Enforcement Malfeasance, Witness Participation, Crime, and Reform*

by

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Abstract

We develop a model wherein a reputation for prosecutorial malfeasance reduces the willingness of witnesses to cooperate with prosecutors. This causes an increase in the crime rate and in wrongly-convicted innocent defendants. Because citizens are taxpayers and may be victims, perpetrators, witnesses, or falsely-accused defendants, they care about the prosecutor's quality. They update beliefs about this quality based on the disposition of cases. If the prosecutor's believed quality falls below a threshold, then a majority of voters choose to replace the prosecutor with a challenger, in expectation of reform. We compare the majority's choice with that of a social planner.

Keywords: Crime, Enforcement, Prosecutor, Witness

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1. Introduction

In the criminal justice system, enforcement authorities (police and prosecutors) are expected to seek justice, yet they sometimes instead pursue winning convictions (even if unjust[1]) so as to enhance their career prospects. Moreover, sometimes errors occur in the arrest process and in the handling of evidence and witnesses. Citizens who recognize these potential shortcomings are likely to be concerned about the integrity of the system. In this paper we develop a model wherein malfeasance by enforcement authorities induces a reduction in the willingness of witnesses (broadly defined) to volunteer evidence and to cooperate with the prosecutor. This, in turn, leads to an increase in the expected crime rate when criminals recognize that witness reticence will result in a reduced likelihood that criminal acts will be successfully prosecuted. Since witnesses can provide useful information on both rightly-accused criminals and wrongly-arrested innocents, such non-cooperation can also lead to an increase in wrongly-convicted innocent defendants. Finally, we embed this model in a larger context wherein citizens form beliefs about the prosecutor and vote to retain or replace them.

We construct a model wherein the quality of the enforcement authority is summarized as an attribute of the Chief Prosecutor (hereafter, "the prosecutor"); this attribute is private information for the prosecutor. Our notion of prosecutor quality will be defined more formally below, but the intuition is that a high-quality prosecutor is more concerned (as compared with a low-quality prosecutor) with avoiding the conviction of innocent defendants (and as concerned with pursuing conviction for an actual perpetrator) and is also more diligent in evaluating the evidence provided

[1] The National Registry of Exonerations (operated by The University of California, Irvine, The University of Michigan, and Michigan State University) has, to date, documented 2515 exonerations of individuals convicted for a range of serious felonies since 1989. The Registry has documented that during that period, approximately 54% of the exonerations reflected official misconduct. It should be noted that for 2017, this specific form of malfeasance is an element in 60% of exonerations, and for 2018 the rate had risen to approximately 71%. National Registry of Exonerations, accessed December 16, 2019, at http://www.law.umich.edu/special/exoneration/Pages/detaillist.aspx

by a witness to convict a guilty defendant or exonerate an innocent one. We initially proceed under the assumption that prosecutorial quality reflects a positive correlation of these two attributes (justice-seeking and diligence); we later relax this correlation in a section devoted to robustness considerations. We show that witnesses are more likely to come forward, and potential perpetrators are less likely to commit a crime, when the prosecutor's quality is high (as compared to when it is low). That is, if we associate prosecutorial malfeasance with low quality, then a reputation of the enforcement authority for malfeasance leads more frequently to negative social outcomes and to longer-run problems of alienation of the citizenry from the enforcement authority.

Moreover, in equilibrium, the (wrongful) conviction of an innocent defendant is less likely, and the (rightful) conviction of a guilty defendant is more likely, when the prosecutor's quality is high. Finally, the observed case disposition for a defendant of unknown type (guilty versus innocent) will differ between high-quality and low-quality prosecutors. In particular, we find that the probability of a dropped case (pre-trial) by the prosecutor is higher, the probability of an acquittal is lower, and (if police are sufficiently accurate in their arrests), the probability of a conviction is higher, when the prosecutor's quality is high.

Citizens interact with the justice system in a variety of ways. A citizen may be a perpetrator, a victim, a witness, or someone falsely arrested; all citizens are taxpayers and, ultimately, all are voters. As such, citizens periodically have the opportunity to replace the prosecutor via an election.[2] In order to determine how citizen-voters make this decision, we construct an overall loss function

[2] In the U.S. there are over 2300 chief prosecutors (or district attorneys) leading prosecutorial offices; the majority of these officials face election by the relevant constituency (the others are generally appointed by elected officials). See Perry and Banks (2011). We ignore federal prosecutors (i.e., U.S. Attorneys), chosen by the President. As of this writing, over the last half-dozen years there has been a spate of prosecutorial elections resulting in replacement; see Sklansky (2017) for an interesting discussion of the details of a number of these elections. See also Lavoie (2018) for some yet more recent election results.

for a voter as a function of the prosecutor's quality (as assessed by the voter). This involves aggregating the citizen's payoffs in their various roles. For instance, *ex ante* expected losses associated with being a victim, being falsely arrested, and being a taxpayer are all lower when the prosecutor's quality is high (as compared to when it is low). On the other hand, some citizens may reap benefits from being a criminal or having an opportunity to be a witness, and these *ex ante* expected benefits may be higher when the prosecutor's quality is low (as compared to when it is high). Assuming that the majority of citizens will not be criminals, all members of this majority will have the same payoff. We refer to a typical member of this majority as the representative majority voter (hereafter, RMV). Under plausible conditions, we find that the RMV's loss is a decreasing function of the prosecutor's assessed quality.

A voter's assessment of the prosecutor's quality is based on the observed outcomes of criminal cases; as noted above, the likelihood of each case disposition depends on the prosecutor's quality, so the observed outcomes of a body of cases are informative to voters. In our model, if the assessed quality of the prosecutor is sufficiently far below the prior assessment for a replacement, then the majority (as represented by the RMV) chooses to replace the prosecutor with a challenger, in expectation of improved performance. We also consider the case wherein a social planner makes the retention decision. We show that (in comparison with the RMV) the social planner may be more willing, or less willing, to tolerate low quality, depending on the extent to which criminals' expected benefits and/or expected sanctions are included in the welfare loss function. To the best of our knowledge, this is the first paper to combine: individual choice to commit or refrain from a crime; the willingness of witnesses to provide relevant evidence to authorities; the reputation of the enforcement authority; and collective voter choice to retain or replace that authority.

1.1. *Review of Related Literature*

This paper is closely-related to two strands of literature. First, there is a substantial literature on deterrence wherein a potential offender chooses whether or not to commit a crime, anticipating the likelihood of apprehension and the level of the penalty. In some models, the likelihood of apprehension and the penalty are taken as given, whereas in others these are chosen by a social planner or enforcement authority. Polinsky and Shavell (2000) provide an extensive survey of such models. In our model, these two specific attributes are taken as given, but the likelihood of conviction (which intervenes between arrest and punishment) is determined endogenously, and depends on the behavior of the prosecutor and a witness (if any). We are not aware of any other models involving third-party witnesses who decide whether or not to volunteer to provide evidence.[3]

Second, there is a substantial literature on the objectives of prosecutors, most often in the context of plea bargaining. Previous models posit objectives that range from pure career concerns (e.g., maximization of expected sentence, net of trial costs; see Landes, 1971; Franzoni, 1999; and Daughety and Reinganum, forthcoming) to pure welfare maximization (see Grossman and Katz, 1983; Reinganum, 1988; Baker & Mezzetti, 2001; and Bjerk, 2007). A few models posit an objective involving a mixture of these two motives. In Daughety and Reinganum (2016), the prosecutor is primarily motivated by winning cases, despite the possibility that some defendants may be innocent. However, "outside observers" of the case disposition can apply informal sanctions to the prosecutor in proportion to their belief that the defendant was guilty but acquitted (or the case was dropped), or innocent but convicted (at trial or by plea bargain). These informal sanctions may affect the prosecutor's future payoffs/career concerns through election, appointment, promotion, or

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[3] Lee and Suen (2020) consider victims, who are the sole witness, deciding whether to report the crime.

outside employment in private firms or universities. It is shown that informal sanctions attenuate the incentive to win and move the prosecutor more in the direction of improving the accuracy of the outcome (to some extent, the prosecutor is induced to behave "as if" she cares about justice). In Daughety and Reinganum (2018), a prosecutor trades off a desire for career advancement (by winning a case) and a disutility for knowingly convicting an innocent defendant by suppressing exculpatory evidence (i.e., evidence that would clear the defendant). Prosecutors' disutility is heterogeneous, so some prosecutors end up dropping the case against a defendant they know to be innocent (i.e., they act in a manner that enhances justice) whereas others end up prosecuting an innocent defendant (pursuing the conviction at the expense of justice). That paper also considers teams of prosecutors with individual members possessing private information about their own disutility for injustice and possibly possessing private information regarding exculpatory evidence (which they can choose whether or not to share within the team).

