The Effects of the Fourth Amendment: A Strategic Model of Crime and Search

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Abstract

The Fourth Amendment requires police to have probable cause before searching people or their property in criminal investigations. In practice, it is enforced through the exclusionary rule: if police search without probable cause, any evidence found in the search may be excluded from court. We analyze the effects of this rule on equilibrium elements of social welfare in a strategic model of crime and search. The rule always increases crime. But it has two opposing effects on police searches. It directly reduces them by reducing the chances that they lead to successful conviction, but it also indirectly increases them by increasing crime. If the indirect effect dominates, the rule actually increases searches, and has an ambiguous effect on wrongful searches. If the direct effect dominates, it reduces searches and wrongful searches. In contrast, direct police accountability for wrongful searches unambiguously reduces searches and wrongful searches. JEL K42 H10.

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1. Introduction

The Fourth Amendment to the U.S. Constitution states that:

> [The] right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no Warrants shall issue, but upon probable cause, supported by Oath or affirmation, and describing the place to be searched, and the persons or things to be seized.[2]

People therefore have a constitutional right not to be searched by the police without probable cause.[3] In practice, the Fourth Amendment is enforced through the "exclusionary rule". The police are not directly prevented from searching without probable cause, but if the court subsequently finds that they have done so, then any evidence that they uncovered in this way may be excluded from trial.[4]

In this paper, we develop a strategic model of crime and search that permits a formal analysis of the welfare effects of the Fourth Amendment's exclusionary rule. In the model, citizens choose whether or not to commit crime and the police choose whether or not to search citizens without probable cause. Citizens' choices affect the police's payoffs, and vice-versa. The model is solved for its Bayesian Nash equilibrium probabilities of crime, search, and conviction. Comparative statics are performed with respect to the strength of the exclusionary rule, which is assumed to affect the ultimate conviction probability in cases where the police searched without probable cause.

Several interesting results emerge. In accordance with intuition, a stronger exclusionary rule increases crime. If an individual commits a crime, the evidence against him might

[2] See, for example, Gunther and Sullivan (1997, Appendix A).

[3] The legal definition of probable cause was formulated in Brinegar v. U.S. (338 U.S. 839, 1949). In practice, probable cause exists when it is more likely than not (more than 50 percent certainty) that the items to be seized are connected to the crime and that they can be found in the places to be searched.

[4] Precedent for the exclusionary rule in state crimes was set in Mapp v. Ohio (367 U.S. 643, 1961).

wrongfully indicate that he is innocent, so that the police would not have probable cause to search him. If the police searched him anyway, thereby finding incriminating evidence, then he would likely escape conviction only if this evidence were excluded from trial. Thus a stronger exclusionary rule reduces the expected punishment for committing a crime, and hence increases crime.

However, a stronger exclusionary rule has two conflicting effects on police searches without probable cause. It tends to decrease police searches without probable cause directly by reducing the probability that such searches lead to successful convictions. But it also tends to increase police searches indirectly by increasing crime. A stronger exclusionary rule increases crime, so that for any given number of searches by the police, the police are searching more guilty citizens. The police then respond by increasing their searches without probable cause. If the direct effect dominates, a stronger exclusionary rule reduces police searches and wrongful searches. But if the indirect effect dominates, it increases police searches, and has an ambiguous effect on wrongful searches.

It is more likely to reduce wrongful searches if the police are accountable to the people for their mistakes, in the sense that they suffer a loss, for example in reputation, when they wrongfully search the innocent. Greater police accountability reduces the size of the indirect effect of the exclusionary rule on police searches. A stronger exclusionary rule increases crime, and the police would respond by increasing their searches without probable cause to the extent that the losses that they would suffer in the process are not too large. Thus, the more accountable are the police for their mistakes, the more likely the exclusionary rule's direct effect on searches dominates its indirect effect, and hence the more likely it reduces searches and wrongful searches. Moreover, unlike a strengthening of the exclusionary rule, an increase in police accountability always reduces searches and wrongful searches.

The next section relates the contribution to the existing law and economics literature. Section 3 develops the strategic model of crime and search. Section 4 analyzes the effects of the Fourth Amendment's exclusionary rule on equilibrium elements of social welfare. Section 5 analyzes the separate and interactive effects of police accountability. Section 6 summarizes, draws policy implications, and suggests avenues for further research.

2. Related Literature

There is a large formal literature on the economics of crime and policing, starting with Becker (1968) and Ehrlich (1973). For a survey, see Ehrlich (1996). In this literature, few studies model the strategic interaction between the police and citizens. One notable exception is the racial profiling model of Persico (2002), in which citizens who differ in their race and legal earnings opportunities choose whether or not to commit crime and the police choose whether or not to search citizens, observing their race but not their legal earnings opportunities. Persico's focus is on fairness issues related to the Fourteenth Amendment, which aims to protect against racial discrimination. Our focus is on the Fourth Amendment, which aims to protect against wrongful searches.

We appear to be the first to develop a formal theory of the effects of the Fourth Amendment on crime and police search. There is, though, a substantial empirical literature on the effects of the Fourth Amendment. Early studies on the effects on crime include Oaks (1970), Cannon (1974), Davies (1983), and Crocker (1993). In an important recent study, employing econometric techniques, Atkins and Rubin (2002) find that the 1961 Supreme Court ruling in Mapp v. Ohio, which set the precedent for the Fourth Amendment's exclusionary rule in all states, substantially increased most types of crime, including larceny, auto theft, burglary, robbery, and assault. In our theoretical model, the Fourth Amendment's exclusionary rule unambiguously increases crime, which is consistent with these empirical findings.

