records for violent felonies or burglaries, suggesting that the typical murderer is not a law-abiding citizen. On the other hand, somewhat less than half of murderers have actually been convicted of a felony prior to their arrest for murder (Sherman, 2001), and hence were proscribed from owning a gun at that time. Another large group of potential killers is proscribed from acquiring a handgun from a dealer because the individuals are under age 21. For the sake of this example we will assume that 65% of the handgun murders, some 5,730 per year, are committed by users who are proscribed. If unable to obtain a firearm, some of these murderers would resort to other methods. For similarly motivated attacks, however, it appears that the instrumentality effect of guns is large. Here, we will take the fatality “advantage” of guns to be 3 to 1, so the switch to personalized guns would result in 3,820 fewer murders annually.5

5. The figure of 3,820 is two-thirds of 5,730—the notion is that the proscribed assailants in the 5,730 handgun murders shift to another weapon, such as a knife, which results in a death at only one-third the rate of handguns. Note that this calculation ignores the potential crime-solving benefits associated with personalization, as discussed at the end of section IV. There is some concern that handgun regulations will result in
There are perhaps 800 fatal firearm accidents per year in the United States. (The true number cannot be known, because it is a matter of interpretation whether a particular instance in which one person shoots another is an “accident” or some degree of homicide.) Assume that 600 of these are committed with a handgun, and that 50% of these fatal handgun accidents would be eliminated by the switch to personalized guns. The leading circumstance of death by firearm is suicide, and adolescents are especially likely to use a handgun that does not belong to them. Teenage firearm suicides claim some 1,300 victims annually; as a very conservative estimate, assume that personalized guns lead to 100 fewer teenage suicides per year. These assumptions on homicide, accidents, and suicide yield a total annual savings of 4,220 lives. Ignoring nonfatal shootings, then, and taking the value of a life to be $3 million (Viscusi, 1992; Cook and Ludwig, 2000, 112), the average annual savings per handgun from a switch to ideally personalized weapons would be more than $180.6 Assuming a gun lasts for 20 years, and that the social discount rate is 5%, an optimal differential at the time of purchase would be approximately $2,355.7 Ideal personalization would be sufficiently socially beneficial, therefore, that the tax differential on standard guns would be prohibitive. In other words, if an ideal world of handgun personalization were the alternative, a ban on standard guns would approximate a socially optimal policy.

The preceding discussion was predicated on the assumption that personalization would have no effect on the total number of guns. If the advantages of personalization caused more individuals to purchase guns, however, then the number of fatal gun accidents and homicides involving nonprohibited users might also be expected to increase (Violence Policy Center, 1998). Furthermore, the advantage of personalized over standard guns will be diminished to the extent that the personalization is not ideal. Designs that do not create a high CVU, and therefore do not pose a barrier to straw purchases or other secondary-market transfers, will be far from ideal. The other major factor is the ease of acquiring standard guns. If the illicit market in these guns remains substantial, then the lower social costs of crime that can accompany personalization also will be diminished. This suggests that the marginal gains from personalization will tend to increase as the penetration rate of personalized guns increases.

B. Ban on the Sale of New Standard Guns

It has been suggested that there might be social gains to laws mandating that all new handguns be equipped with a personalization technology (cf. U.S. Senate bill S. 319, introduced in January 1999). If such a measure were adopted nationally today, what would be the expected penetration of new personalized handguns into the overall stock after 5, 10, or 20 years? To address this question, start by taking the current U.S. handgun stock to be 70 million and assume that annual additions are 2 million per year. Assume for now that personalization has no influence on the size of the flow of new guns, and assume that guns are removed from the stock at a rate of 1% per year. Because it is likely that most removals from the stock are older guns, assume that no personalized guns are among those that exit the stock during the initial 20 years following the introduction of the personalization requirement. With these assumptions, after 5 years, there would be 10 million personalized handguns in a total stock of approximately 76.57 million guns, for a penetration rate of 13.1%; after 10 years, personalized guns would make up 20 million of a total stock of 83.3 million, for a penetration rate of 24%; and after 20 years, the 40 million personalized guns would make up some 41% of the overall handgun pool.

All of the assumptions that were used to generate the calculations of the preceding paragraph are questionable, of course. In particular, the number of new guns purchased might change dramatically. The higher production costs and retail price, coupled with a diminished “arms race,” could cause the

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6. On the value of a life, see Viscusi (1992, 73): “Most of the reasonable estimates of the value of life are clustered in the $3 to $7 million range.” In Cook and Leitzel (1996), we calculated a Pigovian-style tax on handguns using a value-of-life figure of only $1 million, but this figure is unreasonably low.