Empirical examinations of prosecutors' behavior seem consistent with a mixture of motives. Glaeser, Kessler, and Piehl (2000) develop and test a theoretical model of prosecutors and find empirical evidence compatible with both motives. Boylan and Long (2005) find that higher private salaries are associated with assistant U.S. attorneys taking more cases to trial. This suggests that they are using trial experience to enhance their human capital, which will be valuable in obtaining a well-paid private-sector job. Boylan (2005) finds that longer prison sentences obtained by a U.S. attorney are positively related to improvements in his or her career path. Bandyopadhyay and McCannon (2014) find that prosecutors up for reelection (i.e., chief prosecutors for an office) attempt to increase convictions obtained through trial, and McCannon (2013) finds that this pressure can lead to more wrongful convictions (as more convictions are reversed on appeal).

1.2. *Plan of the Paper*

Section 2 develops a model of crime commission by potential perpetrators, witness choice as to whether to volunteer information, and case disposition via dismissal or trial. In Section 3 we embed this model in a larger context wherein citizens use the history of case dispositions to form beliefs about the quality of the prosecutor and then to vote to retain or replace them. In Section 4 we examine the robustness of the model's predictions to: 1) alternative specifications concerning the prosecutor's decision about the use of a witness; 2) alternative representations of prosecutor quality; 3) finer case disposition information for voters; and 4) changes in the timing of voting relative to the receipt of relevant information by citizens. We also compare the RMV's replacement decision rule with that of a social planner. Section 5 summarizes the main elements of the analysis and our primary results, and suggests some other possible extensions for future research.

2. A Model of Crime Commission, Witness Participation, and Case Disposition

2.1. *Model Setup*

Our overall model of crime commission, case disposition, and potential reform is comprised of four stages; the first two stages are addressed in this section of the paper, while the latter two stages are examined in Section 3. We assume throughout the paper that there is a single type of crime, though it can be committed by multiple independent individuals. All citizens have an opportunity to commit a crime, but it suffices for the purposes of this section to consider the actions of three agents: a randomly-chosen citizen who has an opportunity to commit a crime, a witness (also a citizen) who may have evidence for or against the alleged perpetrator, and a prosecutor who wishes to convict the perpetrator of the crime. In Stage 1 the citizen chooses whether or not to commit a crime, based on the benefits and costs that the citizen faces (the population of citizens is heterogenous with respect to benefits, and faces costs that are endogenously-generated). Stage 2 involves actions taken by the Enforcement Authority (police and a chief prosecutor[4]) and the court, conditional on a crime having been committed. Upon detection that a crime has been committed, the police investigate and arrest a suspect (we abstract from the details of this process.). This fact (and who was arrested) becomes known in the general population of citizens; note that the police may mistakenly arrest someone who is actually innocent of the crime in question. In this stage, if a witness who can attest to the suspect's guilt or innocence exists, then that witness makes a decision as to whether to voluntarily "come forward" (voluntarily provide evidence) to the prosecutor's office. The prosecutor (who may be of high or low quality) then chooses whether to employ the witness at trial and whether to dismiss the charges or to pursue the case to trial. If the case is not dismissed, Stage 2 terminates with a trial; for simplicity, we abstract from plea bargaining. The outcome of the trial is that the suspect is either acquitted or convicted, which is also observable to the public at large. Whatever the case disposition, we assume that this outcome is final in the sense that no further case actions are modeled (e.g., no appeals, or further search for an alternative defendant if a case is dropped, etc.).

In Stage 3, citizens use the history of all the crimes committed, and the case dispositions, to update their beliefs about the quality of the prosecutor in office. Also, they randomly draw their personal benefit obtainable from committing a crime (in the future) from a distribution.[5] We assume that a majority of citizens draw a personal benefit from committing a crime in the future that is non-

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[4] For reasons that will become clear as we proceed, we summarize the prosecutor's office via the chief prosecutor. State chief prosecutors are almost always elected, so they are what we have in mind in this paper and we use the words "chief prosecutor" and "prosecutor" as interchangeable references to the same agent.

[5] This allows each citizen to compute future payoffs before voting; see the details about benefit draws in the analysis of Stage 1 below. In Section 4 we consider alternative timing wherein voting precedes the benefit draw.

positive (so that the RMV will not choose to commit a crime), though this certainly does not preclude there being other citizens who obtain personal benefit draws that are sufficiently high so as to result in their choosing to commit a crime. Finally, in Stage 4 all citizens vote as to whether to retain or replace the prosecutor; replacement is a random draw from a distribution of potential prosecutors and reflects a cost of transition to the new official.[6] We complete this outline of the model by recalling that the initial conditions for Stage 1 are a prior assessment on the quality of the prosecutor and an initial benefit draw (for the commission of a crime in Stage 1) for each citizen from the interval $(-\infty, \infty)$, so that some citizens will choose not to commit a crime while others will (if the benefit exceeds the cost).[7]

2.2. *Analysis of Stage 2*

Stages 1 and 2 are at the level of individual agents while Stages 3 and 4 involve aggregation over all citizens, so strategic behavior in Stages 1 and 2 does not influence choices and results in Stages 3 and 4. Thus, we start with Stage 2 so as to enforce sequential rationality in Stages 1 and 2. An arrested suspect is referred to as the defendant (he, denoted as D) and can be either guilty (G) or innocent (I) of the crime (which is the defendant's private information), with commonly-known prior probability of guilt being denoted as α. That is, $\alpha = \Pr\{D \text{ is type } G\}$ is the probability that the

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[6] In reality a prosecutor is also a citizen and is therefore a voter and a potential victim, perpetrator and/or witness. However, in the model P has somewhat different information when considering whether to commit a crime or come forward as a witness (presumably, P knows her own type), and somewhat different incentives when voting on retention, as compared to an ordinary citizen. To keep things simple (and without loss of generality if the number of citizens is large), we exclude P from the population of citizens.

[7] To clarify: imagine a sequence of repeating "periods," with each period comprised of the four stages described above. In such a model the posterior belief about quality and the next period's benefit draw would evolve over time. In this paper we simplify the analysis by restricting ourselves to one such period of four stages, and set the initial conditions (the assessment of prosecutor quality and the individual benefit from a crime) that are to hold before Stage 1 commences, and then allow there to be a "partial" next period (comprised of Stages 1 and 2 of a next period) so as to compute the implications for the citizens in the future of the retention/replacement decision made in the period at hand. For a comprehensive discussion of dynamic election models and accountability, see Duggan and Martinelli (2017).

perpetrator of the crime is correctly apprehended.[8] The police base the arrest on accumulated evidence, which is then provided to the prosecutor (she, denoted as P); this evidence implies that D would be convicted at trial with commonly-known probability π.[9]

A witness (she, denoted as W) exists with probability ω, which is exogenously determined and commonly known.[10] We assume that witnesses cannot choose to provide false testimony about what they know, are not themselves a victim or a perpetrator of the crime in question, and that their existence is initially unknown to D or P.[11] If W exists, she has evidence[12] which could prove to be *significant* in the sense that the evidence provided may substantially change the likelihood of P winning or losing at trial. W's existence, and the nature and content of her evidence (if she exists) is her private information. We model such a witness as being one of two types: W may be viewed as reliable, R, or unreliable, U, with a commonly-known exogenous probability μ of being perceived as reliable. As will be made more precise below, the reliability or unreliability of a witness will be an attribute that can be discerned by a diligent prosecutor before trial, or by a defense attorney at trial. We think of reliability as W being personally credible, persuasive, and/or serious; an unreliable witness would be someone who is thought to be unconvincing or inadequate to the task at hand. W knows μ but not whether she will be viewed as R or U. Finally, if a witness is used at

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[8] To avoid repetitive statements, unless noted otherwise, all exogenously-determined probabilities are assumed to be proper fractions.