On the other hand, empirical studies of the effects of the exclusionary rule on police searches have produced mixed results. Oaks (1970) finds that the rule had no significant effect on arrests by the police in Cincinnati. Cannon (1974) replicated Oaks's Cincinnati research in thirteen other cities and showed that the effect of the exclusionary rule in Cincinnati was not typical. In several other cities, including Baltimore and Buffalo, the exclusionary rule significantly reduced the number of arrests. Based on these studies, the Supreme Court concluded, in U.S. v. Janis (1976), that "No empirical researcher, proponent or opponent of the rule, has yet been able to establish with any assurance whether the rule has a deterrent effect [on police searches]" (428 US 433, at 452, n. 22).

More recently several researchers have used interviews with individual officers (Orfield, 1987, Canon, 1991), and others have used field observation (Skolnick, 1994, Gould and Mastrofski, 2005), as an alternative to official records. The results of these studies are also mixed. Orfield finds that the exclusionary rule has caused police officers from the Narcotics Section of the Chicago police department to use warrants more often and to exercise more care when conducting warrantless searches. Gould and Mastrofski review reports from trained field observers who accompanied police officers from a major metropolitan police department on 115 searches, finding that 30 percent of the searches were in clear violation of Fourth Amendment prohibitions.

Even today, the extant empirical research neither proves nor disproves the inhibitory effect of the exclusionary rule on police searches. In our theoretical model, the Fourth Amendment's exclusionary rule has an ambiguous effect on police searches, which is consistent with the mixed empirical findings. If the rule only weakly increases crime, it strongly reduces police searches, but if it strongly increases crime, it only weakly reduces police searches.

3. Strategic Model of Crime and Search

The model's actors are a unit mass of citizens and a single, coordinated police force. Citizens differ according to their benefit or wage from crime, w_C. At time 1, Nature chooses each citizen's w_C according to a cumulative density function $F(w_C)$, which is assumed to be the uniform distribution defined on the $[0, 1]$ interval.[5] This density function is common knowledge, but the police do not learn its realization.

At time 2, citizens choose an action from the set $\{C, \neg C\}$, that is, they each choose whether or not to commit a crime (C). Their choices at time 2 are not observable to the police. At time 3, Nature chooses the preliminary evidence ε. The random variable ε can be in one of two states, I_ε, meaning that the evidence against the citizen is not probable cause for a search, or G_ε, meaning that this evidence is probable cause.

The quality of the evidence is represented by the parameter $P[I_\varepsilon| \neg C]$, the probability that the evidence is not probable cause given that the citizen did not commit the crime, and the parameter $P[G_\varepsilon|C]$, the probability that it is probable cause given that the citizen did commit the crime. Let $P[I_\varepsilon|\neg C] = P[G_\varepsilon|C] = q$, so that guilty citizens are as likely to generate evidence that is probable cause as innocent citizens are to generate evidence that is not probable cause. The evidence is always more often right than wrong, that is, $q > \frac{1}{2}$.

At time 4, Nature chooses the police's knowledge of the evidence. This random variable can be in one of two states, either the evidence against a citizen comes to the police's attention or it does not. The police are no more likely to come across the evidence if it constitutes probable cause than if it does not. Let π denote the unconditional probability that the evidence comes to the police's attention, which may be larger in places with more

[5] The choice of a uniform distribution is entirely for the sake of computational simplicity. The qualitative results presented in the paper are valid for a general distribution. We have shown this in a technical appendix available on request.

police per capita.

If the evidence does not come to the police's attention, the game is over. If it comes to their attention, then at time 5, the police choose an action from the set $\{S, \neg S\}$, that is, they choose whether or not to search (S) the citizen's property. When the police make their decision, they only know whether or not the evidence is probable cause, that is, whether I_ε or G_ε. If the police have probable cause, they always choose to search. More precisely, if the police learn G_ε, they always choose S.

The police incur a cost c^S to search a citizen's property. Innocent citizens incur a cost η_I of being searched, which measures the extent to which they value their privacy, or equivalently, the costs of having their privacy invaded. The nature and value of privacy is discussed by Posner (1981, 1983), Stigler (1980), and Hirshleifer (1980). Privacy may be interpreted as the ability to conceal personal information that others might use to one's disadvantage. Concealment protects reputation, which is often a valuable asset in relationships. If citizens are searched by the police and the details of the search are then made public, they may suffer a loss of reputation, which may result in the loss of a job or a spouse. Society may thus want to limit the government's ability to obtain, retain and disseminate discrediting personal information.

If the police search an innocent citizen without probable cause, they incur an additional cost η_P, which is a measure of police accountability. The police are accountable for their mistakes if they suffer a loss when they search or arrest innocent citizens without probable cause. The police can be made accountable through the democratic process. With First Amendment rights, if innocent citizens are mistreated by the police, they can assemble outside police headquarters in protest, or report their experiences to the media, which would reduce police reputation. And if government officials face repeated elections, they may be forced to discipline police departments, in order to be re-elected. Police officers could also be made directly accountable, perhaps by making them liable for damages if their searches are unsuccessful. For now, we assume that $\eta_P = \eta_I = \eta$, which corresponds to strict police accountability. In section 5, we relax this assumption to analyze the separate effects of police accountability and its interactive effects with the Fourth Amendment's exclusionary rule.

If the police learn I_ε and choose not to search, the game is over. If they choose to search, at time 6, Nature chooses the verdict v. The random variable v can be in one of two states, I_v, the not guilty verdict, or G_v, the guilty verdict. Define $\alpha_1 = P[I_v|\neg C, G_\varepsilon]$, $\alpha_2 = P[I_v|C, G_\varepsilon]$, $\alpha_3 = P[I_v|\neg C, I_\varepsilon]$, and $\alpha_4 = P[I_v|C, I_\varepsilon]$. Assume that if citizens are innocent and the evidence against them is not probable cause, then the verdict is also always I_v, that is, $\alpha_3 = 1$. And if citizens are guilty and the evidence against them is probable cause, then the verdict is always G_v, that is, $\alpha_2 = 0$. The important parameters are $\alpha_1, \alpha_4 \in (0, 1)$.