7. This is the present value of 20 annual payments of $180, with the first payment occurring immediately, when the annual interest rate is 5%.
number of new handguns purchased to fall considerably if all new handguns were personalized. (A surge in standard sales might be expected prior to the personalization "tax" going into effect.) Table 1 presents the figures derived under the base assumptions of the previous paragraph, as well as under two alternative scenarios: one in which the annual additions to the handgun stock fall in half, from 2 million to 1 million guns, and a second in which additions come to 4 million guns annually. Note that even in the reduced demand scenario personalized guns would make up more than a quarter of the overall stock after 20 years. This penetration rate is substantial, and as it applies to the more desirable new handguns, it can be expected that such a rate would serve as a noticeable deterrent to handgun theft (Clarke, 1997). Over the longer term, following the adoption of mandatory personalization for new guns, the majority of handguns will become personalized, and handgun theft will become an increasingly losing proposition. Mandating a personalization technology for new guns that raises CVU would also help foreclose other means by which prohibited users acquire guns, such as straw purchases.

C. Ban on the Sale of New and Used Standard Handguns

It is conceivable to go beyond a legal requirement that all new guns be personalized, by outlawing (or prohibitively taxing) the transfer of any gun that is not personalized. (There is a precedent in U.S. history: in 1934 Congress adopted the National Firearms Act, which placed a prohibitive tax of $200 on transfers of machine guns and other gangster weapons.) One possibility would be that existing owners of standard guns could continue to legally possess their guns and perhaps pass them down to their heirs. A second possibility would be the ownership of standard handguns could be banned. A buyback or compensation program—such as those that accompanied Great Britain’s 1998 ban on handguns and the Australian ban on semi-automatic weapons—could be implemented to help effect the transition. Alternatively, existing standard guns could be recalled and potentially retrofitted with a personalization technology.

A ban on the transfer of any standard gun would have effects similar to those of a ban on manufacture and sale of new standard guns. By adding a further obstacle to the secondary market in standard guns, however, a ban on transfers would make it harder for criminals and others to acquire used standard guns. Furthermore, the transition to a high penetration rate of personalized guns would be accelerated, as new consumers would have no legal choice but to purchase a personalized gun.

An overall ban on standard guns holds the potential to greatly accelerate the penetration of personalized guns. Although the absence of a firearm registration system in the United States means that evasion of the ban would be easier than in the case of the British handgun ban, for instance, substantial compliance remains a possibility. In particular, compliance will be promoted to the extent that personalized guns are seen as relatively desirable and to the extent that the compensation package is generous. A general ban on standard guns creates a legal bright line that itself aids enforcement: any standard handgun would be illicit and subject to confiscation.

VI. IMPERFECT PERSONALIZATION

The discussion so far has presumed that personalization is effective, in the sense that a personalized gun cannot be transferred involuntarily in working order. Furthermore, it has implicitly been assumed that a personalized gun works as advertised, that is, the matched user and only the matched user (or
matched users) will be successful in attempting to fire the gun. But these ideal conditions are unlikely to be met in practice. There can be Type I errors—failure of the personalized gun to fire when it is used by the authorized user—and Type II errors, when the gun fires even though an unauthorized person is using it. The first of these errors is particularly worrisome to individuals, including police officers, who fear that they may need to fire a gun in a violent conflict. Of course, standard guns can fail to fire, too, if they are jammed, or if the safety catch is on, or if they are unloaded, for example, but personalization adds another route to potential failure. In particular, the radio transmission technology requires a power source—a battery—that might fail if it were not replaced from time to time.

Manufacturers will take pains to minimize Type I errors. In designing a personalized gun, manufacturers can choose whether such a power failure (or, for alternative personalization designs, other potential failures) results in the gun being “locked” and unable to fire or unlocked. The choice could be important in determining the extent to which personalization serves as a barrier to theft, for instance, as it also will influence the possibility of Type II errors, which allow unauthorized users to fire the gun. Biometric-type personalized guns seem to offer the best opportunity to reduce the scope for Type II errors.