[9] We return below, in footnote 25, to provide further conditions on π such that it is rational for P to proceed to trial without any evidence beyond that provided by the police.

[10] We abstract from the production of witnesses by the defense.

[11] Known witnesses are already incorporated in the police case file and thus are reflected in π.

[12] The evidence we have in mind could be eyewitness evidence (in the case of a street crime) or physical evidence (e.g., spreadsheet evidence in the case of an embezzlement, or a recording of a conversation in the case of a collusion). Alternatively, it could take the form of an "air-tight" alibi for D.

trial and is deemed reliable, then her report is believed: we assume that D is surely convicted if a reliable witness reports G and is surely acquitted if a reliable witness reports I. However, if a witness is used at trial and is deemed unreliable, then not only is her report not influential,[13] but the entire case is tainted and P loses (we call this outcome a *fiasco*).[14] In Section 4 we weaken the assumption that unreliable witnesses who testify result in a sure loss for P.

2.2.1. *Modeling Prosecutor Quality*

We model prosecutors as being either *attentive* (denoted as A) to the pro-social goals of avoiding convicting innocent defendants and not misleading the court as to the truth (in short: seek justice), or as being *inattentive* to such goals due to focusing only on winning convictions (in short: career concerns). In keeping with the foregoing notion of attentiveness, we further assume that attentive prosecutors are sufficiently diligent in evaluating witness-provided evidence so as to discern the reliability or unreliability of a witness before trial, while inattentive prosecutors are not sufficiently diligent in this regard. These two attributes (justice-seeking and diligence in evaluating witness reliability) contribute to prosecutorial quality in that, as we show below, the preference for justice reduces the extent of unjust convictions, whereas diligence increases the extent of just convictions and therefore improves deterrence. For this reason we bundle these two attributes together in our initial analysis and return in Section 4 to examine modifications of this bundling so as to understand the limits of this characterization of quality.

Importantly, however, we assume that prosecutors are neither perfectly attentive nor wholly

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[13] Notice that a reliable witness is therefore treated as if they are truthful, while an unreliable witness is therefore treated as if they have no useful information. As we indicated earlier, all witnesses are truthful (i.e., cannot choose to lie), but the issue of reliability goes to persuasiveness and acceptability.

[14] The effect of reliability of the witness on the likelihood that P wins at trial could reflect less extreme increases or decreases in P's likelihood of winning, but that would just add more parameters without additional insight.

inattentive. Rather, we think of individual prosecutors as being a mixture of attentive and inattentive; that is, an individual prosecutor might be attentive for some cases while inattentive for some other cases. We define a *high-quality* (denoted H) prosecutor as one who is attentive on a greater portion of her cases than is true for a *low-quality* (denoted L) prosecutor. Specifically, let θ_H be the probability that an H-type P is attentive and let θ_L be the probability that an L-type P is attentive, with $1 > \theta_H > \theta_L > 0$. Therefore, if γ is the probability that P is H, then the likelihood that a P of unknown type (H or L) is attentive is: $\gamma_A \equiv \gamma\theta_H + (1 - \gamma)\theta_L$.[15] Note that γ_A is increasing in all three parameters. Finally, P's type (H or L) is P's private information.

To summarize P's behavior in Stage 2, a P who is attentive seeks justice and is able to assess the reliability of a witness in advance of putting that witness on the stand. Thus, if W reports that D is G, and W is deemed reliable, then an attentive P will use W at trial and will win the case. On the other hand, if W reports that D is I, and W is deemed reliable, then an attentive P will drop the case, as it would be unjust (and a misuse of resources) to take such a defendant to trial. Regardless of her report, if W is deemed unreliable, then an attentive P declines to use the witness (as using W at trial would yield a fiasco, thereby wasting the court's time and resources) and pursues the case at trial without[16] W, winning on the basis of the original evidence with probability π.

On the other hand, an inattentive P is motivated by winning the case rather than obtaining justice. As indicated earlier, we assume that an inattentive P is less diligent, and is therefore unable to properly assess the reliability of W in advance of the trial; instead she decides whether to use W

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[15] An important technical implication of the foregoing is that there is no action a P can take that perfectly reveals her type, so equilibria will not be separating as to P's type (i.e., H or L). We show below that attentiveness is a desirable quality from the viewpoint of citizens. Further, observe that $1 - \gamma_A = \gamma(1 - \theta_H) + (1 - \gamma)(1 - \theta_L)$.

[16] In Section 4, we consider an attentive P who drops the case when an unreliable W reports I.

based on the likelihood μ that W will later be deemed reliable at trial.[17] Thus, if W reports that D is I, then an inattentive P will not use the witness; this is because a witness reporting I will either be found reliable at trial (in which case D will be acquitted, which the inattentive P counts as a loss) or will be found unreliable at trial (in which case P's case against D is tainted, resulting in a fiasco and a loss for P). On the other hand, if W reports that D is G, then an inattentive P decides whether to use the witness, based on which alternative gives P a higher likelihood of prevailing at trial. If P doesn't use the witness, then her likelihood of prevailing remains π. If P does use the witness, then she wins if W turns out to be R and loses otherwise, so her likelihood of prevailing is $\mu\times 1 + (1 - \mu)\times 0 = \mu$. Thus, the probability of conviction when W reports G to an inattentive P is $\max\{\mu, \pi\}$, since P uses a W who reports G if and only if $\mu \geq \pi$. Notice that only an attentive P would drop a case, and only an inattentive P would use an unreliable witness at trial (resulting in a fiasco). By making both types of P (H and L) reflect a mix of attentiveness and inattentiveness (via θ_T, T = H, L), then all possible dispositions of the case (drop, acquittal without fiasco, acquittal with fiasco, conviction) are on the equilibrium path for both types of P: simply observing one such outcome does not reveal P's type.

2.2.2. *The Decision by a Witness Whether to Volunteer Evidence*

For simplicity, we assume that W's information is about whether the defendant is guilty or innocent, so if W observed τ, where τ = G, I, then W must decide whether to come forward. Let c_τ denote W's cost of coming forward. This cost is drawn (at the time of the crime) from the

[17] Recall that we earlier assumed that the defense attorney can determine at trial whether or not W is reliable (say, via cross-examination), so an unreliable W that testifies against D can be impeached by the defense attorney, resulting in a fiasco.

distribution $F_\tau(c_\tau)$ on the domain $[0, \infty)$, and observed privately by W.[18] We view this cost as being incurred when W comes forward, regardless of whether W is used at trial.[19] This cost represents the disutility of getting involved, and the fear of stigma or retribution from other citizens who want the case to turn out one way or the other (e.g., negative actions towards W by such citizens are sometimes referred to as "snitches get stitches").[20] On the other hand, if W comes forward, then she can potentially forestall a miscarriage of justice if D is innocent and W is able to provide evidence clearing D. We assume that W derives utility that is proportional (at a rate denoted ν_τ) to how much she changes the likelihood of conviction in her desired direction (i.e., towards justice).