The Fourth Amendment protects the right of citizens not to be searched by the police without probable cause. In practice, it is enforced through an exclusionary rule that indirectly constrains police behavior by making evidence produced by unlawful searches less likely to be admissible at trial, and hence reducing the ultimate conviction probability. In the model, the Fourth Amendment's exclusionary rule reduces the conviction probability if the police searched a citizen without probable cause. More precisely, it increases α_4.

If citizens are searched without probable cause, and the search does not uncover reliably incriminating evidence, they are acquitted. But if the search uncovers incriminating evidence, they are likely to be acquitted only if their lawyers can appeal to the exclusionary rule. In practice, the rule tends to result in the acquittal of known criminals. Protecting criminals is not the ultimate objective of the rule, although it is its proximate result. The rule protects the guilty in the hope that "in equilibrium" this will result in fewer innocent citizens being searched. It protects the guilty in order to protect the privacy of the innocent.

The police's utility also depends on the probabilities of the two types of court error. The police's utility from a rightful conviction or a rightful acquittal is 1, its utility from a wrongful acquittal is 0, and its utility from a wrongful conviction is $U_P = U_P(G_v, \neg C)$, where $U_P \leq \; U_P(I_v, C) = 0 < U_P(G_v, C) = U_P(I_v, \neg C) = 1$. A citizen's utility from acquittal is 0 and cost of conviction is s (the sentence length).

Crime, wrongful search, and wrongful conviction are each important components of social welfare. The security, privacy, and freedom of innocent citizens are the basis of a prosperous nation. We study the effects of the Fourth Amendment on these three elements of welfare, and leave the difficult task of weighting their relative importance to policy-makers.

4. Equilibrium, Welfare, and Fourth Amendment

Once citizens have learned their benefit from a crime, they each choose whether or not to commit it. Suppose the police search with probability σ_I when they do not have probable cause. Then if a citizen is of type w_C, his payoffs from each of the two strategies are

$$\begin{aligned} EU_{\text{Ci}\,tizen}(\neg C) &= g(\sigma_I) \text{ and } EU_{\text{Ci}\,tizen}(C) = w_C + h(\sigma_I) \qquad (1) \\ \text{where } g(\sigma_I) &= A_1\sigma_I + A_2,\ h(\sigma_I) = A_3(\alpha_4)\sigma_I + A_4 \\ A_1 &= -\eta\pi q,\ A_2 = -\pi(1-q)[\eta + s(1-\alpha_1)], \\ A_3 &= -s\pi(1-q)(1-\alpha_4),\ A_4 = -s\pi q. \end{aligned}$$

$A_1\sigma_I$ is the probability that police wrongfully search an innocent citizen without probable cause, $\pi q \sigma_I$, times the innocent citizen's cost of being wrongfully searched without probable cause, consisting of a loss of privacy, η, but not of a potential wrongful conviction, since by assumption, if innocent citizens are searched without probable cause, they are always acquitted. A_2 is the probability that police wrongfully search an innocent citizen with probable cause, $\pi(1-q)$, times the innocent citizen's cost of being wrongfully searched with probable cause, consisting of a privacy loss, η, and a potential wrongful conviction, $(1-\alpha_1)s$.

On the other hand, w_C is a citizen's benefit of committing crime, while $A_3(\alpha_4)\sigma_I + A_4$ is the citizen's cost of committing crime. $A_3(\alpha_4)\sigma_I$ is the probability that the evidence wrongfully indicates that criminals are innocent but the police search them anyway, $\pi(1-q)\sigma_I$, times the consequent potential cost of conviction, $(1-\alpha_4)s$, which depends on the probability that criminals can be convicted despite having been wrongfully searched by the police, $1-\alpha_4$. A_4 is the probability that the evidence rightfully indicates that criminals are guilty and the police come across this evidence, πq, times the consequent conviction, s.

A citizen of type w_C chooses $\neg C$ if and only if

$$g(\sigma_I) \geq w_C + h(\sigma_I) \Leftrightarrow w_C \leq g(\sigma_I) - h(\sigma_I). \tag{2}$$

Thus the fraction of citizens who do not commit crime is

$$I(\sigma_I) = F(g(\sigma_I) - h(\sigma_I)) = g(\sigma_I) - h(\sigma_I) = (A_1 - A_3)\sigma_I + (A_2 - A_4). \tag{3}$$

Since $I(\sigma_I)$ is a probability, it must be between 0 and 1. Since $I(\sigma_I)$ is a monotone function of σ_I, if $I(\sigma_I)$ is between 0 and 1 at its minimum and at its maximum, then $0 \leq I(\sigma_I) \leq 1$ for any $\sigma_I \in [0,1]$. Therefore, regardless of whether or not $A_1 - A_3 > 0$, $0 \leq I(\sigma_I) \leq 1$ for any $\sigma_I \in [0,1]$ if $0 \leq (A_2 - A_4) \leq 1$ and $0 \leq A_1 - A_3 + (A_2 - A_4) \leq 1$. This condition is sufficient but not necessary; however, since it simplifies the analysis that follows, we focus on parameter ranges where it is satisfied.

Before considering the police's problem, it is worth noting the effect on crime of an exogenous increase in the police's probability of search. Taking the derivative of expression (3) with respect to σ_I yields $\frac{\partial I(\sigma_I)}{\partial \sigma_I} = A_1 - A_3$, which is positive if and only if $s > \frac{\eta q}{(1-q)(1-\alpha_4)}$. Paradoxically, an increase in the probability of search could increase crime. This would happen if, for example, η is sufficiently large. If the innocent incur a large cost of being searched without probable cause, and they are searched more often without probable cause, then becoming a criminal becomes relatively more attractive for them. In this case, an increase in the probability of search causes the borderline innocent to rebel or turn into criminals.

