The Effects of the Fourth Amendment: An Economic Analysis

Hugo M. Mialon and Sue H. Mialon[1]

Abstract

We develop an economic model of crime and search that allows us to analyze the effects of the Fourth Amendment's exclusionary rule on crime and privacy. We find that the rule always increases crime, but has two opposing effects on searches. It directly reduces searches by reducing the chances that they lead to successful conviction, but it also indirectly increases them by increasing crime. If its indirect effect dominates, the rule actually increases searches, and has an ambiguous effect on wrongful searches. If its direct effect dominates, it reduces wrongful searches, thereby protecting privacy. Its direct effect is more likely to dominate the greater is the number of police officers per capita, the lower is the police's incentive to simply close cases, and the more accountable the police are for their mistakes. Police accountability also increases crime, but unambiguously reduces wrongful searches. We also explore the effects of long-term progress in search technology on crime and privacy. JEL K42 H10.

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[1] Department of Economics, Emory University, Atlanta, GA 30322-2240 (e-mail: hmialon@emory.edu and smialon@emory.edu). We are especially grateful to Preston McAfee, Max Stinchcombe, Tom Wiseman, the Editor, Ian Ayres, and two anonymous referees for extensive feedback. For comments, we thank Don Freeman, Greg Hess, Fahad Khalil, Chuck Mason, Tarun Saberwal, Chris Sanchirico, participants in seminars at Florida International University, Claremont McKenna College, Louisiana State University, the University of Miami, the University of Texas at Austin, the University of Washington at Seattle, the University of Wyoming, and participants in the 2005 Law and Economics Workshop at SUNY Stony Brook.

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 thus have a constitutional right not to be searched by the police without probable cause.[3] This right is designed to protect people's privacy by reducing wrongful searches. In practice, it is enforced through the "exclusionary rule." The police are not directly prevented from searching without probable cause, but if they do search without probable cause, then any evidence that they uncover in this way may be excluded from trial.[4]

We develop an economic model of crime and search that allows a formal analysis of the effects of the Fourth Amendment rule on crime and privacy. In the model, citizens choose whether to commit crime and the police choose whether to search citizens without probable cause. Citizens' choices affect the police's payoffs, and vice-versa. The model is solved for its equilibrium probabilities of crime and wrongful search. 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.

In accordance with intuition, a stronger exclusionary rule increases crime. If an individual commits a crime, the evidence against him might wrongfully indicate that he is innocent, so that the police would not have probable cause to search him. If the police searched him

[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).

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 a greater number of 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, and therefore on privacy.

The exclusionary rule is more likely to reduce wrongful searches if the number of police officers or cameras per capita is greater, the police care more about the guilty being convicted and the innocent being acquitted and less about people simply being convicted to close cases, or the police are more accountable to the people for their mistakes in the sense that they suffer a greater loss from wrongfully searching the innocent. These conditions reduce the magnitude of the indirect effect of the exclusionary rule on police searches. Consider police accountability. A stronger exclusionary rule increases crime, and the police respond by increasing their searches without probable cause to the extent that the losses that they incur in the process are not too large. Thus, the more accountable the police are for their mistakes, the more likely the rule's direct effect on searches dominates, and hence the more likely it reduces searches and wrongful searches, and thus protects privacy. Also, an increase in police accountability increases crime but always reduces searches and wrongful searches.

To derive these results, we focus on the equilibrium in which the police's probability of search without probable cause is between 0 and 1. But the model also has an equilibrium type in which the police always search and many citizens commit crime, an anti-Utopian type of equilibrium, and an equilibrium type in which the police never search without probable cause and few citizens commit crime, a Utopian type of equilibrium. In the last part of our analysis, we examine whether long term progress in search technology leads to a Utopian or an anti-Utopian outcome in the model. We find that it can lead to a Utopian outcome with little crime and great privacy if police accountability is sufficiently high, and to an anti-Utopian outcome with high crime and no privacy otherwise.

The next section relates the contribution to the existing law and economics literature. Section 3 develops the economic model of crime and search. Section 4 analyzes the effects of the exclusionary rule on crime and privacy. Section 5 analyzes the separate and interactive effects of police accountability. Section 6 discusses the implications of long-term progress in search technology. Section 7 summarizes and draws policy and empirical implications.

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). However, 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 to commit crime and the police choose whether to search citizens, observing only their race. 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.

A growing literature employs economic theory to analyze the effects of the individual rights guaranteed by the amendments to the U.S. Constitution. For example, Seidmann (2005) and Mialon (2005) analyze the effects of a right to silence, which is guaranteed by the Fifth Amendment, Gay et al. (1989) analyze the effects of a right to trial by jury, guaranteed by the Sixth Amendment, and Palmer and Henderson (1998) and Andreoni (1991) analyze issues related to the Eighth Amendment right against cruel or unusual punishment.