To model W's decision problem, first recall that W does not know whether she will be deemed reliable, she only knows what she observed and μ. Suppose that W observed I and comes forward. Then an attentive P will drop (i.e., dismiss) the case if W is deemed reliable (and then W will obtain utility $\nu_I\pi$, because her coming forward changes the innocent D's chance of conviction from π to zero), and will ignore W, and take the case to trial, if W is deemed unreliable (and then W will obtain a utility of zero, as her coming forward does not change the innocent D's chance of conviction). Because an inattentive P focuses on maximizing wins, such a prosecutor will never use a W who reports I (either to drop a case or at trial), so in this event W will also obtain a utility of zero. Recall that $\gamma_A = \gamma\theta_H + (1 - \gamma)\theta_L$ is the probability (from the point of view of W and D) that P is attentive. We can write the expected payoff from coming forward for a W who observed I and

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[18] We assume that F_τ is continuous and differentiable, with positive density f_τ, everywhere on $[0, \infty)$.

[19] We could include an incremental cost to W of participating in a trial, but again this would complicate the model without generating additional insight. As was shown in the discussion of P, only a W reporting G would be used at trial, and we already allow the distribution to depend on whether W observed G versus I.

[20] As a very recent example of the cost c_G and how it might arise, see Farzan (2019), describing how the mother of a gang member used her position as a paralegal in the U.S. Attorney's office in New Jersey to identify potential witnesses (against gang members) who were cooperating with authorities, leading to death threats against witnesses.

drew cost c_I, denoted as $V_I^W(c_I)$, as:

$$V_I^W(c_I) = \nu_I\gamma_A\mu\pi - c_I.$$

Thus, W should come forward and report I if $c_I \leq \tilde{c}_I \equiv \nu_I\gamma_A\mu\pi$, that is, if the subjective cost of volunteering the information falls below the threshold $\tilde{c}_I$ which accounts for the expected benefits to W of coming forward. Hence, *ex ante* of observing the cost of coming forward, the probability that W will come forward to report I is $F_I(\tilde{c}_I)$.[21]

Alternatively, suppose that W observed G and comes forward. Then an attentive P will use the witness at trial if W is deemed reliable (and W will obtain utility $\nu_G(1 - \pi)$, as her coming forward changes the guilty D's chance of conviction from π to 1), and will ignore the witness and take the case to trial without W if W is deemed unreliable (and W will obtain utility of zero, as her coming forward does not change the guilty D's chance of conviction). Since an inattentive P cannot determine W's reliability before trial, then if she uses W at trial she can expect to win (for sure) if W turns out to be reliable and to lose (for sure) if W turns out to be unreliable, whereas if P does not use W then the probability of conviction remains π. As noted above, an inattentive P uses a W who reports G if and only if $\mu \geq \pi$. Thus, if a W reporting G faces an inattentive P, then W's expected payoff is $\mu(1 - \pi)\nu_G + (1 - \mu)(0 - \pi)\nu_G = (\mu - \pi)\nu_G$ if $\mu \geq \pi$ and 0 otherwise.

Therefore, we can write the expected payoff for a W who observed G, who faces a cost of volunteering this information of c_G, and who comes forward, as:

$$V_G^W(c_G) = \nu_G[\gamma_A\mu(1 - \pi) + (1 - \gamma_A)\max\{\mu - \pi, 0\}] - c_G.$$

Thus, W should come forward and report G if $c_G \leq \tilde{c}_G \equiv \nu_G[\gamma_A\mu(1 - \pi) + (1 - \gamma_A)\max\{\mu - \pi, 0\}]$. Hence, *ex ante* of observing the cost of coming forward, the probability that a W who observed G

[21] We have omitted consideration of any impact of W coming forward to report I on her tax burden, but this modification is easily-accomplished and the effect is generally small; see the Appendix for details.

will come forward to report is $F_G(\tilde{c}_G)$.

More generally, the probability that a W who observed τ chooses to come forward to P and report τ is $F_\tau(\tilde{c}_\tau)$, for $\tau = G, I$, so any change in the parameters that raises (resp., lowers) the threshold $\tilde{c}_\tau$ also raises (resp., lowers) the probability $F_\tau(\tilde{c}_\tau)$ that W comes forward, for $\tau = G, I$. It is straightforward to show that $\tilde{c}_\tau$ is increasing in γ_A (and hence in γ, θ_H, and θ_L), μ, and ν_τ, for $\tau = G$, I, and that $\tilde{c}_I$ is increasing in π but $\tilde{c}_G$ is decreasing in π. That is, both thresholds increase with the likelihood that W will be deemed reliable, with W's utility parameter for affecting the trial, and with the likelihood that P is attentive.

This last point is of particular note: an increase in W's perception that P is an H-type increases W's belief that P is attentive, thereby increasing the likelihood that W will come forward. Alternatively put, malfeasance (i.e., P being perceived to be inattentive) discourages witnesses from coming forward. Furthermore, a W reporting I will be more likely to come forward if the initial probability of conviction, π, is higher (as she anticipates having a larger impact on ensuring a just outcome), whereas a W reporting G will be less likely to come forward if the initial probability of conviction is higher (as she anticipates having a smaller impact on ensuring a just outcome). We summarize W's optimal behavior via the following proposition.[22]

<u>Proposition 1</u>. There is a threshold value of witness costs c_τ, denoted $\tilde{c}_\tau$, such that a witness who observed $\tau = G, I$ comes forward if and only if $c_\tau \leq \tilde{c}_\tau$; thus, the probability of witness participation is $F_\tau(\tilde{c}_\tau)$. The expressions $\tilde{c}_\tau$ and $F_\tau(\tilde{c}_\tau)$ are increasing in γ_A (and hence in γ, θ_H, and θ_L), μ, and ν_τ, for $\tau = G, I$. The expressions $\tilde{c}_I$ and $F_I(\tilde{c}_I)$ are increasing in π, whereas $\tilde{c}_G$ and $F_G(\tilde{c}_G)$ are decreasing in π.

2.2.3. *The Effect of Prosecutor Quality and Witness Participation on Just and Unjust Conviction*

We conclude the analysis of witness participation with some results on the equilibrium

[22] Whenever an agent is indifferent between binary choices, here and elsewhere in the paper, we assign this behavior. This is without loss of generality.

probabilities of conviction of the two types of defendant conditional on the two types of prosecutor; that is, we find the following probabilities:

$\eta_{\tau T} \equiv \Pr\{D \text{ of type } \tau \text{ is convicted} \mid P \text{ is of type } T\}$, where τ = I, G, and T = H, L.

Thus, for example, η_{IH} is the probability that an innocent D is convicted when faced with a P that is an H-type. When an innocent D is convicted we refer to this as an "unjust conviction," while a D that is G and is convicted is referred to as a "just conviction." These four probabilities are given in the Appendix. Then the following proposition is straightforward (if tedious) to show:

Proposition 2.

a) The equilibrium probability that a guilty D is convicted, and the probability that an innocent D is acquitted, are higher if P is an H-type rather than an L-type. That is:

$$\eta_{GH} > \eta_{GL} \text{ and } \eta_{IH} < \eta_{IL}.$$

b) Witness presence (ω), witness reliability (μ), and arrest accuracy (α) affect these equilibrium probabilities as follows (for T = H, L):

$$\partial\eta_{IT}/\partial\lambda < 0 \text{ for } \lambda = \omega, \mu, \text{ and } \alpha \text{ while } \partial\eta_{GT}/\partial\lambda > 0 \text{ for } \lambda = \omega, \mu, \text{ and } \alpha.$$

That is, as the likelihood that a witness exists increases, then the likelihood of an unjust conviction decreases and the likelihood of a just conviction increases, for both an H-type prosecutor and an L-type prosecutor. Furthermore, this is similarly true for increases in witness reliability and for increases in the likelihood that the police arrest the right person. Thus, Proposition 2 effectively relates the quality of the prosecutor (H or L) to various measures of the availability and reliability (ω and μ) of the witness, and the accuracy of the police (α).