Suppose the population is distributed according to $(I(\sigma_I),\ G(\sigma_I))$. If the police observe I_ε, their expected payoffs from searching (S) and not searching ($\neg S$) are, respectively,

$$\begin{aligned} EU_{Police}(S|I_\varepsilon) &= \frac{I(\sigma_I)q}{I(\sigma_I)q + G(\sigma_I)(1-q)} B_1 + \frac{G(\sigma_I)(1-q)}{I(\sigma_I)q + G(\sigma_I)(1-q)} B_2(\alpha_4) \qquad (4) \\ EU_{Police}(\neg S|I_\varepsilon) &= \frac{I(\sigma_I)q}{I(\sigma_I)q + G(\sigma_I)(1-q)} \\ \text{where } B_1 &= 1-\eta-c^S,\ B_2 = 1-\alpha_4-c^S. \end{aligned}$$

If the signal of probable cause is perfectly accurate ($q = 1$), the police's expected utility of not searching when the evidence is not probable cause reaches its maximum of 1. Intuitively, if the police know that evidence that is not probable cause can only come from innocent citizens, then if they observe evidence that is not probable cause, they know for certain that the citizen is innocent, and hence their payoff from not searching the citizen is highest.

If the signal of probable cause is perfectly noisy ($q = 1/2$), the police's expected utility of not searching when the evidence is not probable cause is exactly equal to the proportion of citizens who are innocent. If the police know that evidence that is not probable cause is as likely to come from guilty citizens as from innocent ones, then if the police observe evidence that is not probable cause, they are completely in the dark as to whether or not the citizen is innocent, and hence their payoff depends only their prior belief that the citizen is innocent.

We expect the police to randomize in equilibrium. If all citizens commit crime, the police want to search them even without probable cause. But if the police search them without probable cause, they do not all want to commit crime. But if enough of them do not commit crime, the police do not want to search them without probable cause, and so on. We now locate the parameter ranges where randomization occurs.

Proposition 1 *Let* $Z(\sigma_I) := EU_{Police}(S|I_\varepsilon) - EU_{Police}(\neg S|I_\varepsilon)$*,* $\overline{Z} := \max\{Z(\sigma_I) : \sigma_I \in [0,1]\}$*,* $\underline{Z} := \min\{Z(\sigma_I) : \sigma_I \in [0,1]\}$*, and*

$$X := \frac{(1-q)B_2}{(1-q)B_2 + q(1-B_1)}.$$

(1) If $\overline{Z} > 0$*,* $\underline{Z} < 0$*, and* $A_1 - A_3 > 0$*, the game has a unique stable equilibrium*

$$(\sigma_I^* = \frac{X - (A_2 - A_4)}{A_1 - A_3}, I(\sigma_I^*) = X).$$

(2) If $\overline{Z} > 0$*,* $\underline{Z} < 0$*, and* $A_1 - A_3 < 0$*, the game has two stable equilibria,* $(\sigma_I^* = 0, I(\sigma_I^*) = A_2 - A_4)$ *and* $(\sigma_I^* = 1, I(\sigma_I^*) = A_1 - A_3 + A_2 - A_4)$*, and one unstable equilibrium*

$$(\sigma_I^* = \frac{(A_2 - A_4) - X}{-(A_1 - A_3)}, I(\sigma_I^*) = X).$$

(3) If $\overline{Z} < 0$*, the game has a unique stable equilibrium,* $(\sigma_I^* = 0, I(\sigma_I^*) = A_2 - A_4)$*.*
(4) If $\underline{Z} > 0$*, the game has a unique stable equilibrium,* $(\sigma_I^* = 1, I(\sigma_I^*) = A_1 - A_3 + A_2 - A_4)$*.*

Proof. Proofs of propositions are presented in the Mathematical Appendix. ■

The model's parameter space can be partitioned into six regions, four of which have different equilibrium sets. The six regions are illustrated in Figure 1.

The benefits to the police of searching without probable cause depend on the fraction of citizens who commit crime. In Figure 1, the cases where $\underline{Z} > 0$ depict parameter ranges where a large enough fraction of citizens commit crime regardless of the search probability, that the police always find it optimal to increase their search probability, which eventually leads them to always search without probable cause ($\sigma_I^* = 1$). Similarly, the cases where $\overline{Z} < 0$ depict ranges where a small enough fraction of citizens commit crime regardless of the search probability, that the police always find it optimal to decrease their search probability, which eventually leads them to never search without probable cause ($\sigma_I^* = 0$).

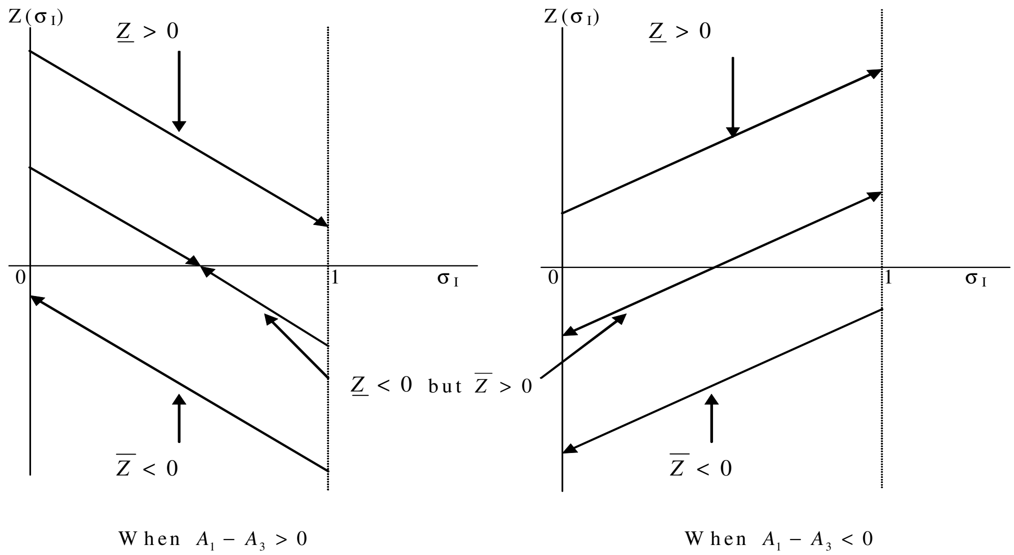

Figure 1: The equilibrium set in the six regions of the model's parameter space.