However, economic theory has rarely been applied to analyze the effects of Fourth Amendment rights. Besides our model, the only other formal economic model of the effects of Fourth Amendment rules is Dharmapala and Miceli (2003). They model the strategic interaction between the courts and the police, and focus on the possibility that the police might plant evidence. They derive important results concerning the effects of Fourth Amendment rules on court errors. In contrast, we model the strategic interaction between citizens and the police, and focus on the possibility that the police might mistakenly search innocent citizens. Our results concern the effects of Fourth Amendment rules on criminal and police behavior.

There is, though, a substantial empirical literature on the effects of the Fourth Amendment on crime and policing. Early studies on the effects on crime include Oaks (1970) and Cannon (1974). In a recent study, employing econometric techniques, Atkins and Rubin (2003) 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, Cannon, 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.

Our economic model implies that crime and police search are determined simultaneously, and that the exclusionary rule directly reduces illegal searches, but also indirectly increases illegal searches by directly increasing crime. The existing empirical studies on the effects of the exclusionary rule on (illegal) searches and arrests have not addressed the simultaneity of crime and police search, and have not accounted for the indirect effect of the exclusionary rule on police searches through its direct effect on crime. The results of these studies may therefore be statistically biased.

3. Economic 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 does not provide probable cause for a search, or G_ε, meaning that this evidence provides probable cause.

The quality of the evidence is represented by the parameter $P[I_\varepsilon| \neg C]$, the probability that the evidence does not provide probable cause given that the citizen did not commit the crime, and the parameter $P[G_\varepsilon|C]$, the probability that it does provide 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 providing probable cause as innocent citizens are to generate evidence that does not provide 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. We assume the police are no more likely to come across the evidence if it provides probable cause than if it does not. Let π denote the probability that the evidence comes to the police's attention; it may be larger in places with more police per capita.

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

If the evidence does not come to the police's attention, the game ends. If the evidence comes to their attention, but does not provide probable cause, 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. If probable cause evidence comes to their attention, they always choose S.[6]

The police incur a cost c^S to search a citizen. Innocent citizens incur a cost η_I of being searched, which measures their cost of having their privacy invaded. The nature and value of privacy are discussed by Posner (1981, 1983), Stigler (1980), and Hirshleifer (1980). Privacy may be interpreted as one's 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.

For innocent citizens, the costs of having their privacy invaded are exacerbated by feelings that these penalties are not deserved. It is not simply that they have to pay a penalty, but that they have to pay a penalty for something they did not do. For this reason, they may feel that an injustice has been committed against them. Guilty citizens may also suffer a penalty from having their privacy invaded, but they cannot feel as badly that this penalty was not deserved. Injustice is only experienced by the innocent. Thus, we normalize the cost that the guilty incur from having their privacy invaded to zero, and assume that η_I is positive. Only the results presented in section 6, on long-term progress in search technology, depend

[6] We assume that the police know whether the evidence provides probable cause if they observe it. Learning search laws is a part of police training. In the U.S., the actual content of the training program varies from state to state, but always includes subject areas in the laws of search and arrest. Moreover, police officers who work in the field are periodically informed about any important changes in laws (Roberg, Novak, and Cordner, 2005). We have also looked at an extension of the model in which the police observe the preliminary evidence but only receive an imperfect signal about whether it provides probable cause, and the paper's main qualitative results continued to hold.

on the assumption that the innocent suffer a larger cost of having their privacy invaded than do the guilty. The other results in the paper continues to hold if we relax this assumption.

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 illegally searched by the police, they can assemble outside police headquarters in protest, or report their experiences to the media, so that the police might suffer a costly loss in reputation. Furthermore, if government officials face repeated elections, they may be forced to discipline police departments, in order to be re-elected. Another way to ensure police accountability is to make police officers liable for tort damages if they search innocent citizens without probable cause. A system of tort liability for police who carry out wrongful searches, as discussed in Posner (1981), increases the cost that the police incur from illegally searching innocent citizens, like an increase in police accountability through the democratic process. 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, which can be in one of two states, I_v, the not-guilty verdict, or G_v, the guilty verdict. Let $\alpha_1 = P[I_v|\neg C, G_\varepsilon]$ be the probability that an innocent citizen is acquitted if the citizen is searched with probable cause, $\alpha_2 = P[I_v|C, G_\varepsilon]$ be the probability of acquittal if a guilty citizen is searched with probable cause, $\alpha_3 = P[I_v|\neg C, I_\varepsilon]$ be the acquittal probability if an innocent citizen is searched without probable cause, and

$\alpha_4 = P[I_v|C, I_\varepsilon]$ be the acquittal probability if a guilty citizen is searched without probable cause. The probability of acquittal is lowest for a guilty citizen who is searched with probable cause, and highest for an innocent citizen who is searched without probable cause. To simplify, we set $\alpha_2 = 0$ and $\alpha_3 = 1$, and keep $\alpha_1, \alpha_4 \in (0, 1)$.