Some forms of what might be termed “imperfect” firearm personalization are already available. Childproofing guns in such a way that small hands cannot fire them raises CI or CVU to one important group of unentitled users. Trigger locks provide some unbundling between possession and the ability to use a gun, and safe storage of firearms in locked and secure gun cabinets is an impediment to unauthorized possession: both of these measures raise CI. Separate storage of unloaded firearms and ammunition also unbundles firearm possession from use in the very short run. Unlike ideal personalization, however, these devices might also make it difficult for the authorized user to fire the gun in some situations. But in many of the circumstances that offer advantages from personalization, safe storage or a trigger lock provide another means to preventing unauthorized use. These circumstances include: (1) legitimate gun users being shot with their own gun after having it wrested from them, (2) accidental shootings by children or other unauthorized users, (3) suicides using borrowed or stolen guns, and (4) theft, possibly followed by transfer to a prescribed or high-risk users. Of course, trigger locks and safe storage also pose a small barrier to some authorized use, because the gun (and perhaps separately, the ammunition) has to be unlocked and loaded before being fired. In situations (including the “wrestling over the gun” scenario) in which the legitimate owner perceives the need for a workable firearm to gain control over an encounter, a locked firearm will be less convenient than a personalized gun. Nevertheless, there is substantial overlap between the effects of personalization and those of safe storage. An important advantage of personalization (as well as childproofing) is that it is automatic: its effect on raising CI is not dependent on ongoing decision making by gun owners.

Many Americans eschew safe storage and keep handguns loaded and unlocked. Apparently they value the opportunity to have ready access to a workable firearm and ignore or are willing to accept the increased risk of accidental use by themselves or others, or of misappropriation, as in scenarios 2, 3, and 4 above. For these users, a personalization technology sufficiently free from Type I errors might dominate keeping an unlocked and loaded standard handgun in a nightstand drawer, for instance.

Ideal personalization, as we have seen, would facilitate effective gun tracing. Nevertheless, serial numbers do capture some of the benefits of personalization. Federal law mandates that firearms have an affixed serial number. Gun traces by the Bureau of Alcohol, Tobacco, and Firearms (ATF) based on the serial number of a recovered gun can be used to identify the first FFL to sell the gun, the identity of the initial retail purchaser, as

8. Approximately one-third of U.S. handguns are kept loaded and unlocked (Cook and Ludwig, 1996, 20–21). One argument arrayed against legislation requiring personalization is that it will undermine the norm of safe storage if people rely on the personalization technology to prevent unauthorized access. See, for instance, the online document at www.beretta.com/smartgun.htm. But this argument is weakened by the surprising laxness that already exists with respect to firearm storage in many American homes. On technological safety improvements leading to reduced precaution and perverse outcomes, see Viscusi and Evans (1984); a different conclusion is reached by Rodgers (1996).
All as well as the address of the purchaser at the time of acquisition. That is, serial numbers provide some aspects of personalization of guns to initial purchasers, although they neither unbundle possession and the ability to use, nor do they serve as a barrier to involuntary transfers. Nevertheless, the tracing ability offered by serial numbers can be used to help the police solve crimes or to identify potential gun traffickers. Some criminals, therefore, prefer guns in which the serial number has been obliterated, though it is illegal to remove the serial number on a firearm or to possess a firearm with an obliterated serial number. In a sample of eight cities, the ATF found that 11.4% of handguns traced as crime guns had obliterated serial numbers (U.S. Department of Treasury, 2000b; Cook and Braga, 2001).

Finally, law enforcement, as well as private civil suits (Siebel, 1999), can change incentives with respect to firearm behavior in ways that reproduce many of the advantages of personalization. Traditionally, little police attention has been paid to how criminals have acquired their firearms. Straw purchasers, for instance, by and large have not faced serious consequences for providing guns to prohibited users. Punishment for the negligent storage of a loaded firearm that is used in an accidental shooting by children is frequently minimal, too. Increased attention to illegal transfers or negligent storage behavior could serve to raise the perceived costs (CI and CVU) of transferring a gun to a high-risk user. The likely effects of personalization and some other measures on the transaction costs of gun exchanges are summarized in Table 2.

VII. PERSONALIZATION OF OTHER GOODS

Some degree of personalization is common for valuable durable commodities. Locks with literal keys are standard equipment for vehicles and entryways. Serial numbers can be applied to home electronics or other relatively high-value but portable goods, as a way of identifying rightful ownership following theft, and thereby serving, at least in a small way, as a theft deterrent.

