

Guns and Crime Revisited

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Abstract

I focus on the effect of changes in public security (policing) on private security measures that potential victims can take. In particular, I look at the tradeoff between different types of private security measures – such as using or carrying guns, carrying less cash or keeping less valuables at home, and using burglar alarms or Lojack – and study how this tradeoff is affected by changes in public security. If private householders’ direct security expenses are *strongly* substitutable with public policing (eg. for guns which may be more useful in badly policed areas), an increase in policing results in a drop in these expenses; it also results in carrying or keeping less cash (an indirect security measure which reduces the prize a criminal can seize). If, however, householders’ direct security expenses are “complementary” to policing in the sense that they are more effective when police response is rapid (eg. for burglar alarms), more policing increases these expenses unless the efficacy of joint (public and private) security expenses on combating crime encounters very sharply diminishing returns; moreover, a rise in policing also induces carrying or keeping more cash. An increase in penalties increases the tendency to keep cash on hand, and also reduces crime, provided that as private precautions increase, with policing constant, it takes a larger increment in security spending to compensate for a specific drop in penalties. The results are consistent with some empirical trends in crime rates, policing, penalties and private precautions.

Keywords: Private precautions, gun laws, policing, crime, penalties, incentives, victims.

JEL Codes: K42.

1. Introduction

A spate of interesting empirical studies have looked at the factors affecting the drop in the U.S crime rate from the nineties. Many of these are surveyed in Levitt (2004). While Levitt (2004) mentions greater policing and harsher penalties for criminals as factors explaining significant parts of the decline, he also notes that relaxation of gun restrictions, such as CCW laws – which gave citizens the right to carry concealed handguns – did not seem to influence the drop in crime

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4 rates.² Moreover, some of the CCW literature that Levitt cites – Duggan (2001), for instance –
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6 makes it clear that there is no indication that potential victims responded to CCW laws by
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8 carrying guns more frequently, while gun *ownership* seems to have fallen, with a 17% drop in
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10 the fraction of households owning guns between 1993-98.

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12 At the same time, other studies (for instance, Cook and Macdonald 2010, 2011, Ayres
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14 and Levitt 1998) stress the increase in *other* types of private precautions (apart from gun
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16 ownership or choosing to carry handguns for defensive purposes). These precautions include an
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18 expansion in the use of burglar alarms, carrying less cash³ and using different debit or credit
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20 cards, and using Lojack to help avoid car thefts.

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22 While different empirical studies have focused on (a) the effect of policing on crime, (b)
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24 the effect of harsher penalties on crime, (c) the impact of relaxation of gun control laws, and (d)
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26 the trends in other types of private precautions taken by households, a coherent theory linking
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28 together these separate findings and illustrating the interplay between them is missing. This
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30 paper takes tentative steps to fill that gap.

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32 I construct a simple theoretical model focusing on potential victims’ incentives, studying
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34 the interaction between government security and private incentives to take precautions. I allow
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36 for the fact that different types of private precautions may differ in several respects. For example,
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38 precautions like keeping less cash and valuables at home or carrying less cash while outside
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40 reduce the prize that a criminal can seize in one criminal attempt, but differ intrinsically from
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42 direct expenses on security (such as on burglar alarms, Lojack or guns) that individuals
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44 undertake to raise the probability that a criminal attempt fails. Similarly, *direct* expenses on
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46 security can also differ in important respects. For instance, burglar alarms and car alarms are
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48 both more effective in the presence of rapid police response and are in this sense
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50 “complementary” to policing intensity. Guns, however, may be more useful to potential victims
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52 where the police are ill armed or in areas with scant police presence (Glaeser and Glendon
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54 (1998) confirm that householders’ ownership of guns seems to be a “substitute” for, rather than a
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56 complement of, policing and is most common in badly policed areas; their results are discussed
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58 at more length in Section 3). I also distinguish between crimes which are financially motivated

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58 ² The empirical literature supporting these conclusions is partially discussed in detail in the literature review that
59 follows.

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61 ³The trend of carrying less cash was also noted by Amromin and Chakravorti (2009), Bolt and Chakravorti (2008),
62 Humphrey et al (1996) and Kosse (2011), among others.

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4 (for example, robbery, burglary or theft) and other violent crimes (such as hate crime or rape)
5 where criminals may have other motives.
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8 I find that if direct private security expenses are *strongly* substitutable with public
9 policing, an increase in policing (i) reduces these expenses, and (ii) induces individuals to
10 keep/carry less cash and valuables. In contrast, if direct private security expenses are
11 complementary or less substitutable to policing, an increase in policing increases these expenses
12 and also encourages individuals to keep or carry *more* cash and valuables. If, however, the
13 marginal efficacy of joint security expenses on crime reduction encounters sharply diminishing
14 returns, I find that an increase in policing reduces direct private security expenses unless there is
15 a strong complementarity between policing and private security expenses. A rise in penalties,
16 holding policing constant, encourages individuals to keep/carry more cash, and also reduces
17 crime, provided that as security expenditure goes up, the same fall in penalties must be
18 compensated by a relatively large increment in security spending to keep crime from increasing.
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21 The rest of the paper is organized as follows. Section 2 discusses some related literature.
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23 Sections 3 and 4 contain my results. Section 5 concludes.
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26 27 28 29 30 31 32 33 **2. Some Related Literature**

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35 This paper is connected to three strands of the literature on the economics of crime. The first is
36 the empirical literature on the determinants of the drop in crime and trends in private precautions.
37 The second is the theoretical literature on private precautionary measures against crime, and the
38 third, which partly overlaps with the second, is a small theoretical literature dealing specifically
39 with gun control laws. I discuss each of these in turn.
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43 First I discuss the relevant empirical literature. Several studies have found that increases
44 in policing reduce crime. These include Levitt (1997,2002), Di Tella and Schargrotsky (2004),
45 Draca, Machin and Witt (2011), Machin and Marie (2011), Marvell and Moody (1996), Corman
46 and Mocan (2000), and Lin (2009).⁴ Similarly, increasing penalties for criminals seem to have
47 been a major factor behind the reduction in crime [Levitt (1996), (2004)]. The effect of penalties
48 on crime may incorporate both deterrence and incapacitation (see Miceli 2010 for a theoretical
49 model which incorporates both these effects). Several studies have independently found that
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60 ⁴ See Cameron (1988) for a survey on earlier studies on the effects of policing on crime. Some of these found mixed
61 results because of endogeneity issues.
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4 changes in average sentence length have an inverse impact on crime (Machin and Meghir 2004,
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6 Kessler and Levitt 1999, Pyle 1989, Owens 2009).
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8 I now turn to the empirical literature on gun control and gun ownership, in particular, that
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10 on CCW laws allowing potential victims to carry concealed weapons for self-defense. Lott and
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12 Mustard (1997) argued in favor of such laws and found that they reduced crime. However, these
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14 results have since been challenged and contradicted by a number of studies including Duggan
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16 (2001), Ayres and Donohue (2003) and Cook and Ludwig (2006), among others. Duggan (2001)
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18 finds that gun ownership did not increase in states that passed CCW laws relative to those that
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20 did not. There was no evidence that private individuals responded positively to CCW laws by
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22 arming themselves more frequently. Moreover, there was no evidence that householders
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24 increased gun ownership in response to anticipated rises in crime. He also finds that the fraction
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26 of gun-owning households actually decreased by 17% between 1993-98 in spite of the
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28 implementation of CCW laws. Both Duggan and Cook and Ludwig (2006) find that gun
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30 ownership, far from causing crime to fall, causes crime to increase, if anything (this increase in
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32 crime being driven by criminals who used the guns to commit homicide). Similarly Ayres and
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34 Donohue (2003) also find that the CCW laws did not play a role in reducing crime.