2.3. *Analysis of Stage 1: Deciding to Commit a Crime*

We turn now to analyzing Stage 1, wherein a citizen[23] decides about committing a crime,

[23] A perpetrator can also be a victim of a separate crime and a victim can be a perpetrator of a separate crime.

given how things will play out in Stage 2. We assume that all citizens might be perpetrators and might be victims. Let b denote the citizen's benefit from committing a crime, which the citizen observes before choosing to either commit the crime or to refrain; b is drawn from the interval $(-\infty, \infty)$. As indicated earlier, we assume this value is drawn just before Stage 1, thereby influencing choices made in Stages 1 and 2 (we will later assume a second, independent[24] draw of b in Stage 3 before each citizen votes, as this will be used to estimate the future effects of an election). As observed earlier, b can be negative, indicating that such an individual would refrain from crime even if he anticipated no formal sanction. This might reflect social and educational influences that make someone averse to committing a crime.

Consider an individual citizen's decision about whether to commit a particular crime. If the individual refrains from committing the crime, he obtains a payoff of 0. If he commits the crime, then he is (correctly) apprehended with probability α, and he becomes a defendant of type G. As implied by the discussion in Stage 2, his expected sanction, conditional on apprehension, depends on: 1) whether there is a witness; 2) whether she comes forward; 3) whether she is reliable; and 4) whether P is attentive or inattentive with regard to this case. Trial will entail a cost to D of k^D, a cost to P of k^P, and a sentence for D of S upon conviction.[25] Then we can write D's expected net benefit from crime, denoted $V^D(b)$, as the difference between the crime's benefit, b, and its expected cost:

$$V^D(b) = b - \alpha(\pi S + k^D)[1 - \omega + \omega(1 - F_G(\tilde{c}_G))]$$
$$- \alpha\omega F_G(\tilde{c}_G)[\gamma_A\mu(S + k^D) + \gamma_A(1 - \mu)(\pi S + k^D) + (1 - \gamma_A)(\max\{\mu, \pi\}S + k^D)].$$

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[24] We are assuming i.i.d. draws for Stage 1 and Stage 3, but one could extend the analysis so that the draws are, say, positively correlated.

[25] Observe that, for both types of P, the likelihood of conviction if P chooses to take the case against D to trial is at least π. A sufficient condition for any P to be willing (based only on the initial evidence) to proceed to trial against D is that π satisfy the inequality $\pi S \geq k^P$. Note that this is the rationality restriction foreshadowed in footnote 9.

This expression is interpreted as follows. The first term in square brackets is the probability that either there is no witness or that there is a witness but she chooses not to come forward; in these events, the probability of conviction remains π and the resulting payoff loss is $(\pi S + k^D)$ times the likelihood of apprehension. If a witness exists and comes forward (which occurs with probability $\omega F_G(\tilde{c}_G)$), then P is attentive with probability γ_A. Such a P will use a reliable witness to raise the likelihood of conviction to 1 and will ignore an unreliable witness, resulting in a conviction with probability π; this explains the first two terms in the second set of square brackets. The final term represents what happens if P is inattentive; such a P uses the witness if and only if $\mu \geq \pi$ (and wins with probability μ when she uses the witness and with probability π when she does not use the witness). Simplifying, we obtain:

$$V^D(b) = b - \alpha(\pi S + k^D) - \alpha\omega F_G(\tilde{c}_G)S[\gamma_A\mu(1 - \pi) + (1 - \gamma_A)\max\{\mu - \pi, 0\}].$$

Thus, a citizen with benefit b will commit the crime whenever:

$$b \geq \tilde{b} \equiv \alpha(\pi S + k^D) + \alpha\omega F_G(\tilde{c}_G)S[\gamma_A\mu(1 - \pi) + (1 - \gamma_A)\max\{\mu - \pi, 0\}].$$

Observe that $\tilde{b}$ is the expected sanction (inclusive of D's trial costs) given a crime has been committed.[26] Note that the expression in square brackets in the definition of $\tilde{b}$ above is positive: witnesses who come forward reduce the expected net benefits of crime, thereby raising the threshold for choosing to commit a crime (and reducing the crime rate).[27]

2.3.1. *Comparative Statics of Deterrence*

The parameters α, S, ω, and k^D enter the threshold $\tilde{b}$ only directly (where indicated above);

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[26] We have omitted consideration of any impact of crime commission on the criminal's tax burden, but this modification is easily-accomplished and the effect is generally small; see the Appendix for details.

[27] In a traditional analysis of the choice to commit crime, wherein there is no witness ($\omega \equiv 0$), then we obtain the usual result that $V^D(b) = b - \alpha(\pi S + k^D)$ and the resulting sanction is $\tilde{b} = \alpha(\pi S + k^D)$.

an increase in any of these parameters increases the threshold and thus increases the deterrence of crime. W's utility parameter ν_G enters only indirectly through $F_G(\tilde{c}_G)$; since $\tilde{c}_G$ is increasing in ν_G, an increase in ν_G also increases the threshold and thus increases deterrence. The parameters γ_A, μ, and π enter the threshold $\tilde{b}$ both directly and indirectly through $F_G(\tilde{c}_G)$. Recall that $\tilde{c}_G$ is increasing in γ_A and μ, and decreasing in π. Re-write $\tilde{b}$ as $\alpha(\pi S + k^D) + \alpha\omega F_G(\tilde{c}_G)S\varphi(\gamma_A, \mu, \pi)$, where the expression $\varphi(\gamma_A, \mu, \pi) \equiv [\gamma_A\mu(1 - \pi) + (1 - \gamma_A)\max\{\mu - \pi, 0\}]$ is the expected impact of W on the likelihood of conviction and is increasing in γ_A and μ, and decreasing in π. Then the direct effect of an increase in γ_A or μ is to increase the threshold; moreover, the indirect effect of an increase in γ_A or μ is to increase the threshold. A key parameter of interest is γ, the probability that P is type H (recall: γ_A is increasing in γ). Thus, an increase in the likelihood of P being type H deters crime, both through the direct effect on the expected sanction and through the indirect effect of inducing a witness to come forward.

An increase in π, the strength of the case developed by the police (i.e., without W), has a mixed effect on deterrence. Differentiating the threshold $\tilde{b}$ with respect to π yields:[28]

$$d\tilde{b}/d\pi = \alpha S + \alpha\omega F_G(\tilde{c}_G)S[\partial\varphi(\gamma_A, \mu, \pi)/\partial\pi] + \alpha\omega S\varphi(\gamma_A, \mu, \pi)f_G(\tilde{c}_G)[\partial\tilde{c}_G/\partial\pi].$$

The first term is clearly positive, but the second and third terms are both negative. The second term reflects the reduction in the impact of the witness due to any increase in the case strength (which might reflect increased employment of police resources). W can only raise the conviction probability from π to 1, so when π increases, W's participation has a lower impact on the expected

[28] The expression for $\tilde{b}$ is continuous everywhere, and differentiable almost everywhere (the exception being at $\pi = \mu$), in π.

sanction.[29] The last term reflects the fact that this lower impact discourages W from coming forward by reducing the threshold $\tilde{c}_G$. That we are unable to sign this comparative static effect means that greater resources applied to case development by the police may not increase deterrence (i.e., may not increase the threshold for choosing to commit a crime). The potential that this is simply diminishing marginal returns to investment in case development suggests that other uses of such resources (such as increasing the likelihood of apprehension, α) might be more productive. We summarize the choice made by a citizen as committing a crime via the following proposition.

Proposition 3. There is a threshold value of benefits to a crime b, denoted as $\tilde{b}$, such that a citizen will commit the crime if and only if $b \geq \tilde{b}$. The expression $\tilde{b}$ is increasing in α, S, ω, k^D, γ_A (and hence in γ, θ_H, and θ_L), μ, and ν_G. The effect of an increase in π is indeterminate.