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.

We assume that $\alpha_4 < 1$. It may be impossible to set $\alpha_4 = 1$ because the precedents for the exclusionary rule tend to erode over time as the courts are reluctant to free plainly guilty plaintiffs. Since *Mapp v. Ohio*, which set the precedent for the exclusionary rule, the courts have carved out numerous exceptions to the rule, including the impeachment exception, the independent source exception, the inevitable discovery exception, the good faith exception, the harmless error exception, and the rule of attenuation, among others. Jackson (1996) provides a summary of each of the exceptions to the exclusionary rule that have arisen since

Mapp, and documents the steady erosion of Fourth Amendment protections over time.

There is also another reason why it may be impossible to set $\alpha_4 = 1$. In the model, we assume that the police know whether the preliminary evidence provides probable cause if they observe it, but we do not assume that, if the case later goes to court, the judge or jury knows for certain whether the preliminary evidence provided probable cause at the time of the search. In reality, the court may not know exactly what preliminary evidence the police observed at the time of their search. Moreover, if the police searched without probable cause, they may choose to conceal or misrepresent that evidence to ensure that their search is not thrown out. In part for these reasons, the court outcome is uncertain when a guilty citizen is searched without probable cause even when the Fourth Amendment exclusionary rule strictly dictates that searches without probable cause be excluded from trial. The court may not learn that the search was illegal. But the stronger is the exclusionary rule and the greater are the efforts to enforce it (which include interrogating the police officers who conducted the search), the more likely the court learns that the search was illegal, and the more likely the citizen is acquitted, that is, the higher is α_4.

The police's utility also depends on the two types of court error and on convictions. The police want people to be convicted if they are guilty and acquitted if they are innocent. But the police may also simply want convictions, because convictions close cases. Thus, we assume that the police's utility from a correct conviction is $1 + k$, where $k \geq 0$, their utility from a correct acquittal is 1, their utility from a wrongful conviction is k, and their utility from a wrongful acquittal is 0. If $k = 0$, the police want people to be convicted only if they are guilty, and do not want to close cases for other reasons. If $k > 0$, the police receive a premium for simply closing cases. In this case, they prefer a correct conviction to a correct acquittal, and a wrongful conviction to a wrongful acquittal.

This formulation of police utility motivates the notion of police accountability and the Fourth Amendment's exclusionary rule defined above. If the police care about closing cases as well as protecting the security of citizens, while society cares about protecting the privacy as well as the security of citizens, then society may want to exclude evidence that the police obtain without probable cause or make the police accountable for searching without probable cause by imposing a cost on them if they search innocent citizens without probable cause. This cost (η_P in our model), like the Fourth Amendment's exclusionary rule, is motivated by the possible conflict between the objectives of the police and society.

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. 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

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

$A_1\sigma_I$ is the probability that police wrongfully search an innocent citizen without probable cause, $q\pi\sigma_I$, 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, $(1-q)\pi$, 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 a 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, $(1-q)\pi\sigma_I$, 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, $q\pi$, 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

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

$I(\sigma_I)$ is a probability so it must be between 0 and 1. Since $I(\sigma_I)$ is a monotone function of $\sigma_I \geq 0$, if $I(\sigma_I)$ is between 0 and 1 at its minimum and maximum, $0 \leq I(\sigma_I) \leq 1$ for any $\sigma_I \in [0,1]$. Thus, 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, to simplify the analysis, 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, if parameter values are extreme enough, an increase in the probability of search could increase crime. This would happen if, for example, η is very high. If the innocent incur a very high cost of being searched, and they are searched more often, then becoming a criminal becomes relatively more attractive for them. If they have to suffer the cost of being treated like a criminal, and this cost is high enough, then they might as well also derive the benefit from actually being a criminal. In this case, an increase in the probability of search causes the borderline innocent to rebel or turn into criminals.[7]

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,

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

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

[7] We analyze the particular regions of the model's parameter space where this unusual effect occurs in section 6, where we consider the effects of long-term progress in search technology.

provide probable cause is as likely to come from guilty citizens as from innocent ones, then if the police observe evidence that does not provide 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 that there are parameter ranges where the police randomize in equilibrium. The game between potential criminals and the police is essentially a game of inspection, in which we expect randomization. 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. In strategic interaction of this kind, a mixed strategy equilibrium arises most naturally. We now locate the parameter ranges where randomization occurs.

Proposition 1 *Let* $Z(\sigma_I) := X - (A_1 - A_3)\sigma_I - (A_2 - A_4)$, $\overline{Z} := \max\{Z(\sigma_I) : \sigma_I \in [0,1]\}$, *and* $\underline{Z} := \min\{Z(\sigma_I) : \sigma_I \in [0,1]\}$, *where*

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

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

Figure 1: The stable equilibrium probabilities of search without probable cause in the six regions of the model's parameter space.