The cases where $\overline{Z} > 0$, $\underline{Z} < 0$ depict parameter ranges where the police's probability of search affects the fraction of citizens who commit crime to an extent large enough for the police to mind this effect. If $A_1 - A_3 > 0$, an increase in the search probability reduces the fraction of citizens who commit crime. In these parameter ranges, if the police usually search without probable cause, the fraction of citizens who commit crime is small enough that the police want to reduce their search probability. Similarly, if the police usually do not search without probable cause, the fraction of citizens who commit crime is large enough that the police want to increase their search probability. Thus the only stable equilibrium involves the police randomizing between searching and not searching without probable cause.

On the other hand, if $A_1 - A_3 < 0$, an increase in the police's probability of search without probable cause increases the fraction of citizens who commit crime. In these (rebellious) ranges, if the police usually search without probable cause, the fraction of citizens who commit crime is large enough that the police want to increase their search probability even more. If the police usually do not search without probable cause, the fraction of citizens who commit crime is small enough that the police want to reduce their search probability even further. So the only stable equilibria involve the police either searching always or never.

We focus on the only region of parameter space where the equilibrium is both stable and non-extreme, in the sense that the police's equilibrium strategy is neither to search with probability 0 nor 1 when the evidence is not probable case: $\overline{Z} > 0$, $\underline{Z} < 0$, and $A_1 - A_3 > 0$.

From Proposition 1, we know that in this region the equilibrium is

$$I(\sigma_I^*) = X = \frac{(1-q)B_2}{(1-q)B_2 + q(1-B_1)} \text{ and } \sigma_I^* = \frac{X - (A_2 - A_4)}{A_1 - A_3}. \tag{5}$$

Taking the derivative of the equilibrium search probability with respect to the strength of the Fourth Amendment's exclusionary rule yields

$$\frac{\partial \sigma_I^*}{\partial \alpha_4} = \frac{\frac{\partial X}{\partial \alpha_4}(A_1 - A_3) + \frac{\partial A_3(\alpha_4)}{\partial \alpha_4}[X - (A_2 - A_4)]}{(A_1 - A_3)^2}. \tag{6}$$

In the numerator of (6), two opposing effects are at play:

- Direct Effect: A stronger exclusionary rule directly discourages searches by reducing the probability that they lead to rightful convictions.
- Indirect Effect: A stronger exclusionary rule indirectly encourages searches by directly increasing the crime rate and hence increasing the probability that the searches lead to rightful convictions.

More precisely, the direct effect of the exclusionary rule corresponds to the term $\frac{\partial X}{\partial \alpha_4}(A_1 - A_3(\alpha_4))$. The term $\frac{\partial X}{\partial \alpha_4}$ is equal to $\frac{-q(1-q)(1-B_1)}{[(1-q)B_2+q(1-B_1)]^2} < 0$. Also, in the region of parameter space that we are considering, the only region where the equilibrium is both stable and non-extreme, $A_1 - A_3 > 0$. This "stability condition" guarantees that the direct effect is negative, that is,

$$\frac{\partial X}{\partial \alpha_4}(A_1 - A_3(\alpha_4)) < 0. \tag{7}$$

On the other hand, the indirect effect corresponds to the term $\frac{\partial A_3(\alpha_4)}{\partial \alpha_4}[X-(A_2-A_4)]$. The term $\frac{\partial A_3(\alpha_4)}{\partial \alpha_4}$ is equal to $s\pi(1-q)>0$. Also, $X-(A_2-A_4)>0$ in the region of parameter space that we are considering. Therefore,

$$\frac{\partial A_3(\alpha_4)}{\partial \alpha_4}[X-(A_2-A_4)]>0. \tag{8}$$

The direct effect tends to reduce the police's equilibrium probability of search without probable cause, whereas the indirect tends to increase it. If the direct effect dominates, the exclusionary rule reduces the police's search probability. If the indirect effect dominates, it reduces the police's search probability. Here is the necessary and sufficient condition for the direct effect to dominate.

Proposition 2 *A stronger exclusionary rule reduces the police's probability of search without probable cause if and only if*

$$X<\overline{X}:=\frac{(A_1-A_3)+s\pi Y(A_2-A_4)}{(A_1-A_3)+s\pi Y}$$

where $Y=[(1-q)B_2+q(1-B_1)]$.

Let us now analyze the impact of the rule on three important elements of social welfare, crime, wrongful search, and wrongful conviction.

Proposition 3 *A stronger exclusionary rule increases the crime rate but reduces the probability of wrongful conviction. It reduces the probability of wrongful search if* $X<\overline{X}$*, but has an ambiguous effect on the probability of wrongful search if* $X>\overline{X}$*.*

The exclusionary rule reduces the expected cost of crime for citizens. But citizens also expect that the police will increase searches without probable cause as they expect there to be more crime (the indirect effect of the exclusionary rule on searches), which increases the expected cost crime for citizens. These two effects offset each other, leaving only the direct effect of the rule on police searches without probable cause to affect crime. The rule directly reduces police searches without probable cause by reducing the probability that these searches lead to successful conviction, and a reduction in searches increases crime. Thus the exclusionary rule always increases crime, and hence reduces wrongful convictions.

On the other hand, the exclusionary rule tends to reduce wrongful searches without probable cause by increasing crime, and also tends to increase (reduce) wrongful searches without probable cause by increasing (reducing) searches without probable cause. Therefore, if it reduces searches without probable cause (its direct effect on searches dominates its indirect effect), then it unambiguously reduces wrongful searches without probable cause. But if it increases searches without probable cause (its indirect effect dominates), then its overall effect on wrongful searches is ambiguous.