35 Despite this, potential victims' use of several other types of precautions was increasing.
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37 For instance, Cook and Macdonald (2011) document an increase in the use of burglar alarms and
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39 other types of security equipment while Cook and Macdonald (2010), Amromin and Chakravorti
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41 (2009), Humphrey et al (1996), Kosse (2011), and Bolt and Chakravorti (2008), among others,
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43 note the trend of carrying or keeping less cash at hand. Interestingly, there is empirical evidence
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45 that the trend of keeping less cash at hand, and, in particular, tending to substitute away from
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47 cash towards debit cards is significantly driven by safety concerns. Kosse (2011) finds using
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49 Dutch survey data that consumers' safety perceptions play a major role in determining their
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51 preferences between the use of cash versus debit cards. Consumers who were afraid of being
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53 mugged were significantly more likely to prefer debit cards.⁵ Similarly Humphrey et al (1996)
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55 find, using macro data for 13 countries over the period 1987-93, that the use of debit cards rather
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57 than cash was negatively related to security perception. Thus, it seems reasonable to suppose that
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59 at least part of the trend towards less cash was driven by safety concerns. Turning to other

60 ⁵While debit cards can also be stolen, thieves cannot use them unless they know the customer's PIN. Moreover, if
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62 customers notify banks of the theft speedily, the cards can be canceled. According to Kosse (2011), Dutch banks
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64 also compensate customers for any losses arising from debit card theft, provided reasonable precautions were taken.
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4 private precautions, Ayres and Levitt (1998) describe an increase over time in the proportion of
5 cars equipped with Lojack, which helps police track cars as soon as they are stolen by sending
6 them a radio signal. According to both Ayres and Levitt (1998) and Cook and Macdonald
7 (2010), private expenditure on security now outstrips public expenditure on security.
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11 Next I turn to the theoretical literature. While the general theoretical literature on the
12 economics of crime dates back to Becker (1968) and is vast, here I simply discuss part of the
13 literature dealing with private precautions. Some of this literature, including Shavell (1991),
14 Ben-Shahar and Harel (1995) and Clements (2003) focuses on whether the equilibrium level of
15 private precautions differs from the social optimum. These papers – unlike mine – are not
16 concerned with the interaction of private incentives to take precautions with the level of
17 government policing. Similarly Leeson (2007) has a model where farmers expecting to be
18 attacked by bandits can take precautions – again, in a stateless society where government
19 policing, by definition, plays no role. Grossman and Kim (1995) examine individuals’ incentives
20 to invest in productive activity, defensive precautions and predation, once again in a stateless
21 society. Bolt and Chakravorti (2008) – while its focus is on payment instruments – models a
22 precautionary incentive to move away from cash towards debit cards, by endogenizing the effect
23 of probable theft on willingness to carry cash. Similarly, He, Huang and Wright (2005) which
24 studies the early evolution of the banking system, endogenizes individuals’ precautionary
25 incentives to substitute away from cash which involved a high risk of theft.
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39 Papers in the literature in which government does play a role include Ehrlich (1981),
40 Friedman, Hakim and Spiegel (1987) and Lacroix and Marceau (1995). In Ehrlich (1981) the
41 government’s only role is to set fines for criminals, and it is assumed that therefore government’s
42 actions do not affect private individuals’ demand for precautions in the “market for offenses”.
43 Friedman et al assume that “private security” is a collectively consumed commodity and also
44 explicitly postulate that private and public security are substitutes and additively separable.
45 Lacroix and Marceau (1995) model private precautions in a setting of incomplete
46 information. While their focus is not on the interaction between private and government security
47 measures, they find that if public spending is high, people are less likely to take precautions.
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55 In contrast, my focus *is* the interaction between government security and private
56 incentives to take precautions. I therefore do not assume additive separability. Nor do I assume
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4 that private security is collectively consumed. Unlike the papers above, I allow for the fact that
5 different private precautions may differ in several respects, as highlighted in the introduction.
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8 Another paper in this literature which relates closely to the present one is Guha and Guha
9 (2012). In that paper we showed that an increase in policing need not always be offset by an
10 increase in victims' moral hazard to be negligent about their safety. We argued that this held
11 irrespective of whether one was guarding an indivisible asset – say a painting by an Old Master –
12 or had divisible assets which could be separated into several equally-sized lots (costly
13 diversification). In the present paper, I do not assume that individuals separate their assets into
14 several equal-sized lots, but adopt the more realistic approach of allowing them to keep only a
15 small, endogenously chosen amount of cash with them at any particular time, incurring some
16 disutility due to liquidity or transactions cost in the process. Also, unlike in the previous paper, I
17 separately model crimes that are not necessarily financially motivated, as noted above. The most
18 important difference, though, is that this paper seeks to provide a theory linking the various
19 empirical findings related to the drop in crime that I have already mentioned, while the main aim
20 of the previous paper was to find out if the Peltzman effect⁶ would necessarily hold in a variety
21 of situations. In addition to this theoretical literature, my paper, because it considers deterrence,
22 also relates to the more general theoretical literature on deterrence, for instance Garoupa and
23 Stephen (2004) and Konrad and Skaperdas (1998).
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37 I now turn to the theoretical literature that specifically deals with guns. Donohue and
38 Levitt (1998) has a model focusing on the effect of gun ownership on willingness to engage in
39 conflicts. They argue that guns reduce the certainty of victory and thereby raise willingness to
40 participate in violence. Somewhat closer to my paper are Mialon and Wiseman (2005) and Bac
41 (2010). Mialon and Wiseman (2005) study a mixed strategy equilibrium in which criminals
42 randomize between “gun” and “non-gun” crimes while victims randomize between “carrying
43 guns” (for self-defense) and “lying low”. They then study the impact of “marginal gun control” –
44 defined as a small increase in the cost of carrying guns – on this equilibrium. The focus of this
45 paper is on optimal gun control policy. Bac (2010) has a similar aim and studies heterogeneous
46 victims and offenders emphasizing the fact that the greater the potential victim's loss, the larger
47 the criminal's gain. His focus is on optimal sanctions for armed versus unarmed crime.
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58 ⁶Peltzman (1975) argued that safety regulations induce moral hazard causing reckless individual behavior that may
59 ultimately offset the direct effect of the safety regulation. Similarly, Hylton (1996) mentions that individuals under-
60 invest in private precautions simply from a tendency to over-rely on government enforcement.
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4 In contrast, I am not concerned in the present paper with optimal gun control policy,
5 optimal sanctions or, indeed, with armed versus unarmed crime. In tune with the empirical
6 literature cited above, I take CCW and other gunlaws as given rather than study the impact of an
7 increase or decrease in gun control⁷. I do deal with potential victims' incentives to arm
8 themselves with guns. However, my emphasis is on the interaction of these incentives with
9 exogenous changes in policing or penalties, as well as on the tradeoffs between guns and other
10 types of private precautions and how this tradeoff is affected by changing policing intensity.
11 Simultaneously, I also study the deterrent effect of policing and penalties, sometimes working
12 through indirect channels such as through potential victims' behavior. While "lying low" as in
13 Mialon and Wiseman can also be considered as a different private precaution, the interaction
14 effect of the incentives to take different precautions with policing intensity or penalties is not
15 considered there. Moreover, in my model victims have a continuum of choices rather than the
16 dichotomous choice set of gun carrying/lying low considered in Mialon and Wiseman (2005).
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28 **3. Financially motivated crimes : a model and results**