From (4), $EU_{Police}(S|I_\varepsilon) - EU_{Police}(\neg S|I_\varepsilon) \lesseqqgtr 0$ if $X - I(\sigma_I) \lesseqqgtr 0$. Thus, given $I(\sigma_I) \geq 0$, the police always search without probable cause if $X - I(\sigma_I) > 0$, randomize between searching and not searching without probable cause if $X - I(\sigma_I) = 0$, and never search without probable cause if $X - I(\sigma_I) < 0$.From (3), citizens' best response function is $I(\sigma_I) = (A_1 - A_3)\sigma_I + (A_2 - A_4)$ for any given σ_I. Substituting citizens' best response function into the expression $X - I(\sigma_I)$, we obtain the function $Z(\sigma_I) := X - (A_1 - A_3)\sigma_I - (A_2 - A_4)$, which is maximized and minimized over σ_I at $\overline{Z}$ and $\underline{Z}$ respectively. In Proposition 1, the function $Z(\sigma_I)$ and the signs of $\overline{Z}$, $\underline{Z}$, and $(A_1 - A_3)$ are used to partition the parameter space into six regions, and derive the Bayesian Nash equilibria in each of them. The six regions are illustrated in Figure 1, with arrows pointing to the probabilities of search without probable cause in the stable equilibria in each of the six regions.

The cases where $\underline{Z} > 0$ depict parameter ranges where the police's expected utility from searching without probable cause is always greater than the expected utility from not searching without probable cause, regardless of the fraction of citizens who commit crime, that is, $X - I(\sigma_I) > 0$ for all $I(\sigma_I) \in [0,1]$. Thus, the police always search without probable cause, $\sigma_I^* = 1$, and the fraction of citizens who do not commit crime is $I(\sigma_I^*) = A_1 - A_3 + A_2 - A_4$. The cases where $\overline{Z} < 0$ depict ranges in which the police's expected utility from searching without probable cause is always smaller than the expected utility from not searching without probable cause, regardless of the fraction of citizens who commit crime, that is, $X - I(\sigma_I) < 0$ for all $I(\sigma_I) \in [0,1]$. Thus, the police never search without probable cause, $\sigma_I^* = 0$, and fraction of citizens who do not commit crime is $I(\sigma_I^*) = A_2 - A_4$.

The cases where $\overline{Z} > 0$ and $\underline{Z} < 0$ depict parameter ranges where the police's probability of search without probable cause depends on the fraction of citizens who commit crime. If $A_1 - A_3 > 0$, $\frac{\partial I(\sigma_I)}{\partial \sigma_I} > 0$. That is, 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. This equilibrium occurs where $Z(\sigma_I) = X - (A_1 - A_3)\sigma_I - (A_2 - A_4) = 0$, so that $\sigma_I^* = \frac{X-(A_2-A_4)}{A_1-A_3}$, $I(\sigma_I^*) = X$.

On the other hand, if $A_1 - A_3 < 0$, $\frac{\partial I(\sigma_I)}{\partial \sigma_I} < 0$. 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, that is $\sigma_I^* = 0$ and $I(\sigma_I^*) = A_2 - A_4$) or $\sigma_I^* = 1$ and $I(\sigma_I^*) = A_1 - A_3 + A_2 - A_4$).

For now, to analyze the effects of changes in the strength of the exclusionary rule, we focus on the only region of parameter space with a stable equilibrium in which the police search with a probability between 0 and 1 when the evidence does not provide probable cause: $\overline{Z} > 0$, $\underline{Z} < 0$ and $A_1 - A_3 > 0$. This is the only parameter range where the police are responding to marginal changes in their incentives.

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. First, there is the direct effect: a stronger exclusionary rule directly discourages searches by reducing the probability that they lead to rightful convictions. Second, there is the 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 $\frac{-q(1-q)(1-B_1)(1+k)}{[(1-q)B_2+q(1-B_1)]^2} < 0$. Moreover, in the only region of parameter space considered where the mixed-strategy equilibrium is stable, $A_1 - A_3 > 0$. 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 $s\pi(1-q)>0$. Furthermore, $X-(A_2-A_4)>0$ in the region of parameter space considered. 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 effect tends to increase it. If the direct effect dominates, the exclusionary rule reduces the police's search probability. If the indirect effect dominates, the rule increases 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*

$$X<\overline{X}:=\frac{(1+k)(A_1-A_3)+s\pi Y(A_2-A_4)}{(1+k)(A_1-A_3)+s\pi Y},$$

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 the police to increase searches without probable cause when the police expect crime to be higher (the indirect effect of the exclusionary rule on searches), which increases the expected cost of 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.