Whether the direct effect of the exclusionary rule dominates its indirect effect depends on several parameters. Let us look at the role played by the probability that the evidence comes to the police's attention, π.

Proposition 4 *A stronger exclusionary rule reduces the police's probability of search without probable cause for a larger range of parameters the larger is* π.

If citizens commit crime they are more likely to generate evidence that is probable cause. The larger is π the more likely this evidence comes to the police's attention. Because an increase in π increases the expected cost of crime, the exclusionary rule does not directly increase crime, and thereby police searches, as much the larger is π. In other words, an increase in π reduces the indirect effect of the exclusionary rule on police searches, making its direct effect more likely to dominate. This suggests that the Fourth Amendment's exclusionary rule should be more likely to reduce police searches without probable cause in places with more police officers or surveillance cameras per capita.

5. Police Accountability

Thus far, we have assumed that $\eta_P = \eta_I = \eta$, that is, the costs that the police incur from invading the privacy of innocent citizens is directly proportional to the costs that citizens incur from having their privacy invaded. This assumption is valid if the police are perfectly accountable to citizens for their mistakes. If the police are not perfectly accountable, $\eta_P < \eta_I$, and the less accountable they are, the lower is η_P relative to η_I. How does police accountability interact with the Fourth Amendment's exclusionary rule?

Proposition 5 *A stronger exclusionary rule reduces the police's probability of search without probable cause for a larger parameter range the larger is η_P.*

The exclusionary rule reduces police searches without probable cause by reducing the probability that such searches lead to successful convictions (the direct effect), but it also directly increases crime. The police would respond to the increase in crime by increasing searches without probable cause (the indirect effect), especially if they did not care too much about searching the innocent in the process. But if the police are wary of wrongfully searching innocent citizens, say because that would harm their reputation, then the indirect effect of the exclusionary rule on police searches without probable cause is smaller. Thus the exclusionary rule is more likely to decrease police searches without probable cause, and hence decrease wrongful searches, the more accountable are the police for their mistakes.

It is also important to analyze the effect of police accountability on the equilibrium behavior of citizens and the police, independently of the exclusionary rule.

Proposition 6 *An increase in η_P reduces the police's probability of search without probable cause and increases crime.*

Although police accountability increases crime, it always reduces police searches without probable cause, and hence reduces wrongful searches, unlike the exclusionary rule, which may or may not reduce wrongful searches. The reason is that police accountability only reduces searches directly by reducing the expected utility of search. It also increases crime, but only because it increases the expected utility of search so that crime must rise in order to make the police indifferent between searching and not searching, not because it directly increases the expected utility of crime. In contrast, the exclusionary rule directly increases the expected utility of crime, and therefore tends to increase searches indirectly, in addition to tending to reduce searches directly by reducing the expected utility of search.

6. Conclusion

The model's principal implications may be summarized as follows. A strengthening of the Fourth Amendment's exclusionary rule increases crime but reduces wrongful convictions. It tends to decrease police searches directly by decreasing the chances that they lead to successful conviction, but also tends to increase them indirectly by increasing crime. If its indirect effect dominates, it increases police searches, and has an ambiguous effect on wrongful searches. If its direct effect dominates, it decreases police searches and wrongful searches. It is more likely to decrease police searches and wrongful searches the larger is the size of the police force relative to the total population, and the more accountable are the police to the people. Police accountability increases crime but unambiguously reduces searches and wrongful searches as well as wrongful convictions.

The results may have policy implications. If society's more pressing objective is to protect the privacy of the innocent, then the model suggests that it is more likely to achieve this objective by increasing police accountability than by strengthening the exclusionary rule. While the exclusionary rule has an ambiguous effect on wrongful searches, police accountability unambiguously reduces wrongful searches, thereby protecting individual privacy. If the social objective is to reduce crime, then the model suggests that the objective is better achieved by weakening the exclusionary rule than by reducing police accountability. Weakening the exclusionary rule reduces crime, and although it directly tends to increase police searches, it also indirectly tends to reduce them by reducing crime. In contrast, reducing police accountability reduces crime but always increases police searches and wrongful searches. Thus, weakening the exclusionary could reduce crime at a lesser sacrifice in individual privacy.

The results may also be useful to the empirical research on the effects of the exclusionary rule on police search practices. The existing research has produced mixed results (see section 2), with some studies finding that the rule reduced searches in some U.S. cities, and other studies finding no effect in other cities. The model suggests that the rule is less likely to inhibit police searches in places with fewer police officers per capita. For example, it should be less likely to reduce police searches in Houston, where the mean number of sworn officers per 100,000 citizens from 1970 to 1992 was one of the lowest in the nation among big cities at 265, than in Chicago, where it was the second highest at 475 (these data are from Levitt, 1997). The model also suggests that the rule is less likely to inhibit searches in places where the police are less accountable. Police accountability at the city level could be measured by whether the city's police chief is elected or appointed. Controlling for these factors and interacting them with the exclusionary rule might improve the empirical estimates of the effects of the rule on police behavior.

A Mathematical Appendix

Proof of Proposition 1. We know that

$$
\begin{aligned}
Z(\sigma_I) &= EU_{Police}(S|I_\varepsilon) - EU_{Police}(\neg S|I_\varepsilon) \\
&= I(\sigma_I)[q(B_1 - 1) - (1-q)B_2(\alpha_4)] + (1-q)B_2(\alpha_4).
\end{aligned}
$$

When $Z(\sigma_I) > 0$, $EU_{Police}(S|I_\varepsilon) > EU_{Police}(\neg S|I_\varepsilon)$, and vice versa.