29 The agents in my model are private householders (also referred to as "potential victims"). They
30 are risk-neutral and have complete information. Now potential victims' probability of *not* being
31 victimized is given by
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$$35 \qquad f(S, p(G,z)) \qquad (1)$$

36 where G represents government policing, z represents direct private expenditure on security (for
37 instance on burglar alarms, guns or Lojack), and S is a known penalty (sanction) faced by
38 criminals. The form of the function implies the plausible assumption that, from the point of view
39 of the victim, the marginal rate of substitution between government and private expenditure (G
40 and z) is independent of the penalty S imposed on a captured criminal. We have $f_S > 0$: harsher
41 penalties discourage crime. We also have $f_p > 0$, $f_{pp} < 0$; we can think of p as the contribution of
42 joint expenditure by government (through G) and private individuals (through z) to the
43 probability of non-victimization. Our assumptions above signify that this probability is
44 increasing at a diminishing rate in p. Meanwhile p is increasing and concave in both its
45 arguments: $p_G > 0$, $p_{GG} < 0$, $p_z > 0$, $p_{zz} < 0$: government policing and private expenditure both
46 increase security, but at a diminishing rate. The sign of p_{zG} depends on the nature of z. $p_{zG} > 0$
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59 ⁷Because of this, for my purposes the distinction between CCW, which affects ability to **carry** weapons, and other
60 laws on private gun **ownership**, is not important.
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4 holds when private expenses on security are relatively more effective when police presence is
5 strong or police response is rapid ; this is likely to be the case with burglar alarms or Lojack.⁸
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8 With other types of private security expenses – for example, guns – we have $p_{zG} < 0$. As
9 mentioned in the previous section, there is evidence that guns are relatively more useful to
10 private householders when the police are ill-armed or when there is scant policing. Glaeser and
11 Glendon (1998) find that gun ownership responds negatively and significantly both to
12 quantitative measures of policing intensity (police per square mile) and to perceived police
13 quality (perceptions of how much police “care”). Moreover, their regressions include a host of
14 controls which, if omitted, could plausibly generate a spurious correlation between policing and
15 gun ownership. For example, one may argue that guns may often be used for hunting, which
16 occurs in rural areas where police presence might be smaller. However, this objection does not
17 apply here as the regressions in question controlled for whether the area in question was a
18 metropolitan state area. In particular, the result that gun ownership responds negatively to
19 perceived police quality provides strong support for my assumption that $p_{zG} < 0$ for guns.⁹ We do
20 not impose any restriction on the sign of f_{pS} .
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32 **A1:** $f(S, p(G, z)) < I$.

33 A1 states that even for the largest feasible penalties, deterrence is always incomplete so that
34 private householders face a nonzero probability of being victimized.
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37 Denoting the total value of a potential victim’s assets by V , the victim can choose v , the
38 value of the loot that can be seized from him in a single criminal attempt. That is, he can, if he
39 wishes to, lower v below V by keeping only a small amount of cash or valuables at home, or by
40 carrying less cash with him when he goes out. This has the effect of reducing the value of the
41 prize that a criminal can seize in a single successful attempt. However, by taking this precaution,
42 the potential victim suffers some disutility due to reduced liquidity and associated transactions
43 costs. This disutility is given by $B(v)$ where $B'(v) < 0$ (if v is larger, the victim suffers less
44 disutility as he gets to keep more cash with him) and $B''(v) > 0$ (utility drops more sharply with a
45 marginal reduction in v when v is already very small). The sign of the second derivative reflects
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56 ⁸ Arguably, this may not hold for all levels of policing; for instance, when policing is already very high.

57 ⁹ Liu and Neilson (2006) examine the interaction between private (endogenous) and public (exogenous)
58 expenditures that jointly reduce mortality risk. Their discussion of partial derivatives is similar. They show that the
59 degree of substitutability or complementarity between these measures affects the statistical value of a life (an
60 individual’s marginal willingness to pay for a further drop in mortality risk).
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that the marginal inconvenience suffered due to reduced liquidity is highest when the amount of cash one keeps at hand is negligible.

Now, by examining potential victims' incentives to optimally choose z and v , it is possible to derive a relationship between these two variables. Potential victims, being risk-neutral, maximize expected utility by minimizing expected losses. These include the loss v in the event of being victimized, (with probability $1-f(S,p(G,z))$), the direct expenses on security z , and the disutility from reduced liquidity $B(v)$. Hence they solve the problem

$$\text{Min}_{v, z} [1-f(S,p(G, z))]v + z + B(v)$$

This yields the two following first order conditions (with respect to z and v respectively):

$$-f_p p_z + 1/v = 0 \quad (2)$$

and

$$1-f(S,p(G, z)) + B'(v) = 0 \quad (3)$$

Now (2) gives us a positive relationship between z and v . Intuitively, the larger the prize that has to be protected from criminals, the greater the incentive to spend on private security. The positive relationship can be confirmed by differentiating (2) with respect to z and v : rearrangement yields

$$\frac{\partial z}{\partial v} = - \frac{1}{v^2 [p_{zz} f_p + f_{pp} (p_z)^2]} > 0 \quad (4)$$

The positive sign follows as $p_{zz} < 0$, $f_{pp} < 0$, $f_p > 0$.