3. Assessment, Voting, and Reform

In Section 2 we modeled a single criminal case, from the decision by a citizen to commit the crime to the disposition of a case against a defendant (who might or might not be the perpetrator). The possibility of a witness (to either the defendant's guilt or innocence) played a major role in the possible trial outcomes. We now expand this analysis to the context of many cases and the associated observations of the prosecutor's choices, with the objective of providing a posterior assessment of P's quality. In this section we first provide the relevant Bayesian update of the prior belief that P is H, yielding the posterior estimate of the probability that P is an H-type based on the population's experience with P. We then provide the voter's loss function and characterize the decision by voters to retain or replace P.

Assume that there are N citizens and that there are periodic elections which allow for retention or replacement of the prosecutor. Between elections there is an accumulation of

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[29] Recall that since we are examining the decision problem for the *perpetrator*, this analysis must be about a witness who is testifying that they observed G, since W must be telling the truth.

observations on crimes and the disposition of cases arising from those crimes; that is, a history. In this section we first consider the aggregation of that experience and its use to draw an inference as to the quality of the prosecutor; this is Stage 3 of the game. In Stage 4 voters employ an endogenously-determined quality standard to decide on retention or replacement, where replacement means a draw from the distribution of prosecutor types.

3.1. *The Posterior Assessment That P is Type H*

Let Φ denote the realized vector of case dispositions from crimes arising from the population of N citizens over the interarrival time of two elections. That is, Φ is of the form: (number of convictions, number of acquittals, number of dropped cases).[30] Let the common prior belief (at the start of Stage 1) across all citizens for the probability that P is H be denoted as γ^0. This prior assessment represents a pool of potential candidates for prosecutor, all of whom are (*ex ante*) indistinguishable from one another. Each voter will use the history Φ of case dispositions from Stage 2 to update her beliefs about γ, obtaining a posterior estimate of P's quality, denoted as $\hat{\gamma}$:

$$\hat{\gamma} = \Pr\{\text{P is H} \mid \Phi\}$$

$$= \Pr\{\Phi \mid \text{P is H}\}\Pr\{\text{P is H}\}/[\Pr\{\Phi \mid \text{P is H}\}\Pr\{\text{P is H}\} + \Pr\{\Phi \mid \text{P is L}\}\Pr\{\text{P is L}\}]$$

$$= \Pr\{\Phi \mid \text{P is H}\}\gamma^0/[\Pr\{\Phi \mid \text{P is H}\}\gamma^0 + \Pr\{\Phi \mid \text{P is L}\}(1 - \gamma^0)].$$

In order to update her beliefs about γ, the voter will need to calculate the probability of each case disposition, conditional on P's type. Note that the number of crimes committed and the number of witnesses who come forward are not informative about P's type, as they depend on γ^0, which is common knowledge; only the case dispositions are informative about P's type. Each disposition (i.e., a conviction, an acquittal, or a dropped case) is informative to the extent that the different P

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[30] If fiascos are observationally distinct from ordinary acquittals, then the history would be a four-tuple (we consider this in subsection 4.2).

types (H versus L) generate different likelihoods of these dispositions.

We formalize this as follows. Let ρ_H (respectively, ρ_L) denote the equilibrium probability that a D of unknown type is convicted, when P is type H (respectively, type L). Let a_H (respectively, a_L) denote the equilibrium probability that a D of unknown type is acquitted, when P is type H (respectively, type L). Finally, let d_H (respectively, d_L) denote the equilibrium probability that the case is dropped, when P is type H (respectively, type L). In the Appendix we provide formulae for these expressions, and we show that the following proposition holds.

Proposition 4. For a randomly-chosen defendant of unknown type:

a) the probability of an acquittal is lower if P is an H-type rather than an L-type ($a_H < a_L$);

b) the probability of a dropped case is higher if P is an H-type rather than an L-type ($d_H > d_L$); and

c) the probability of a conviction can be higher, or lower, if P is an H-type rather than an L-type, depending on the other parameter values. More precisely, ρ_H (>, =, <) ρ_L as

$$\alpha F_G(\tilde{c}_G)[\mu + (1 - \mu)\pi - \max\{\mu, \pi\}] \ (>, =, <) \ (1 - \alpha)F_I(\tilde{c}_I)\mu\pi.$$

In part (c), the left-hand-side of the displayed material represents the additional convictions an attentive P obtains (as compared to an inattentive one) when D is G, whereas the right-hand-side represents the additional convictions that an inattentive P obtains (as compared to an attentive one) when D is I. This condition can be re-expressed in terms of the accuracy of the arrest process:[31]

$$\rho_H \ (>, =, <) \ \rho_L \text{ as } \alpha \ (>, =, <) \ \max\{\mu, \pi\}F_I(\tilde{c}_I)/[\max\{\mu, \pi\}F_I(\tilde{c}_I) + (1 - \max\{\mu, \pi\})F_G(\tilde{c}_G)].$$

In particular, this means that the probability of a conviction is higher for an H-type rather than an L-type when the accuracy of the arrest process (α) is sufficiently high.

As an illustration, suppose that a history Φ consists of n convictions, m acquittals, and q

[31] $F_I(\tilde{c}_I)$ and $F_G(\tilde{c}_G)$ are independent of α, and thus the right-hand-side of this inequality is independent of α.

dropped cases, all of which are independent events. Then $\Pr\{\Phi \mid P \text{ is } H\} = X(\rho_H)^n(a_H)^m(d_H)^q$ and $\Pr\{\Phi \mid P \text{ is } L\} = X(\rho_L)^n(a_L)^m(d_L)^q$, where $X \equiv (n + m + q)!/(n!m!q!)$, providing what is needed for the Bayesian updating of beliefs as specified above.

Furthermore, as discussed earlier, the current analysis starts with a draw of a b-value, and then (eventually) proceeds to a vote (in Stage 4). In order that voters are able to compute the future payoffs from voting to retain or replace P, they will need to either know their b-value for the next period of play before voting, or they will need to make voting decisions based on knowing the distribution of b-values and forming an expectation of their anticipated loss under the alternatives of retaining or replacing P. We first consider a model structure wherein voters draw a new b-value in Stage 3 (similar to what occurred before Stage 1 above); we then turn to consider the alternative (wherein voting occurs before voters learn their b-value for the upcoming period) in subsection 4.3, as an extension of the basic model. As will be shown in Section 4.4, this difference in what the voters know (and when they know it) can have a substantial effect on the relationship between majority voting results and the choice a central planner would make.

3.2. *Construction of the Representative Majority Voter's Overall Loss Function*

In this subsection we assume that it is common knowledge that a strict majority of voters (i.e., a number strictly greater than (N/2) + 1) have drawn, at the end of Stage 3, a non-positive b-value. To implement this, we assume that society can be viewed as comprised of two groups of citizens, with each group drawing b-values from distinct distributions. One distribution generates citizens with non-positive b-values (i.e., citizens who, optimally, will never choose to commit a crime) and the other distribution generates citizens with positive b-values (i.e., citizens who, depending upon the value of the sanction $\tilde{b}$, will entertain committing a crime). More precisely, let

$Z^-(\bullet)$ be a continuously-differentiable cumulative distribution, with positive density $z^-(\bullet)$, of b-values on (-∞, 0]. Also, let $Z^+(\bullet)$ be a continuously-differentiable cumulative distribution, with positive density $z^+(\bullet)$, of b-values on (0, ∞).[32] Corresponding to these distributions we let N^- be the number of citizens who obtain draws from Z^-, and N^+ be the number of citizens who obtain draws from Z^+, where $N^- + N^+ \equiv N$, so the previous requirement on N stated above can be more precisely stated as $N^+ < (N/2) - 1$; that is, the N^- citizens will constitute a clear majority. These voters, plus others with draws of b-values in $(0, \tilde{b})$, do not anticipate committing a crime in the next period (after Stage 4). When there is a vote on retention of the current prosecutor (in Stage 4), all members of this majority will have the same payoff from whatever outcome of the vote occurs, and none will be pivotal (i.e., crucial to the majority). Therefore, it is optimal for each member of this majority to vote sincerely.[33] We designate an arbitrary member of this majority as the representative majority voter (that is, the RMV discussed earlier), and this agent will decide whether to retain or replace P. Moreover, we refer to the N^+ citizens as "potential perpetrators," since which of them will choose to commit a crime is influenced by the b-value they draw and the endogenously-determined expected sanction $\tilde{b}$.