However, 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. Consider the role played by the utility that the police derive from simply closing cases, k.[8]

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

The exclusionary rule directly reduces searches without probable cause by increasing the probability that these searches are thrown out, but also indirectly increases these searches by increasing crime. But the more the police care about closing cases, the less an increase in the probability that their searches are thrown out deters them from searching, and therefore the smaller is the exclusionary rule's direct effect on illegal searches. Moreover, the more the police care about closing cases, the more they increase their searches in response to an increase in crime, and therefore the larger is the exclusionary rule's indirect effect on illegal searches. Hence, the greater is the police's utility from simply closing cases, the smaller

[8] In the following propositions, when we write "for a larger range of parameters" we are referring to proper supersets.

is the direct effect, and the larger is the indirect effect, of the exclusionary rule on illegal searches, and hence the more likely the exclusionary rule actually increases illegal searches.

Next, consider the probability that the evidence comes to the police's attention, π.

Proposition 5 *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 provides 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 is 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 cost that the police incur from invading the privacy of innocent citizens is directly proportional to the cost 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 6 *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 do not suffer too great a loss from 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 7 *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 thus 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.

This result may be relevant to the debate, initiated by Posner (1981), about the merit of the exclusionary rule relative to a system a tort liability for police who carry out illegal searches. It provides a new argument in favor of tort liability over the exclusionary rule (which was not made in Posner, 1981, and has not been made in the subsequent literature). Tort liability for police officers produces no indirect effect on illegal searches, and therefore always reduces illegal searches, whereas the exclusionary rule indirectly increases illegal searches by increasing crime, and therefore may not reduce illegal searches.

6. Long-Term Progress in Search Technology

Thus far we have focused on the only region of the model's parameter space with a stable equilibrium in which the police do not search with probability 0 or 1. This region is $\overline{Z} > 0$, $\underline{Z} < 0$ and $A_1 - A_3 > 0$ (the second region in the first half of Figure 1). This is the only region that gives rise to an equilibrium that resembles the current state of interaction between citizens and the police.

However, the model also has five other regions with stable equilibria in which the police either never search without probable cause or always search. There are two types of stable equilibria that arise in these regions, one in which the police always search and many citizens commit crime, an anti-Utopian type of equilibrium, and one in which the police never search without probable cause and few citizens commit crime, a Utopian type of equilibrium. For example, in regions $\underline{Z} < 0$, and $A_1 - A_3 > 0$ or $A_1 - A_3 < 0$ (the bottom regions in Figure 1), only a stable Utopian equilibrium arises.

Long-term progress in police search technology could alter the parameters of the model sufficiently to propel the interaction between citizens and the police out of region $\overline{Z} > 0$, $\underline{Z} < 0$ and $A_1 - A_3 > 0$, toward another region where the equilibrium may be either Utopian or anti-Utopian. An interesting question, which we can address within the context of our model, is whether long-term progress in search technology will lead to a Utopian or an anti-Utopian equilibrium.

In the future, police search technologies (such as satellites, x-rays, biometric measures and DNA testing) will become increasingly accurate and omniscient. In terms of our model, α_1

(the probability of acquittal if a citizen did not commit the crime but is nevertheless searched without probable cause) will increase because search technologies will become more accurate, and π (the probability that evidence comes to the police's attention) will increase because search technologies will become more omniscient.

If α_1 and π increase sufficiently, we would move from region $\overline{Z} > 0$, $\underline{Z} < 0$ and $A_1 - A_3 > 0$, to region $\underline{Z} < 0$ and $A_1 - A_3 > 0$ (the bottom region in the first half of Figure 1), where the unique stable equilibrium is Utopian. As α_1 and π increase, the relative expected costs of committing crime increase and thus crime decreases. Thus, if α_1 and π increase sufficiently, a small enough fraction of citizens commit crime that the police always want to reduce their search probability, until they are never searching without probable cause. Therefore, if progress in search technology only increases α_1 and π, it leads to an outcome in which few citizens commit crime and the police never search: a Utopian outcome.

But search technologies may also become increasingly invasive (as they become increasingly accurate and omniscient), which might cause a greater loss of privacy if citizens are searched. For example, if the police had search technologies capable of constantly monitoring citizens' actions and even thoughts (as in Orwell's *Nineteen Eighty-Four*), or uncovering citizens' genetic predispositions toward crime, and if they used these technologies to search citizens without probable cause, then citizens would incur a tremendous loss of privacy. In terms of our model, η_I (citizens' cost of privacy invasion) would increase.

If η_I increases sufficiently (along with α_1 and π), then $A_1 - A_3$ becomes negative. Thus, we would move from region $\overline{Z} > 0$, $\underline{Z} < 0$ and $A_1 - A_3 > 0$ to a region where $A_1 - A_3 < 0$ (a region in the second half of Figure 1), that is, a rebellious/mutual trust region where high search probabilities are associated with high crime and low search probabilities are associated with low crime. There are three such regions, one in which only a stable Utopian equilibrium arises, one in which only a stable anti-Utopian equilibrium arises, and one in which both a stable Utopian and a stable anti-Utopian equilibrium arise.