We now state our main result.

Proposition 1: *Consider an increase in policing intensity G . Then*

- (i) *If p_{zG} is strongly negative ($p_{zG} < 0$ and $|p_{zG}| p_z > |p_{zz}| p_G$), higher policing intensity reduces z and v – private security expenditure and cash in hand.*
- (ii) *Suppose the marginal efficacy of p on f , the non-victimization probability, does not diminish too fast, so that $|f_{pp}| p_z < f_p / v^2 B''(v)$. Then both z and v rise with higher policing intensity either if z and G are complementary ($p_{zG} > 0$), or if z and G are not complementary but are not strongly substitutable, specifically if, $p_{zG} < 0$ but $|p_{zG}| / p_G < 1 / v^2 B''(v) - |f_{pp}| p_z / f_p$.*
- (iii) *Suppose the marginal efficacy of p on f does diminish very fast, so that $|f_{pp}| p_z > f_p / v^2 B''(v)$. Then if $p_{zG} > 0$, higher policing intensity raises v but raises z if and only if*

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4 z and G are strongly complementary, with $p_{zG}/p_G > |f_{pp}| p_z/f_p - 1/v^2 B''(v)$. If $p_{zG} < 0$,
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6 higher policing intensity always reduces z . It raises v if and only if $|p_{zG}| p_z < |p_{zz}| p_G$
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8 so that z and G are not strong substitutes.
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11 **Proof:** Totally differentiating the two first order conditions (2) and (3), with respect to z , v and
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13 G , and writing in matrix notation, we obtain
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$$15 \begin{bmatrix} -f_p p_{zz} - f_{pp} (p_z)^2 & -1/v^2 \\ -f_p p_z & B''(v) \end{bmatrix} \begin{bmatrix} dz \\ dv \end{bmatrix} = \begin{bmatrix} f_p p_{zG} + f_{pp} p_z p_G \\ f_p p_G \end{bmatrix} [dG] \quad (5)$$

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17 Denote the determinant of the matrix of second derivatives, $\begin{bmatrix} -f_p p_{zz} - f_{pp} (p_z)^2 & -1/v^2 \\ -f_p p_z & B''(v) \end{bmatrix}$ by \mathbf{A} .
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20 By the second order condition for minimization, the determinant \mathbf{A} is positive. That is,
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$$23 -f_p p_{zz} B''(v) - f_{pp} (p_z)^2 B''(v) - f_p p_z / v^2 > 0 \quad (6)$$

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25 Applying Cramer's rule,
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$$28 \frac{dz}{dG} = \frac{1}{\mathbf{A}} [f_p p_{zG} B''(v) + f_{pp} p_z p_G B''(v) + \frac{f_p p_G}{v^2}] \quad (7)$$

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30 From (6), \mathbf{A} is positive. Therefore the sign of dz/dG is the same as the sign of the
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32 numerator of (7). Rearranging (6) and multiplying through by p_G , we get
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$$35 [-f_p p_{zz} p_G - f_{pp} (p_z)^2 p_G] B''(v) > f_p p_G p_z / v^2 \quad (8)$$

36 From the condition given in the Proposition, we have $-p_{zz} p_G < -p_{zG} p_z$. Using this and (8), we
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38 have
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$$41 [-f_p p_{zG} p_z - f_{pp} (p_z)^2 p_G] B''(v) > f_p p_G p_z / v^2$$

42 Or
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$$45 p_z [f_p p_{zG} B''(v) + f_{pp} p_z p_G B''(v) + f_p p_G / v^2] < 0 \quad (9)$$

46 Given $p_z > 0$, the bracketed term in (9) is negative. But note that this is identical to the numerator
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48 of (7). Therefore, we have $dz/dG < 0$.
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51 Similarly we can solve for dv/dG : this yields
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$$53 \frac{dv}{dG} = \frac{(f_p)^2}{\mathbf{A}} [-p_G p_{zz} + p_z p_{zG}] < 0 \quad (10)$$

54 The sign of dv/dG is the sign of its numerator, given \mathbf{A} is positive. It is easy to see that this is
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56 negative if and only if the condition stated in part (i) of the Proposition holds.
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From the above, the condition in Part (i) is necessary and sufficient for v to fall with a rise in G , and is sufficient, though not necessary, for z to fall as G rises. This proves part (i).

(ii) If $p_{zG} > 0$, the bracketed term in (10) is necessarily positive, so that v rises with a rise in G . With $|f_{pp}| p_z < f_p/v^2 B''(v)$, the sum of the second and third terms in the bracketed expression in (7) is necessarily positive, so that the bracketed expression as a whole is positive for any positive p_{zG} ; thus z also rises with a rise in G . Now consider $p_{zG} < 0$ but $|p_{zG}|/p_G < 1/v^2 B''(v) - |f_{pp}| p_z/f_p$. Multiplying this last condition through by $f_p p_G B''(v)$ and rearranging, we get the condition that the bracketed expression in (7) is positive, so that $dz/dG > 0$. Multiplying this positive bracketed expression through by p_z and rearranging, we obtain

$$[-f_p p_{zG} p_z - f_{pp} (p_z)^2 p_G] B''(v) < f_p p_G p_z / v^2 \quad (11)$$

From (8) and (11), we have

$$-p_{zG} p_z < -p_{zz} p_G$$

which makes the bracketed term in (10) positive, so that $dv/dG > 0$. This proves part (ii).

(iii) If the marginal efficacy of p on f falls very rapidly, so that $|f_{pp}| p_z > f_p/v^2 B''(v)$, the sum of the second and third terms in the bracketed expression in (7) is necessarily negative. Then the bracketed expression as a whole is negative for any $p_{zG} < 0$, so that $dz/dG < 0$ if $p_{zG} < 0$. The bracketed expression, and therefore dz/dG , is positive if and only if p_{zG} is sufficiently strongly positive, that is, if $p_{zG}/p_G > |f_{pp}| p_z/f_p - 1/v^2 B''(v)$. As in part (ii), the bracketed term in (10), and therefore dv/dG , is positive for any $p_{zG} > 0$. If $p_{zG} < 0$, a rise in policing intensity raises v if and only if z and G are not sufficiently strong substitutes, that is, if the condition of part (i) does not hold, i.e., we have $|p_{zG}| p_z < |p_{zz}| p_G$.