We model the RMV's loss function as being comprised of: 1) the *ex ante* expected harm from being a victim of a crime; 2) the *ex ante* expected harm from being falsely arrested; 3) the *ex ante* expected tax burden; and 4) the *ex ante* expected net benefit from being a witness. The first

[32] The Z^+ support is open on the left-end to emphasize that these values will be compared with the endogenously-determined sanction $\tilde{b}$, which is strictly positive, and that Z^+ only indexes potential perpetrators (which b = 0 is not).

[33] See Austen-Smith and Banks (1996) for a discussion of sincere versus strategic voting. Weakening our condition that no voter is pivotal means that strategic voting could become relevant; we return to this as a possible further extension in Section 5.

three of these items will be referred to as expected costs (EC) while the fourth is an expected benefit (EB). In all cases, these elements depend upon γ, which will be reflected in the notation.

3.2.1. *The RMV's Expected Harm from Being a Victim*

First, consider the expected harm from being a victim of a crime, denoted EC(victim; γ). If the society is comprised of N individuals partitioned as discussed above, then the expected number of crimes is the number of potential perpetrators times the probability that a randomly drawn potential perpetrator chooses to commit a crime; that is, $N^+(1 - Z^+(\tilde{b}))$. Moreover, there are N - 1 potential victims for each crime (anyone except a crime's perpetrator could be the victim), so the RMV expects to be the victim for each crime with probability 1/(N - 1).[34] Note that the RMV could be the victim of more than one crime, with independent probabilities. Therefore, the *ex ante* expected cost of being a victim is:

$$EC(victim; \gamma) = [N^+(1 - Z^+(\tilde{b}))/(N - 1)]h,$$

where h is the harm suffered by a victim.

This expression is a decreasing function of γ_A (because $\tilde{b}$ is increasing in γ_A) and, thus, is decreasing in γ. Therefore, the RMV's *ex ante* expected harm from being a crime victim is lower when γ is higher, as a "better" prosecutor (higher likelihood of being type H) deters crime.

3.2.2. *The RMV's Expected Cost from False Arrest*

Now consider the expected cost to the RMV from being falsely arrested, denoted as EC(false arrestee; γ). We allow the RMV to be falsely arrested for multiple crimes, with independent probabilities. Since the perpetrator and the victim of a particular crime cannot be falsely arrested for it, there are N - 2 individuals at risk of being falsely arrested. By assumption, the RMV is not

[34] Each crime committed affects one victim, so there are no spillovers to others in the society.

the perpetrator, but she could be the victim with probability 1/(N - 1). Hence (given that there is a false arrest), the RMV is falsely arrested for a given crime with probability (1 - 1/(N - 1))(1/(N - 2)); the first term represents the likelihood that she is not the victim and the second term represents that she is chosen from among the N - 2 individuals who are neither victim nor perpetrator. This term reduces to 1/(N - 1). Therefore, taking into account the chance that there is a false arrest, and the expected number of crimes, the RMV's *ex ante* risk of false arrest is $[N^+(1 - Z^+(\tilde{b}))(1 - \alpha)/(N - 1)]$.

Suppose that the RMV is falsely arrested; what is her expected sanction? If a witness exists and comes forward, then W will report I. An inattentive P will never use such a witness (and will simply proceed to trial), whereas an attentive P will determine whether W is reliable. If W is deemed reliable, then an attentive P will drop the case, but if W is deemed unreliable, then an attentive P will proceed to trial without the witness. Thus, the probability of conviction will remain π except in the event that P is attentive and W exists, comes forward, and is deemed reliable (in which event the case is dropped). Thus, the expected sanction for the falsely accused RMV is $(\pi S + k^D)(1 - \gamma_A \omega F_I(\tilde{c}_I)\mu)$. Combining these two terms yields:

$$EC(\text{false arrestee}; \gamma) = [N^+(1 - Z^+(\tilde{b}))(1 - \alpha)/(N - 1)](\pi S + k^D)(1 - \gamma_A \omega F_I(\tilde{c}_I)\mu).$$

As established above, the term in square brackets is decreasing as γ_A increases, as a higher γ_A deters crime. The final term, in parentheses, is also decreasing as γ_A increases, both directly (reflecting a P who is attentive more often) and indirectly because $\tilde{c}_I$ increases as γ_A increases (reflecting a W who is more willing to come forward to help exonerate an innocent D). Thus, the product of these two terms is a decreasing function of γ_A (and, hence, of γ). Therefore, the RMV's *ex ante* expected cost from being falsely arrested is lower when γ is higher, as a better prosecutor deters crime and encourages W to come forward after observing I, which leads to P dropping the case when she learns (from a reliable W) that D has been falsely arrested.

The foregoing expression assumes that the overall probability that a witness exists is the same (ω) regardless of whether the perpetrator or an innocent party is arrested for the crime. That is, ω is held constant and simply spread out over those who are available to serve as a witness. This raises the question of whether the perpetrator can be a witness when there is a false arrest (and whether he can give false testimony; we have ruled out false testimony in our analysis); since inclusion or exclusion of the perpetrator as a potential witness makes essentially no difference when N is large, we do not consider this issue further.

3.2.3. *The RMV's Expected Tax Burden*

The third numbered cost item above concerns the tax burden for the justice system, which is shared equally by all N members of society; we denote this by EC(taxpayer; γ). Prosecution costs are k^P whenever there is a trial; a trial occurs in every event except when there is a false arrest, P is attentive, and a witness exists, comes forward, and is deemed reliable. Thus, the total prosecution costs are $N^+(1 - Z^+(\tilde{b}))[1 - (1 - \alpha)\gamma_A\omega F_I(\tilde{c}_I)\mu]k^P$. Apprehension costs (which are presumably greater the higher is the accuracy of the arrest process α) may include both a fixed cost, denoted $M(\alpha)$, and a variable cost per crime, denoted $m(\alpha)$. The fixed component represents activities such as patrolling, whereas the variable component represents activities such as investigation. Combining these terms, and dividing by N to represent the RMV's expected tax burden, yields:

$$EC(\text{taxpayer}; \gamma) = \{N^+(1 - Z^+(\tilde{b}))[1 - (1 - \alpha)\gamma_A\omega F_I(\tilde{c}_I)\mu]k^P + N^+(1 - Z^+(\tilde{b}))m(\alpha) + M(\alpha)\}/N.$$

This expression is also decreasing as γ_A (and, hence, γ) increases. As shown above, the expected number of crimes decreases as γ_A increases. The expression in square brackets also decreases as γ_A increases, both directly (reflecting a P who is attentive more often) and indirectly because $\tilde{c}_I$ increases as γ_A increases (reflecting a W who is more willing to come forward to help exonerate an innocent D). The RMV's *ex ante* expected tax burden is lower when γ is higher, as a better prosecutor deters crime, encourages W to come forward after observing I, and drops the case when she learns (from a reliable W) that D has been falsely arrested.

3.2.4. *The RMV's Expected Net Benefits from Being a Witness*

The fourth numbered item above represents the expected benefits (net of costs) of being a witness, denoted EB(witness; γ). This will offset, to some extent, the previous numbered cost items. First, we calculate the RMV's *ex ante* probability of being a witness; this calculation may depend on whether the perpetrator is apprehended or whether some innocent party is apprehended. This is because a witness must be drawn from the set of all individuals excluding the perpetrator and the victim if the perpetrator is arrested, whereas a witness must be drawn from the set of all individuals excluding the perpetrator, the victim, and the falsely-arrested person if the perpetrator is not the one who is arrested for the crime. That is, we assume that the actual perpetrator is not drawn as a witness when another individual is arrested for the crime.[35] Although we allow the RMV's *ex ante* probability of being a witness to vary depending on whether the perpetrator or an innocent party is arrested, it turns out to be 1/(N - 1) regardless.