Once possession has been secured, even through theft, most commodities are relatively easy to use. But there are some

| TABLE 2 | Transactions Costs Involved in Transferring a Gun and the Authorization to Fire the Gun |
|-----------------|-----------------|-----------------|-----------------|
| “Ideal” controls | CI | CVE | CVU |
| Personalized guns with radio | high | some increase | low |
| transmitters or magnetic rings | | | little or no effect |
| Personalized guns with fingerprint | increase | increase | high |
| detectors, voice recognition, | | | little or no effect |
| or other biometric technology | | | |
| Trigger locks | increase | no effect | no effect |
| Safe storage | increase | little or no effect | no effect |
| Meaningful liability imposed on | increase | increase | increase |
| owners whose guns are | | | |
| misappropriated and then misused | | | |
| Tougher measures against straw | no effect | no effect | increase |
| purchasers | | | |
| Enforcement against scofflaw dealers | no effect | no effect | increase |
| Regulating the secondary market | no effect | little or no effect | increase |
| identically with the primary market | | | |

9. Personalization might also interact in interesting ways with concealed carry laws, which have been a subject of great controversy (Lott, 2000; Ludwig, 2000; Duggan, 2001). Among the concerns with liberalized concealed-carry laws is that the increased prevalence of guns in public areas fostered by a liberal concealed-carry regime will serve to fuel the secondary market in firearms, in part by theft. Further, licensed carriers in some states are relatively advantaged in serving as straw purchasers, in that they are exempt from back- background checks, and there is some evidence that the liberalized laws have promoted straw transactions (Benson and McCoy, 1998.) Legislation limiting concealed carrying to personalized guns, however, would mitigate these potential adverse consequences of the liberalized concealed carry laws while protecting the claimed private and social benefits from permissive rules on concealed carrying. Again, the extent to which personalization offers gains in this area depends on the ability of personalization to raise CI and CVU.
commodities in which the unbundling of possession from the authorization to use is quite developed. Cash, despite being equipped with serial numbers, in general can be spent just as well by an illegitimate possessor as by the rightful owner: a stolen dollar is worth a dollar. Credit cards and checking accounts, however, are institutional innovations that achieve a much higher degree of personalization of funds: some credit cards even come bundled with a photo of the authorized user. The unlawful possessor of a checkbook or a credit card faces some barrier in making purchases; furthermore, unlike cash purchases, credit card or check purchases create a record that can be traced by law enforcement authorities. And as checks and credit cards have become more common, the cost of voluntary and legitimate credit card and check transactions has become rather minimal, while the cost of illegitimate transactions is raised relative to cash. Car stereo systems now frequently come with a removable part, the absence of which renders the system unusable—another form of personalization motivated to reduce the threat of theft.

The trade-offs identified with the personalization of guns also exist with the personalization of other commodities. Specifically, there is the question of the extent to which the cost of voluntary exchange is raised when personalization raises the cost of involuntary exchange. There is also the issue of the extent to which personalization provides the government the ability to raise the costs of (or simply to monitor) unauthorized exchanges, even when they are voluntary. Thus “wanted” or missing individuals can be tracked through their automatic teller withdrawals (from their own accounts) or through legitimate credit card purchases. A similar issue has arisen with identifiers that trace Internet commerce.

Standard forms of personalization, as in the car stereo case, are motivated primarily by an interest in deterring theft. Few people are concerned that scofflaw stereo owners might sell their stereos to “high-risk” users, who could then misuse the stereo and injure themselves or others. If the more or less only source of black market supply of a good is theft, as is the case with stereos, then personalization is quite similar to a standard lock. In such a case, the spread of personalization (or, for that matter, more or better locks) can make major inroads into restricting black market supply. The case with firearms is more problematic, because the social costs of voluntary (though unentitled) trade is a serious issue with respect to guns. Although deterring gun theft is clearly beneficial, personalization offers the additional benefit (when combined with government monitoring of transactions) of stopping voluntary transfers to high-risk, prohibited users.

VIII. CONCLUSIONS

Ideal personalization of firearms would be a very effective means to control the transfer of guns to prohibited users. The conditions that mark this best-case scenario include a high cost to repersonalizing a gun following an involuntary transfer, as well as a high cost of repersonalization following a voluntary but illegal transfer to a prohibited user. Some forms of personalization, such as magnetic rings or radio transmitters, are effective at limiting involuntary transfers but pose little barrier to illicit, voluntary trade. Other personalization technologies, such as those that rely on biometric keys, more closely approximate the ideal conditions for effective control against transfers to prohibited users. Nearly complete penetration of such ideally personalized guns would make major inroads into theft and straw purchases, as well as most other sources of guns for prohibited users, while also aiding the police in identifying those who misuse guns. Thus the long-run benefits of a shift to personalized guns appear to be significant, even if the personalization is less than ideal.

REFERENCES