But if police accountability is sufficiently high, that is, η_P is sufficiently high, then the increase in η_I (along with α_1 and π) leads to a Utopian equilibrium, while if η_P is sufficiently low, then it leads to an anti-Utopian equilibrium. The intuition is straightforward. If the police are not accountable, then they suffer few losses from invading the privacy of the innocent. Thus, the probability of search without probable cause is higher. With progress in search technology, citizens' cost of having their privacy invaded rises sufficiently that high search probabilities are associated with high crime. If innocent citizens have to suffer the costs of being treated like criminals, and these costs are high, then they find it in their interest to at least derive the benefits from actually being criminals. For this reason, more innocent citizens rebel and commit crime. Since crime is higher, the police respond by increasing their search probability even further, which increases crime even more, until the police are always searching without probable cause and crime is at its highest: an anti-Utopian outcome.

However, if the police are accountable, then they suffer large losses from invading the privacy of the innocent. Thus, the probability of search without probable cause is lower. With progress in search technology, citizens' cost of having their privacy invaded rises sufficiently so that lower search probabilities are associated with lower crime. Since crime is lower, the police respond by reducing their search probability even further, which reduces crime even more, and so on until the police never search without probable cause and crime is at its lowest: a Utopian outcome.

This analysis implicitly assumes that the police have better control of emerging technology than the population. Otherwise citizens might possess new hiding technology to counter the police's new search technology. In this case, technological progress would not increase

η_I, α_1 or π, so that the interaction would remain in the region where the stable equilibrium is in mixed strategies, which we analyzed in the previous sections.

7. Conclusion

We performed an economic analysis of the effects of the Fourth Amendment's exclusionary rule on crime and privacy. We found that the rule tends to decrease police searches directly, but also tends to increase them indirectly by increasing crime. If the indirect effect dominates, the rule increases police searches, and has an ambiguous effect on wrongful searches. If the direct effect dominates, it decreases police searches and wrongful searches. It is more likely to decrease police searches and wrongful searches, thereby protecting privacy, the greater is the number of police per capita, the lower is the police's benefit from simply closing cases, and the more accountable are the police to the people. Police accountability increases crime but reduces wrongful searches. Long-term progress in search technology may lead to low crime and high privacy if the police are sufficiently accountable, and to high crime and no privacy otherwise.

Several of the results may have short-term 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 of individual privacy.

Several of the results may also be useful to the empirical research on the effects of the exclusionary rule on police search practices. The existing empirical studies have 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. However, these studies have not accounted for the simultaneity of crime and police search, nor for the indirect effect of the exclusionary rule on police searches through its direct effect on crime. The economic model developed in this paper implies that crime and police search are determined simultaneously, and that the exclusionary rule directly reduces illegal searches, but also indirectly increases illegal searches by directly increasing crime. According to the theory, a simultaneous equation regression model is required to correctly estimate the impact of the exclusionary rule on police searches. The first equation would regress crime on the exclusionary rule, police searches, and other determinants of crime. The second equation would regress police searches on the exclusionary rule, crime, and other determinants of searches. The empirical model would yield estimates of both the direct and indirect effects of the exclusionary rule on police searches.

Moreover, the theory 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 large cities at 265, than in Chicago, where it was the second highest at 475 (see Levitt, 1997). The theory 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 further improve the empirical estimates of the effects of the rule on police behavior.

The theoretical model of crime and search developed in this paper could be extended to the case of a continuum of evidence strength. In this extended model, one could jointly choose the cutoff for the evidence to constitute probable cause (the probable cause standard) and the probability of acquittal for a guilty citizen who is searched without probable cause (the strength of the exclusionary rule) to maximize a measure of social welfare. This approach might yield insights into other important issues related to the Fourth Amendment.

A Mathematical Appendix

Proof of Proposition 1. From (4), we find that $EU_{Police}(S|I_\varepsilon) - EU_{Police}(\neg S|I_\varepsilon) \lesseqgtr 0$ if $X - I(\sigma_I) \lesseqgtr 0$. Therefore, for any given $I(\sigma_I) \geq 0$, the police always choose S given I_ε if $X - I(\sigma_I) > 0$, randomize between S and $\neg S$ given I_ε if $X - I(\sigma_I) = 0$, and always choose $\neg S$ given I_ε if $X - I(\sigma_I) < 0$.Similarly, from (3), citizens' best response function is given by $I(\sigma_I) = (A_1 - A_3)\sigma_I + (A_2 - A_4)$ for any given σ_I. Let $Z(\sigma_I) := X - (A_1 - A_3)\sigma_I - (A_2 - A_4)$, $\overline{Z} := \max\{Z(\sigma_I) : \sigma_I \in [0, 1]\}$, and $\underline{Z} := \min\{Z(\sigma_I) : \sigma_I \in [0, 1]\}$.