QED

The intuition underlying part 1 of Proposition 1 is as follows. This is relevant for items of private security which are most useful when police presence is scant. If private security expenses (such as on guns) are relatively less effective in raising p when policing increases, the initial effect is to reduce the demand for them. Moreover, if the substitutability between z and policing is strong enough, the effect of the lowered demand for z on lowering p outweighs the impact of greater policing which tends to increase p . As a result, the chances of being victimized rise with no change in v . This then propels a reduction in v by keeping or carrying around less cash and valuables. This precautionary behavior in turn reduces the marginal benefit of z by lowering the loss in the event of a successful crime. This factor further reinforces the initial drop in z , so that

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4 incentives to own guns drop with an increase in policing. Note that this result does not follow
5 automatically from the assumption that $p_{zG} < 0$ for guns, which is necessary but not sufficient.
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8 I now turn to the intuition driving parts 2 and 3. Initially, an increase in policing raises
9 the marginal efficacy of z when $p_{zG} > 0$, raising demand for z with v constant. Both the rise in
10 policing and the induced rise in demand for z increase p , reducing the chances of being
11 victimized. This in turn enables people to increase v . This rise in v , in turn, means that more is
12 lost in the event of a criminal's success, thus raising the marginal benefit of z , and further raising
13 z . However, there is also an opposing effect tending to reduce z ; the increase in p reduces f_p , the
14 marginal efficacy of p in reducing the non-victimization probability, and this in turn reduces the
15 overall marginal efficacy of direct private security expenditure on f , prompting a reduction in z .
16 However, this opposing effect is small unless the marginal efficacy of p on f diminishes very
17 fast. Thus spending on complementary expenses, such as burglar alarms, rises as policing does.
18 If the marginal efficacy of p on f does fall very fast, the opposing effect just mentioned is strong;
19 however, if p_{zG} is sufficiently strongly positive, it is still outweighed by the first effect and z rises
20 in G .
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22
23 Now consider the case where z and policing are substitutes but not strong substitutes.
24 Therefore, while an increase in policing initially lowers the demand for z , this reduction in z is
25 too small to overpower the effect of the rise in policing on raising p . Thus, with v constant, the
26 chances of being victimized fall, prompting an increase in v . This in turn increases the amount
27 that would be lost in the event of an attack succeeding, prompting a net increase in z . (Again, if
28 the marginal efficacy of p on f falls very fast, the opposing effect which tends to reduce the
29 demand for z would dominate and z would fall with a rise in G). As noted earlier, while it is
30 reasonable to assume that alarms and police are complements for at least some levels of policing,
31 it may be argued that this complementarity could go away when policing becomes high enough.
32 Nonetheless, alarms are unlikely to become strong substitutes for policing, unlike guns.
33 Therefore, this part of the Proposition indicates that the effect of greater policing on alarms and
34 cash holdings could remain positive even at relatively high levels of policing (provided the
35 marginal efficacy of joint security expenditure on the probability of non-victimization does not
36 diminish too steeply).
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4 *3.1 Interpreting the Sufficient Condition and Empirical Testability*
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6 Proposition 1 shows how an exogenous rise in policing causes a drop in gun use and a drop in
7 cash on hand, provided $|p_{zG}|p_z > |p_{zz}|p_G$. This condition can be interpreted in terms of
8 whether policing is an “inferior input” in crime prevention.
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11 To understand this, visualize crime prevention – proxied by p (for a given level of
12 penalties S) – as an “outcome” resulting from two “inputs”, z and G . An input is called “inferior”
13 when progressively less of it is required to maintain a constant marginal rate of technical
14 substitution (MRTS) as the “output” goes up (along the “expansion path”) (Bear 1965, Syrquin
15 1970). Therefore, policing, G would be an inferior input if and only if less policing is required to
16 maintain a constant MRTS between G and z as p increases. I show below that our sufficient
17 condition of Proposition 1 is identical to the condition that G be an inferior input in crime
18 prevention.
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26 The MRTS here is the rate of tradeoff between z and G required to maintain a constant p ,
27 that is,
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$$29 \text{MRTS} = -dz/dG_{p \text{ constant}} = p_G/p_z \quad (12)$$

30 Now, if and only if G is an inferior input, the curvature of the expansion path towards the z axis
31 implies as z increases with G constant, the “ p ” isoquants would get progressively less steep, that
32 is, using (12),
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$$37 \partial(p_G/p_z)/\partial z < 0$$

38
39 or

$$40 (p_{zG}p_z - p_{zz}p_G)/p_z^2 < 0$$

41 or, given the positive sign of the denominator,
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43

$$44 p_{zG}p_z - p_{zz}p_G < 0 \quad (13)$$

45 Since $p_{zz} < 0$, $p_z > 0$, $p_G > 0$, (13) can hold only if $p_{zG} < 0$, as we have assumed for guns. Moreover,
46 note that given $p_{zG} < 0$, (13) is identical to our sufficient condition of Proposition 1.
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50 To see what our sufficient condition means in empirical terms, imagine that gun
51 ownership z increases while policing G is held constant. This would result in progressively better
52 crime prevention (higher p). Now if policing were relatively less productive compared to guns at
53 these higher levels of crime prevention (so that a small fall in gun ownership would need to be
54 compensated by a large increment in policing to maintain p constant), our sufficient condition
55 would hold. Our results thus predict that if policing is relatively less productive in fighting crime
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(compared to guns owned by private householders) when crime is low (or conversely, if policing is relatively **more** productive compared to private security when crime is **high**), an exogenous rise in policing should reduce gun ownership and use and willingness to carry cash. While I know of no existing empirical work on this issue, the results thus do generate empirically testable implications. Further implications are contained in the results that follow.

3.2 A Result on Penalties

Proposition 2: Consider an increase in criminal penalties, S . Provided the marginal rate of technical substitution between p and S (holding policing constant) is increasing in p , a rise in penalties raises cash kept on hand and reduces crime.