Case 1: $\overline{Z} > 0$, $\underline{Z} < 0$, and $A_1 - A_3 > 0$. If $A_1 - A_3 > 0$, $I(\sigma_I)$ increases as σ_I increases. Since $[q(B_1 - 1) - (1-q)B_2] < 0$, $Z(\sigma_I)$ is a decreasing function of σ_I. That is, $Z(\sigma_I)$ is at its maximum when $\sigma_I = 0$, and at its minimum when $\sigma_I = 1$. Thus the conditions that $\overline{Z} > 0$ and $\underline{Z} < 0$ mean that $Z(\sigma_I) > 0$ at $\sigma_I = 0$ and $Z(\sigma_I) < 0$ at $\sigma_I = 1$. Since $EU_{Police}(S|I_\varepsilon) > EU_{Police}(\neg S|I_\varepsilon)$ when $\sigma_I = 0$, but $EU_{Police}(S|I_\varepsilon) < EU_{Police}(\neg S|I_\varepsilon)$ when $\sigma_I = 1$, no pure-strategy equilibrium exists. The unique mixed-strategy equilibrium is defined by $Z(\sigma_I) := I(\sigma_I)q(B_1 - 1) + G(\sigma_I)(1-q)B_2 = 0$. Thus

$$I(\sigma_I^*) = \frac{(1-q)B_2}{(1-q)B_2 + q(1-B_1)} = X.$$

Therefore, the police's equilibrium probability of search without probable cause is

$$\sigma_I^* = \frac{X - (A_2 - A_4)}{(A_1 - A_3)}.$$

This mixed-strategy equilibrium is stable. Suppose police perturb their strategy by $\varepsilon > 0$. At $\sigma_I^* + \varepsilon$, $Z(\sigma_I = 0) < 0 \Leftrightarrow EU_{Police}(S|I_\varepsilon) < EU_{Police}(\neg S|I_\varepsilon)$ since $Z(\sigma_I)$ is a decreasing function of σ_I. That is, police would want to decrease their search probability as a result. Any small perturbation from the equilibrium would eventually lead back to the original equilibrium. The conditions that $Z(\sigma_I)|_{\sigma_I=0} > 0$ and $Z(\sigma_I)|_{\sigma_I=1} < 0$ are equivalent to $(A_2 - A_4) < X < A_1 - A_3 + (A_2 - A_4)$.

Case 2: $\overline{Z} > 0$, $\underline{Z} < 0$, and $A_1 - A_3 < 0$. If $A_1 - A_3 < 0, I(\sigma_I)$ decreases as σ_I increases. Given that $[q(B_1 - 1) - (1-q)B_2] < 0$, $Z(\sigma_I)$ is an increasing function of σ_I. That is, $Z(\sigma_I)$ is at its minimum when $\sigma_I = 0$, and at its maximum when $\sigma_I = 1$. Hence, the conditions that $\overline{Z} > 0$ and $\underline{Z} < 0$ mean that $Z(\sigma_I) > 0$ at $\sigma_I = 1$ and $Z(\sigma_I) < 0$ at $\sigma_I = 0$. Since $EU_{Police}(S|I_\varepsilon) > EU_{Police}(\neg S|I_\varepsilon)$ when $\sigma_I = 1$, but $EU_{Police}(S|I_\varepsilon) < EU_{Police}(\neg S|I_\varepsilon)$ when $\sigma_I = 0$, the two pure-strategy equilibria are: $(\sigma_I^* = 0, I(\sigma_I^* = 0))$ and $(\sigma_I^* = 1, I(\sigma_I^* = 1))$. The unique mixed equilibrium is defined by $Z(\sigma_I) := I(\sigma_I)q(B_1 - 1) + G(\sigma_I)(1-q)B_2 = 0$. Thus

$$I(\sigma_I^*) = \frac{(1-q)B_2}{(1-q)B_2 + q(1-B_1)} = X.$$

Therefore, the police's equilibrium probability of search without probable cause is

$$\sigma_I^* = \frac{(A_2 - A_4) - X}{-(A_1 - A_3)}.$$

This mixed-strategy equilibrium is not stable. Suppose police increase their search probability by ε.For $\sigma_I^* + \varepsilon$, $EU_{Police}(S|I_\varepsilon) > EU_{Police}(\neg S|I_\varepsilon)$ since $Z(\sigma_I)$ is an increasing function of σ_I.In this case, police would want to increase their search probability even more, and vice versa. The conditions that $Z(\sigma_I)|_{\sigma_I=0} < 0$ and $Z(\sigma_I)|_{\sigma_I=1} > 0$ are equivalent to $0 < A_1 - A_3 + (A_2 - A_4) < X < (A_2 - A_4)$.

Case 3: $\overline{Z} < 0$. Regardless of $A_1 - A_3 > 0$, the condition that $\overline{Z} < 0$ implies $EU_{Police}(S|I_\varepsilon) < EU_{Police}(\neg S|I_\varepsilon)$ for all $\sigma_I \in [0,1]$. Therefore, the unique pure-strategy equilibrium is $\sigma_I^* = 0$.

Case 4: $\underline{Z} > 0$. Regardless of $A_1 - A_3 > 0$, the condition that $\underline{Z} > 0$ implies $EU_{Police}(S|I_\varepsilon) > EU_{Police}(\neg S|I_\varepsilon)$ for all $\sigma_I \in [0,1]$. Therefore, the unique pure-strategy equilibrium is $\sigma_I^* = 1$.

Proof of Proposition 2. Comparing (7) and (8) in the text, we find that

$$-\frac{\partial X}{\partial \alpha_4}(A_1 - A_3(\alpha_4)) > \frac{\partial A_3(\alpha_4)}{\partial \alpha_4}[X - (A_2 - A_4)]$$

$$\Leftrightarrow \frac{1-X}{[(1-q)B_2 + q(1-B_1)]} > s\pi\left(\frac{X - (A_2 - A_4)}{A_1 - A_3}\right) \Leftrightarrow X < \overline{X} := \frac{A_1 - A_3 + s\pi Y(A_2 - A_4)}{A_1 - A_3 + s\pi Y}$$

where $Y = (1-q)B_2 + q(1-B_1)$.