Case 1: Suppose $\overline{Z} > 0$, $\underline{Z} < 0$, and $A_1 - A_3 > 0$. If $A_1 - A_3 > 0$, $I(\sigma_I)$ increases as σ_I increases. Then, $Z(\sigma_I)$ 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 $\sigma_I = 1$. By the definition of $Z(\sigma_I)$,the conditions that $Z(\sigma_I)|_{\sigma_I=0} > 0$ and $Z(\sigma_I)|_{\sigma_I=1} < 0$ are equivalent to $(A_2 - A_4) < X < A_1 - A_3 + (A_2 - A_4)$. That is, at $\sigma_I = 0$, $X - (A_2 - A_4) > 0$ or equivalently $X - I(\sigma_I) > 0$, so that σ_I increases. Similarly, at $\sigma_I = 1$, $X - (A_1 - A_3) - (A_2 - A_4) < 0$ or equivalently $X - I(\sigma_I) > 0$, so that σ_I decreases. The unique mixed strategy equilibrium arises when $Z(\sigma_I) = X - (A_1 - A_3)\sigma_I - (A_2 - A_4) = 0$. Thus $\sigma_I^* = \frac{X-(A_2-A_4)}{(A_1-A_3)}$ and $I(\sigma_I^*) = X$. This mixed-strategy equilibrium is stable. Since $A_1 - A_3 > 0$, a small increase in σ_I from the equilibrium would increase $I(\sigma_I)$, and the increase in $I(\sigma_I)$ would lead to $X - I(\sigma_I) < 0$, and thus induce σ_I to return to its original level. Any small perturbation from the equilibrium would eventually lead back to the equilibrium. Therefore, the unique mixed-strategy equilibrium $(\sigma_I^* = \frac{X-(A_2-A_4)}{(A_1-A_3)}, I(\sigma_I^*) = X)$ is stable.

Case 2: Suppose $\overline{Z} > 0$, $\underline{Z} < 0$, and $A_1 - A_3 < 0$. If $A_1 - A_3 < 0$, $I(\sigma_I)$ decreases as σ_I increases and $Z(\sigma_I)$ 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 $\sigma_I = 0$. The conditions that $Z(\sigma_I)|_{\sigma_I=0} < 0$ and $Z(\sigma_I)|_{\sigma_I=1} > 0$ are equivalent to $0 < A_1 - A_3 + (A_2 - A_4) < X < (A_2 - A_4)$. Since $X - (A_1 - A_3) - (A_2 - A_4) > 0$ when $\sigma_I = 1$, but $X - (A_2 - A_4) < 0$ 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 arises when $Z(\sigma_I) = 0$. In this case, $I(\sigma_I^*) = X$, and $\sigma_I^* = \frac{(A_2-A_4)-X}{-(A_1-A_3)}$. This mixed-strategy equilibrium is not stable. Suppose the police increase their probability of search without probable cause by ε. For $\sigma_I^* + \varepsilon$, $X - I(\sigma_I) > 0$. In this case, the police would want to increase their search probability even more.

Case 3: Suppose $\overline{Z} < 0$. Regardless of $A_1 - A_3 > 0$, the condition that $\overline{Z} < 0$ implies $X - I(\sigma_I) < 0$ for all $I(\sigma_I) \in [0, 1]$. Therefore, the unique pure-strategy equilibrium is $(\sigma_I^* = 0, , I(\sigma_I^*) = (A_2 - A_4))$.

Case 4: Suppose $\underline{Z} > 0$. Regardless of $A_1 - A_3 > 0$, the condition that $\underline{Z} > 0$ implies $X - I(\sigma_I) > 0$ for all $I(\sigma_I) \in [0, 1]$. Therefore, the unique pure-strategy equilibrium is $(\sigma_I^* = 1, I(\sigma_I^*) = (A_1 - A_3) + (A_2 - A_4))$.

Proof of Proposition 2. Comparing (7) and (8) in the text, we find $-\frac{\partial X}{\partial \alpha_4}(A_1 - A_3(\alpha_4)) >$