Proof: Totally differentiating (2) and (3) with respect to z , v and S , we obtain

$$\begin{bmatrix} -f_p p_{zz} - f_{pp}(p_z)^2 & -1/v^2 \\ -f_p p_z & B''(v) \end{bmatrix} \begin{bmatrix} dz \\ dv \end{bmatrix} = \begin{bmatrix} f_{pS} p_z \\ f_S \end{bmatrix} [dS] \quad (14)$$

As in the proof of Proposition 1, we solve by Cramer's rule obtaining

$$\frac{dz}{dS} = \frac{f_{pS} p_z B''(v) + f_S / v^2}{A} \quad (15)$$

The denominator is positive from (6). If p and S are substitutes in fighting crime, as is likely, we would have $f_{pS} < 0$, so the sign of the numerator is ambiguous. (If we had $\frac{|f_{pS}| p_z}{f_S} > 1/B''(v) v^2$, then a rise in penalties would decrease z). Similarly we have

$$\frac{dv}{dS} = \frac{1}{A} [-f_p p_{zz} f_S - f_{pp}(p_z)^2 f_S + f_p (p_z)^2 f_{pS}] \quad (16)$$

Again, the denominator is positive from (6). Expressing the condition stated in the Proposition mathematically, we have

$$\frac{\partial(f_S/f_p)}{\partial p} > 0$$

Or

$$\frac{f_{pS} f_p - f_S f_{pp}}{(f_p)^2} > 0 \quad (17)$$

This implies that the numerator of the LHS of (17) is positive, given that the denominator is necessarily positive. But then, the sum of the second and third terms in the bracketed expression in (16) is positive. Given $p_{zz} < 0$, the first term is always positive, so that $dv/dS > 0$

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4 ; a rise in penalties raises cash carried or kept on hand. Computing the overall effect of a rise in
5 penalties on the probability f of not being victimized, we have
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$$\frac{df}{dS} = f_S + f_p p_z \frac{dz}{dS} \quad (18)$$

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8
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10 Substituting (15) into (18) and simplifying,
11

$$\frac{df}{dS} = \frac{B'(v)}{A} [-f_p f_S p_{zz} - f_{pp} f_S (p_z)^2 + f_p f_{pS} (p_z)^2] \quad (19)$$

12
13
14 From (6), the sign of (19) is the sign of the bracketed term. Given $f_p f_{pS} - f_{pp} f_S > 0$, from (17), the
15 sum of the second and third terms in the bracketed expression in (19) is positive. But the first
16 term in the bracketed expression is always positive given $p_{zz} < 0$, so we have $df/dS > 0$. A rise in
17 penalties raises f , reducing the probability of being victimized. *QED*
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19

20 21 22 *Interpretation*

23
24 The interpretation of the condition in the statement of Proposition 2 becomes clear if we now
25 visualize crime prevention as an output f depending on two inputs, p and S ; S is chosen by the
26 government, while p can be affected (through z) by private individuals, holding policing
27 constant. The assumption that the marginal rate of technical substitution between p and S is
28 increasing in p is equivalent to assuming that S is *not* an inferior input. At higher levels of p , the
29 same fall in S must be compensated by relatively larger increments in p to keep crime from
30 increasing. Empirically, the implication is that if a rise in penalties is highly effective relative to
31 a rise in security expenses in combating crime at relatively low levels of crime (when f is
32 relatively high) – or equivalently if security expenses are highly effective relative to penalties at
33 combating crime when crime is *high* – then a rise in penalties S increases cash carried or kept on
34 hand, but at the same time reduces overall crime. It may also result in a reduction in direct
35 private security expenses.
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46 Intuitively, an increase in penalties reduces, through a substitution effect, the marginal
47 efficacy of increasing p , with v constant. This encourages potential victims to cut back on their
48 direct spending on security, z . Provided the marginal rate of technical substitution between p and
49 S is increasing in p , as stated in the Proposition, this fall in z (and therefore p) is modest
50 compared to the rise in S , so the probability of being victimized falls (a net increase in safety).
51 This prompts individuals to increase v . Since this raises the value of the prize lost in the event of
52 a successful attack, this rise in v induces some increase in z , tempering the initial reduction in z .
53 The net effect is to lower the probability of being victimized, with the direct deterrent effect of
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4 penalties overpowering indirect effects via a possible net reduction in private expenses on
5 security.
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8 There is empirical evidence that higher penalties reduce property crime. Kessler and
9 Levitt (1999) examined the immediate effect of sentence enhancements for various crime
10 categories including property crime. They reasoned that if announcements of sentence
11 enhancements generated an immediate sharp drop in the relevant crimes, this would prove a
12 deterrent effect (as the incapacitative effect of sentence enhancements would kick in only later).
13 They found substantial evidence of significant deterrence. Similarly, Machin and Meghir (2004)
14 and Pyle (1989) find, using UK data, that property crime falls as sentences lengthen. While these
15 findings are in tune with my results, I take into account not only the direct deterrent effect of
16 penalties on criminals, but also indirect effects through the channel of private precautions.
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24 *3.3 Discussion*

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26 The results so far have highlighted different channels through which intensified policing can lead
27 to (a) decreased use of guns, even if laws allow gun use for self defense, (b) increased use of
28 burglar alarms and similar “complementary” security equipment, and (c) reduced use of cash
29 particularly if the homeowners rely on guns rather than alarms for self-defense. However there
30 are some additional implications regarding the channels through which policing and penalties
31 affect crime.
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37 I first turn to the effect of penalties on crime. Apart from the incapacitation effect, which
38 this model does not deal with, penalties have a direct deterrent effect on criminals. However, the
39 additional channel that I highlight works through potential victims’ incentives.
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43 Next, I turn to the effect of policing on crime. The direct effect of policing is to reduce
44 criminals’ chances of success, as well as to deter them by increasing the chance that they are
45 caught and punished. However I highlight that policing can affect crime through indirect
46 channels working through potential victims’ incentives. In some circumstances, it can induce
47 greater precautionary behavior where victims try to reduce the prize that a criminal can seize in a
48 single attempt (this happens if the victims’ direct expenses on security are chiefly substitutable
49 for, rather than complementary with, policing). In other circumstances, if victims’ direct
50 expenses on security are chiefly complementary with policing, policing can reduce crime
51 indirectly by increasing victims’ expenses on their security equipment.
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4 **4. Crimes that are not Financially Motivated**
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6 In earlier sections, victims could, in addition to spending directly on security, reduce the “prize”
7 that can be seized in a criminal attempt. However, this second option is missing for crimes that
8 are not financially motivated. Now, let W denote the value which the victim places on his or her
9 safety. I assume that the probability of not being victimized continues to be given by (1).
10

11 One would expect to see a greater response to CCW laws in these more violent crimes
12 (even though this does not hold up to careful empirical examination, see Ayres and Donohue
13 2003). What does a simple theoretical model predict about the interaction of incentives of
14 potential victims to arm themselves against these crimes with the level of policing and penalties?
15
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17 A potential victim who spends z on his own security and places value W on his safety
18 chooses $z = z^*$ where
19

$$20 \quad z^* = \operatorname{argmin} [(1-f(S,p(G,z)))W + z] \quad (20)$$

21 We now have

22 **Proposition 3:** *Potential victims’ incentives to arm themselves with guns against non-financially*
23 *motivated crimes are always decreasing in policing intensity. Assuming z and S are substitutes in*
24 *crime prevention, they are also decreasing in the severity of criminal penalties.*
25