Proof of Proposition 3. The equilibrium crime rate is $1 - I(\sigma_I^*)$, where $I(\sigma_I^*) = (A_1 - A_3)\sigma_I^* + (A_2 - A_4)$. Differentiating with respect to α_4 yields

$$\begin{aligned}\frac{\partial(1 - I(\sigma_I^*))}{\partial \alpha_4} &= \frac{\partial A_3}{\partial \alpha_4}\sigma_I^* - (A_1 - A_3)\frac{\partial \sigma_I^*}{\partial \alpha_4} = \frac{\partial A_3}{\partial \alpha_4}\sigma_I^* - \frac{\partial X}{\partial \alpha_4} + \frac{\partial A_3}{\partial \alpha_4}\frac{[X - (A_2 - A_4)]}{(A_1 - A_3)} \\ &= -\frac{\partial X}{\partial \alpha_4} > 0.\end{aligned}$$

The probability of a wrongful conviction is $P[G_v, \neg C] = I(\sigma_I^*)(1-q)\pi(1-\alpha_1)$. Differentiating with respect to α_4 yields

$$\frac{\partial P[G_v, \neg C]}{\partial \alpha_4} = \frac{\partial I(\sigma_I^*)}{\partial \alpha_4}(1-q)\pi(1-\alpha_1) < 0.$$

The probability of a wrongful search is $P[S, \neg C] = I(\sigma_I^*)q\pi\sigma_I + I(\sigma_I^*)(1-q)\pi$. Differentiating with respect to α_4 and using the chain rule twice yields

$$\frac{\partial P[S, \neg C]}{\partial \alpha_4} = \frac{\partial I(\sigma_I^*)}{\partial \alpha_4}[q\pi\sigma_I + (1-q)\pi] + \frac{\partial \sigma_I^*}{\partial \alpha_4} I(\sigma_I^*).$$

We know $\frac{\partial I(\sigma_I)}{\partial \alpha_4} < 0$. If $X < \overline{X}$, $\frac{\partial \sigma_I}{\partial \alpha_4} < 0$, so $\frac{\partial P[S,\neg C]}{\partial \alpha_4} < 0$. If $X > \overline{X}$, $\frac{\partial \sigma_I}{\partial \alpha_4} > 0$, so $\frac{\partial P[S,\neg C]}{\partial \alpha_4} \gtrless 0$.

Proof of Proposition 4. From the proof of Proposition 2 above, we know that the direct effect is greater than the indirect effect if and only if

$$\frac{1-X}{[(1-q)B_2 + q(1-B_1)]} > s\pi\left(\frac{X-(A_2-A_4)}{A_1-A_3}\right)$$
$$\Leftrightarrow \frac{1-X}{[(1-q)B_2 + q(1-B_1)]} > s\left(\frac{X - \pi\left[sq - s(1-q)(1-\alpha_1) - \eta(1-q)\right]}{s(1-q)(1-\alpha_4) - \eta q}\right).$$

The left-hand-side is unaffected by the change in π, while the right-hand-side is decreasing as π increases. Thus as π increases, the condition that the direct effect is greater than the indirect effect is more likely to be satisfied.

Proof of Proposition 5. A_3, A_4, and B_2 do not depend on η_P or η_I. In terms of η_P and η_I, $A_1 = -\eta_I\pi q$, $A_2 = -\pi(1-q)[\eta_I + s(1-\alpha_1)]$, and $B_1 = 1 - \eta_P - c^S$. Therefore, only B_1 depends on η_P. Since X is a function of B_1, it is also a function of η_P. From expression (6) in the text, we know that

$$\frac{\partial \sigma_I^*}{\partial \alpha_4} = \frac{\frac{-(1-q)(1-X(\eta_P))}{(1-q)B_2+(1-B_1(\eta_P))}(A_1-A_3) + \frac{\partial A_3(\alpha_4)}{\partial \alpha_4}[X(\eta_P) - (A_2-A_4)]}{(A_1-A_3)^2}$$
$$\Longrightarrow \frac{\partial^2 \sigma_I^*}{\partial \alpha_4 \partial \eta_P} = \frac{(1-q)q}{[(1-q)B_2+(1-B_1(\eta_P))]^2(A_1-A_3)^2}[(A_1-A_3)q(1-2X) - s\pi(1-q)B_2].$$

If the indirect effect dominates the direct effect, so that $\frac{\partial \sigma_I^*}{\partial \alpha_4} > 0$, then

$$-\frac{\partial X}{\partial \alpha_4}(A_1 - A_3) < \frac{\partial A_3(\alpha_4)}{\partial \alpha_4}[X - (A_2 - A_4)] \Longrightarrow -\frac{\partial X}{\partial \alpha_4}(A_1 - A_3) < \frac{\partial A_3(\alpha_4)}{\partial \alpha_4} X$$

$$\Longrightarrow (A_1 - A_3)(1 - X) < s\pi(1-q)B_2 \Longrightarrow q(A_1 - A_3)(1 - X) < s\pi(1-q)B_2.$$

so that $\frac{\partial^2 \sigma_I^*}{\partial \alpha_4 \partial \eta_P} < 0$. Similarly, if the direct effect dominates, so that $\frac{\partial \sigma_I^*}{\partial \alpha_4} > 0$ then $\frac{\partial^2 \sigma_I^*}{\partial \alpha_4 \partial \eta_P} > 0$. Hence, the exclusionary rule reduces search for a larger parameter range the higher is η_P.

Proof of Proposition 6. From Proposition 1, we know that in equilibrium

$$\sigma_I^* = \frac{X - (A_2 - A_4)}{A_1 - A_3} \text{ and } I(\sigma_I^*) = X = \frac{B_2(1-q)}{(1-q)B_2 + q(1 - B_1(\eta_P))}.$$

But $\partial X / \partial \eta_P < 0$. Thus the crime rate is higher, and the police's probability of search without probable cause is lower, the higher is η_P.

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