$\frac{\partial A_3(\alpha_4)}{\partial \alpha_4}[X-(A_2-A_4)] \Leftrightarrow \frac{(1-X)(1+k)}{[(1-q)B_2+q(1-B_1)]} > s\pi\left(\frac{X-(A_2-A_4)}{A_1-A_3}\right)$, which is equivalent to $X < \overline{X} = \frac{(1+k)(A_1-A_3)+s\pi Y(A_2-A_4)}{(1+k)(A_1-A_3)+s\pi Y}$, 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 $\frac{\partial(1-I(\sigma_I^*))}{\partial \alpha_4} = \frac{\partial A_3}{\partial \alpha_4}\sigma_I^* - (A_1 - A_3)\frac{\partial \sigma_I^*}{\partial \alpha_4} = \frac{\partial A_3}{\partial \alpha_4}\sigma_I^* - \frac{\partial X}{\partial \alpha_4} - \frac{\partial A_3}{\partial \alpha_4}\frac{[X-(A_2-A_4)]}{(A_1-A_3)} = -\frac{\partial X}{\partial \alpha_4} > 0$. 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 $\frac{\partial P[S,\neg C]}{\partial \alpha_4} = \frac{\partial I(\sigma_I^*)}{\partial \alpha_4}[q\pi\sigma_I + (1-q)\pi] + \frac{\partial \sigma_I^*}{\partial \alpha_4}I(\sigma_I^*)q\pi$. 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 $\frac{\partial P[S,\neg C]}{\partial \alpha_4} \gtreqless 0$. A sufficient condition for $\frac{\partial P[S,\neg C]}{\partial \alpha_4} > 0$ is $\frac{[X-(A_2-A_4)]s\pi Y}{(A_1-A_3)(1-X)(1+k)} > \frac{Xq+[X-(A_2-A_4)]q+(A_1-A_3)(1-q)}{Xq}$.

Proof of Proposition 4. We only need to show that $\frac{\partial^2 \sigma_I^*}{\partial \alpha_4 \partial k} > 0$. From (6), we have that $\frac{\partial \sigma_I^*}{\partial \alpha_4} = \frac{(1-q)}{(A_1-A_3)^2}[-\frac{(A_1-A_3)(1-X)(1+k)}{Y} + s\pi(X-(A_2-A_4))]$. Thus $\frac{\partial^2 \sigma_I^*}{\partial \alpha_4 \partial k} = \frac{(1-q)}{(A_1-A_3)^2}[-\frac{(A_1-A_3)(1-X)}{Y} + \frac{(A_1-A_3)(1+k)\frac{\partial X}{\partial k}}{Y} + \frac{(A_1-A_3)(1-X)(1+k)}{Y^2}\frac{\partial Y}{\partial k} + s\pi\frac{\partial X}{\partial k}] = \frac{(1-q)}{(A_1-A_3)^2}\left(\frac{1-X}{Y^2}\right)(A_1-A_3)(1-q)(B_2+2c_S) + s\pi(1-q)^2(1-\alpha_4)B_2 + q^2(1-B_1)\pi\eta] > 0$.

Proof of Proposition 5. From the proof of Proposition 2 above, we know that the direct effect is greater than the indirect effect if and only if $\frac{(1-X)(1+k)}{[(1-q)B_2+q(1-B_1)]} > s\pi\left(\frac{X-(A_2-A_4)}{A_1-A_3}\right) \Leftrightarrow \frac{(1-X)(1+k)}{[(1-q)B_2+q(1-B_1)]} > s\left(\frac{X-\pi[sq-s(1-q)(1-\alpha_1)-\eta(1-q)]}{s(1-q)(1-\alpha_4)-\eta q}\right)$.The left-hand side is unaffected by the change in π, while the right-hand side decreases 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 6. 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 (6) in the te$\frac{\partial \sigma_I^*}{\partial \alpha_4} = \frac{(1-q)}{(A_1-A_3)^2}[-\frac{(A_1-A_3)(1-X(\eta_P))(1+k)}{Y(\eta_P)} + s\pi(X(\eta_P) - (A_2 - A_4))]$. Thus, $\frac{\partial^2 \sigma_I^*}{\partial \alpha_4 \partial \eta_P} =$

$\frac{(1-q)q}{Y^3(A_1-A_3)^2}[-(A_1-A_3)(1+k)(1-q)B_2+Y((A_1-A_3)(1+k)(1-X)-s\pi(1-q)B_2)]$. If the indirect effect dominates the direct effect, so that $\frac{\partial\sigma_I^*}{\partial\alpha_4}>0$, then $-\frac{\partial X}{\partial\alpha_4}(A_1-A_3)<\frac{\partial A_3(\alpha_4)}{\partial\alpha_4}[X-(A_2-A_4)]\Rightarrow -\frac{\partial X}{\partial\alpha_4}(A_1-A_3)<\frac{\partial A_3(\alpha_4)}{\partial\alpha_4}X\Rightarrow(A_1-A_3)(1+k)(1-X)<s\pi(1-q)B_2$, so that $\frac{\partial^2\sigma_I^*}{\partial\alpha_4\partial\eta_P}<0$. If the direct effect dominates, so that $\frac{\partial\sigma_I^*}{\partial\alpha_4}>0$, then $\frac{\partial^2\sigma_I^*}{\partial\alpha_4\partial\eta_P}\lesseqgtr 0$. However, $\frac{\partial^2\sigma_I^*}{\partial\alpha_4\partial\eta_P}>0$ for a larger range of parameters the higher is η_P. That is, the exclusionary rule is likely to reduce search for a larger parameter range the higher is η_P.

Proof of Proposition 7. From Proposition 1, we know that in equilibrium $\sigma_I^*=\frac{X-(A_2-A_4)}{A_1-A_3}$ 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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