26 **Proof:** From (20), z^* solves the first order condition

$$27 \quad f_p p_z = 1/W \quad (21)$$

28 Totally differentiating (21) with respect to z and G, and rearranging, we obtain

$$29 \quad \frac{dz}{dG} = - \frac{f_{pp} p_G p_z + f_p p_{zG}}{f_{pp} (p_z)^2 + f_p p_{zz}} < 0 \quad (22)$$

30 As, with guns, $p_{zG} < 0$, (22) gives us $dz/dG < 0$ so that potential victims choose to carry guns less
31 often provided policing intensity is increasing.
32

33 As for the effect of penalties, totally differentiating (21) with respect to z and S,

$$34 \quad \frac{dz}{dS} = - \frac{f_{ps} p_z}{f_{pp} (p_z)^2 + p_{zz} f_p} < 0 \quad (23)$$

35 given $f_{ps} < 0$ since z and S are substitutes in crime prevention.
36

37 **QED**

38 In reality, victims need to consider both types of crimes. However, note that, for instance,
39 the conditions for gun ownership or use by potential victims to decline in policing intensity are
40 weaker if only non-financially motivated crimes are considered. Therefore, if guns are
41 sufficiently strong substitutes for policing for gun ownership/use by victims to decline in
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4 policing for financially motivated crimes, then gun use by potential victims will decrease with
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6 policing intensity for *all* crimes.

7 8 **5. Conclusion and Extensions**

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10 This paper provides a theoretical backdrop to the links between different empirical findings on
11 the fall in crime. The increase in policing was a key factor in the decline of crime. Taking this
12 rise in policing as exogenous, I focus on its effects on victims' incentives to (a) use defensive
13 measures like guns which are more useful in badly policed areas, (b) use safety measures like
14 burglar alarms whose efficacy is more complementary to rapid police response, and (c) change
15 the amount of cash or valuables that criminals can seize during a successful attempt. The results
16 are consistent with empirical findings such as the drop in gun use/ownership, or for the increased
17 use of burglar alarms. Moreover, they highlight the fact that policing and sentencing affect crime
18 through several indirect channels in addition to their direct effects.

19
20 Of course, there are many interesting channels from which I have abstracted in the
21 interests of simplicity. In my model, while assuming that criminal attempts are discouraged by
22 higher penalties, I concentrate on the motives of potential victims, without examining criminal
23 motivations.¹⁰ One advantage of this simpler approach, though, is that its informational
24 requirements are not strong. It is enough for criminals to know the level of criminal penalties.
25 Potential victims, of course, know all model parameters, and choose z and v ; but criminals need
26 not be aware of these. If criminals are unaware of z and v , the sole purpose of choosing z is to
27 affect the effectiveness of foiling a given criminal attempt, while the purpose of lowering v is to
28 reduce the loss in the event of a successful attack (rather than to deter attacks in the first place).
29 All results would go through. Therefore, there is no implicit assumption that z and v are known
30 to criminals.

31
32 I have looked at expenditure on private security without considering its price. A possible
33 extension would be to allow for rising gun prices as policing rises. This price effect would then
34 feed back into private demand for guns. Allowing for this effect strengthens the results further:
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57 ¹⁰ If criminal motivations were considered, a further layer of complexity could be added by considering
58 heterogeneous criminals. For example, the worst offenders might require higher penalties to be discouraged from an
59 attempt. Moreover, different private precautions (eg guns and alarms) can cause different degrees of harm to
60 criminals – yet another source of heterogeneity.
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4 an increase in policing would, now, drive up gun use (by police) and therefore the price of guns,
5 bolstering the tendency of private gun ownership to respond negatively to greater policing.¹¹
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8 Yet another possible extension would be to look at a repeated game which takes into
9 account criminals' response to the level of precautions chosen by victims. For instance, if victims
10 arm themselves with guns, criminals may respond by making their own attacks more violent
11 (opting for more arms themselves) leading to an escalation in violence. I do not focus on this
12 problem, because my focus remains on identifying how different private security measures
13 respond to an exogenous increase in policing. Nonetheless, allowing for this "escalation of
14 violence" effect is likely to further reinforce private householders' reluctance to increase their
15 use of guns, given the possible repercussions. This would strengthen their response to an increase
16 in policing (substituting away from gun use towards other private security measures).
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24 While I have modeled financially motivated (property) crime and non-financially
25 motivated crimes, drug-related crime does not fit into either of the categories. I do not attempt to
26 deal with drug-related crime because of two fundamental differences that mark it out from other
27 kinds of crime. First, drug users (and sometimes drug sellers) are addicts, and therefore it is
28 difficult to model them as rational decision makers. Secondly, the distinction between "criminal"
29 and "victim" is not always well-defined. For example, in the case of drug possession, the same
30 individual may be both a criminal and a victim.
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39 **References**

- 40 Amromin, G and S Chakravorti (2009) "Whither Loose Change? The Diminishing Demand for Small-Denomination
41 Currency", *Journal of Money, Credit and Banking* 41(2-3): 315-335.
42
43 Ayres, I and J Donohue (2003) "Shooting Down the 'More Guns, Less Crime' Hypothesis", *Stanford Law Review*
44 55(4) :1193-1312.
45
46 Ayres, I and S Levitt (1998) "Measuring Positive Externalities from Unobservable Victim Precaution: An Empirical
47 Analysis of Lojack", *Quarterly Journal of Economics* 113: 43-77.
48
49 Bac, M (2010) "The interaction between potential criminals' and victims' demand for guns", *Journal of Public*
50 *Economics* 94(5-6) : 337-343.
51
52 Bear, D.V.T (1965) "Inferior inputs and the theory of the firm", *Journal of Political Economy* 73: 287-289.
53
54 Becker, G S. (1968) "Crime and Punishment : An Economic Approach", *Journal of Political Economy* 76: 169-217.
55
56 Ben-Shahar, O. and A. Harel (1995) "Blaming the Victim: Optimal Incentives for Private Precautions Against
57 Crime", *Journal of Law, Economics and Organization* 11: 434-455.
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60 ¹¹However this may not happen if police buy guns at a subsidized rate.
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4 Bolt, W. and S. Chakravorti (2008) “Consumer Choice and Merchant Acceptance of Payment Media”, Federal
5 Reserve Bank of Chicago Working Paper 2008-11.
6
7 Cameron, S. (1988) “The Economics of Crime Deterrence : A Survey ”, *Kyklos* 41(2): 301-323.
8
9 Clements, M.T (2003) “Precautionary incentives for privately informed victims”, *International Review of Law and*
10 *Economics* 23: 237-251.
11
12 Cook, P and J Ludwig (2006) “The Social Costs of Gun Ownership”, *Journal of Public Economics* 90.1-2 : 379-391.
13
14 Cook, P and J Macdonald (2011) “Public Safety Through Private Action: An Economic Analysis of BIDs”
15 *Economic Journal* 121(552): 445-462.
16
17 Cook, P and J Macdonald (2010) “Mobilizing Private Inputs for Crime Prevention”, NBER Economical Crime
18 Control Conference working paper.
19
20 Corman, H and H.N Mocan (2000) “A Time-Series Analysis of Crime, Deterrence and Drug Use in New York
21 City”, *American Economic Review* 90: 584-604.
22
23 Di Tella, R and E Schargrotsky (2004) “Do Police Reduce Crime? Estimates Using the Allocation of Police Forces
24 After a Terrorist Attack”, *American Economic Review* 94(1): 115-133.
25
26 Donohue, J and S Levitt (1998) “Guns, Violence and the Efficiency of Illegal Markets”, *AER Papers and*
27 *Proceedings* 463-467.
28
29 Draca, M, S. Machin and R. Witt (2011) “Panic on the Streets of London: Police, Crime and the July 2005 Terror
30 Attacks”, *American Economic Review* 101(5): 2157-2181.
31
32 Duggan, M (2001) “More Guns, More Crime”, *Journal of Political Economy* 109(5): 1086-1114.
33
34 Ehrlich, I. (1981) “On the usefulness of controlling individuals: An Economic Analysis of Rehabilitation,
35 Incapacitation and Deterrence”, *American Economic Review* 71: 307-322.
36
37 Friedman, J., S. Hakim and U. Spiegel (1987) “The effects of community size on the mix of private and public use
38 of security services”, *Journal of Urban Economics* 22: 230-241.
39
40 Garoupa, N. and F.H Stephen (2004) “Optimal Law Enforcement with Legal Aid”, *Economica* 71: 493-500.
41
42 Glaeser, E and S Glendon (1998) “Who Owns Guns? Criminals, Victims and the Culture of Violence”, *AER Papers*
43 *and Proceedings* 88: 458-462.
44
45 Grossman, H.I and M. Kim (1995) “Swords or Plowshares? A Theory of the Security of Claims to Property”,
46 *Journal of Political Economy* 103(6): 1275-1288.
47
48 Guha, B and A.S Guha (2012) “Crime and Moral Hazard: Does More Policing Necessarily Induce Private
49 Negligence?” *Economics Letters* 115(3): 455-459.
50
51 He, P., L.Huang and R. Wright (2005) “Money and Banking in Search Equilibrium”, *International Economic*
52 *Review* 46: 637-670.
53
54 Humphrey, D.B, L.B Pully and J.M Vesala (1996) “Cash, paper and electronic payments: a cross-country analysis”,
55 *Journal of Money, Credit and Banking* 28(4):914-939.
56
57 Hylton, K.N (1996) “Optimal Law Enforcement and Victim Precaution”, *Rand Journal of Economics* 27: 197-206.
58
59 Kessler, D. and S. Levitt (1999) “Using Sentence Enhancements to Distinguish between Deterrence and
60 Incapacitation”, *Journal of Law and Economics* 42: 343-363.
61
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63
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2
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4 Konrad, K and S. Skaperdas (1998) "Extortion", *Economica* 65: 461-477.
- 5
6 Kosse, A (2011) "The Safety of Cash and Debit Cards: a study on the perception and behavior of Dutch consumers",
7 SSRN De Nederlandsche Bank Working Paper No 245.
- 8
9 Lacroix, G. and N. Marceau (1995) "Private protection against crime", *Journal of Urban Economics* 37: 72-87.
- 10
11 Leeson, P (2007) "Trading with Bandits", *Journal of Law and Economics* 50(2): 303-321.
- 12
13 Levitt, S (1996) "The Effect of Prison Population Size on Crime Rates: Evidence from Prison Overcrowding
14 Litigation", *Quarterly Journal of Economics* 111(2): 319-352.
- 15
16 Levitt, S (1997) "Using Electoral Cycles in Police Hiring to Estimate the Effects of Police on Crime", *American
17 Economic Review* 87(3): 270-290.
- 18
19 Levitt, S (2002) "Using Electoral Cycles in Police Hiring to Estimate the Effects of Police on Crime: A Reply",
20 *American Economic Review* 92(4): 1244-1250.
- 21
22 Levitt, S (2004) "Understanding Why Crime Fell in the 1990s: Four Factors that Explain the Decline and Six that
23 Do Not", *Journal of Economic Perspectives* 18(1): 163-190.
- 24
25 Lin, M.J (2009) "More Police, Less Crime: Evidence from U.S State Data", *International Review of Law and
26 Economics* 29(2): 73-80.
- 27
28 Liu, L. and W.S. Neilson (2006) "Endogenous Private Safety Investment and the Willingness to Pay for Mortality
29 Risk Reductions", *European Economic Review* 50: 2063-2074.
- 30
31 Lott, J and D Mustard (1997) "Right-to-Carry Concealed Guns and the Importance of Deterrence", *Journal of Legal
32 Studies* 26: 1-68.
- 33
34 Machin, S. and C. Meghir (2004) "Crime and Economic Incentives", *Journal of Human Resources* 39(4): 958-979.
- 35
36 Machin, S and O Marie (2011) "Crime and Police Resources: The Street Crime Initiative", *Journal of the European
37 Economic Association* 9(4) : 678-701.
- 38
39 Marvell, T and C. Moody (1996) "Specification Problems, Police Levels and Crime Rates", *Criminology* 34: 609-
40 646.
- 41
42 Mialon, H and T Wiseman (2005) "The impact of gun laws: a model of crime and self-defense", *Economics
43 Letters* 88(2): 170-175.
- 44
45 Miceli, T (2010) "A Model of Criminal Sanctions that Incorporates both Deterrence and Incapacitation", *Economics
46 Letters* 107: 205-207.
- 47
48 Owens, E.G (2009) "More Time, Less Crime? Estimating the Incapacitative Effects of Sentence Enhancements",
49 *Journal of Law and Economics* 52(3): 551-579.
- 50
51 Peltzman, S (1975) "The Effects of Automobile Safety Regulation", *Journal of Political Economy* 83: 677-725.
- 52
53 Pyle, D (1989) "The Economics of Crime in Britain", *Economic Affairs* 9(2): 6-9.
- 54
55 Shavell, S. (1991) "Individual Precautions to Prevent Theft: Private Versus Socially Optimal Behavior",
56 *International Review of Law and Economics* 11: 123-132.
- 57
58 Syrqin, M (1970) "A Note on Inferior Inputs", *Review of Economic Studies* 37: 591-598.
- 59
60
61
62
63
64
65