When the perpetrator is arrested (which happens with probability α), then the RMV can be a witness if she is not the victim; thus, there are N - 2 possible witnesses. The probability that the RMV is not the victim and is drawn as the witness has probability [(N - 2)/(N - 1)][1/(N - 2)] =

[35] Alternatively, we could assume that the perpetrator could be drawn as a witness when another individual is arrested for the crime, but (if we maintain our assumption of no false testimony), then the perpetrator/witness would never come forward to exonerate the falsely-arrested D (whereas if we allowed false testimony then the perpetrator/witness might come forward to throw suspicion onto the falsely-accused D). Again, these alternative assumptions make essentially no difference if N is relatively large, so we do not consider them further.

1/(N - 1), where [(N - 2)/(N - 1)] is the probability that the RMV is not the victim, and [1/(N - 2)] is the probability that the RMV is drawn to be the witness out of the N - 2 eligible individuals (that is, N minus the victim and the perpetrator).

When someone other than the perpetrator is arrested (which happens with probability 1 - α), then the RMV can be a witness if she is not the victim and was not falsely-arrested herself; there are N - 3 such possible witnesses (assuming we also exclude the perpetrator). Thus, this event has probability [(N - 2)/(N - 1)][(N - 3)/(N - 2)][1/(N - 3)] = 1/(N - 1), where [(N - 2)/(N - 1)] is the probability that the RMV is not the victim; [(N - 3)/(N - 2)] is the probability that the RMV is not the one who is falsely arrested; and [1/(N - 3)] is the probability that the RMV is drawn to be the witness out of the N - 3 individuals who are eligible to be a witness (that is, N minus the victim, the falsely-arrested individual, and the perpetrator).

Suppose that the perpetrator is arrested, and the RMV becomes a witness. This means that she must have observed G; she draws her cost parameter c_G and comes forward whenever $c_G \leq \tilde{c}_G$. Then the RMV's expected net benefits are given by the partial expectation of $V_G^W(c_G)$ over $[0, \tilde{c}_G]$; let this be denoted $EV_G^W(\tilde{c}_G)$:

$$EV_G^W(\tilde{c}_G) = F_G(\tilde{c}_G)[\gamma_A \mu \nu_G(1 - \pi) + (1 - \gamma_A)\nu_G \max\{\mu - \pi, 0\}] - \int c_G dF_G(c_G),$$

where the integral is over the domain $[0, \tilde{c}_G]$.

Now suppose that someone other than the perpetrator is arrested, and the RMV becomes a witness. She draws her cost parameter c_I and comes forward whenever $c_I \leq \tilde{c}_I$. Then her expected net benefits are given by the partial expectation of $V_I^W(c_I)$ over $[0, \tilde{c}_I]$; let this be denoted $EV_I^W(\tilde{c}_I)$:

$$EV_I^W(\tilde{c}_I) = F_I(\tilde{c}_I)[\gamma_A \mu \nu_I \pi] - \int c_I dF_I(c_I),$$

where the integral is over the domain $[0, \tilde{c}_I]$.

By the definition of the thresholds $\tilde{c}_I$ and $\tilde{c}_G$ it follows that $\partial EV_G^W(\tilde{c}_G)/\partial\tilde{c}_G = 0$ and $\partial EV_I^W(\tilde{c}_I)/\partial\tilde{c}_I = 0$. Therefore the parameter γ_A affects these expressions only directly (and not indirectly through the thresholds), and both are increasing functions of γ_A (and γ). Thus, the net benefits of being a witness are higher when the prosecutor is better.

We can write the RMV's overall expected benefits EB(witness; γ) as follows:

$$EB(\text{witness}; \gamma) = [N^+(1 - Z^+(\tilde{b}))](\omega/(N - 1))\{\alpha EV_G^W(\tilde{c}_G) + (1 - \alpha)EV_I^W(\tilde{c}_I)\}.$$

We have argued above that the term in curly brackets is increasing in γ_A, whereas the term in square brackets is decreasing in γ_A (and, hence in γ); thus the overall impact of a better prosecutor is unclear. The witness anticipates a higher expected payoff from coming forward, but has the opportunity less often, because a better prosecutor deters crime.

3.2.5. *The RMV's Overall Loss Function and RMV's Preference for a P of Type H*

Therefore, the RMV's overall loss function is given by:

$$LOSS^{RMV}(\gamma) \equiv EC(\text{victim}; \gamma) + EC(\text{false arrestee}; \gamma) + EC(\text{taxpayer}; \gamma) - EB(\text{witness}; \gamma),$$

where:

$$EC(\text{victim}; \gamma) = [N^+(1 - Z^+(\tilde{b}))/(N - 1)]h.$$

$$EC(\text{false arrestee}; \gamma) = [N^+(1 - Z^+(\tilde{b}))(1 - \alpha)/(N - 1)](\pi S + k^D)(1 - \gamma_A\omega F_I(\tilde{c}_I)\mu).$$

$$EC(\text{taxpayer}; \gamma) = \{N^+(1 - Z^+(\tilde{b}))[1 - (1 - \alpha)\gamma_A\omega F_I(\tilde{c}_I)\mu]k^P + N^+(1 - Z^+(\tilde{b}))m(\alpha) + M(\alpha)\}/N.$$

$$EB(\text{witness}; \gamma) = [N^+(1 - Z^+(\tilde{b}))](\omega/(N - 1))\{\alpha EV_G^W(\tilde{c}_G) + (1 - \alpha)EV_I^W(\tilde{c}_I)\}.$$

Recall that EC(false arrestee; γ) and EC(taxpayer; γ) are both decreasing in γ. We will now consider the remaining terms EC(victim; γ) - EB(witness; γ) = $[N^+(1 - Z^+(\tilde{b}))/(N - 1)][h - \omega\{\alpha EV_G^W(\tilde{c}_G) + (1 - \alpha)EV_I^W(\tilde{c}_I)\}]$. As long as $h > \omega\{\alpha EV_G^W(\tilde{c}_G) + (1 - \alpha)EV_I^W(\tilde{c}_I)\}$, then this difference is also decreasing in γ. Although the following sufficient condition is stronger than necessary, it is simple to interpret and plausible.

Assumption 1: $h > \omega\{\alpha EV^W_G(\tilde{c}_G) + (1 - \alpha)EV^W_I(\tilde{c}_I)\}$; that is, the harm from being a victim exceeds the expected benefit (net of costs) from being a witness with probability ω.

Thus, under Assumption 1, which we maintain for the rest of the paper, the function $LOSS^{RMV}(\gamma)$ is decreasing in γ, so the RMV prefers an H-type P to an L-type P.

3.3. *The RMV's Choice and Reform*

We now consider a dynamic process, wherein at the beginning of the period discussed in Section 2 (i.e., just before Stage 1), the common belief (among all citizens) about the quality of a randomly-drawn P is given by γ^0. Then the behavior of potential criminals and witnesses is given as described above (i.e., the thresholds $\tilde{c}_I$, $\tilde{c}_G$, and $\tilde{b}$ will be computed as a function of the parameters and γ^0), and a vector of dispositions, Φ, will occur. Given the updating process described in subsection 3.1, the RMV will therefore be able to update her prior γ^0 to a posterior, denoted $\hat{\gamma}$, based on the observed vector of dispositions. Stage 4 involves an election wherein the RMV can choose to retain or replace the incumbent, and expects a loss of $LOSS^{RMV}(\hat{\gamma})$ if P is retained. We assume that the outside option of replacing P is as before (in Stage 1): a draw is made from a pool of indistinguishable candidates for prosecutor and the prior that the drawn candidate is type H is γ^0. Thus, replacement implies an expected loss of $LOSS^{RMV}(\gamma^0)$.

No such change is likely to be perfectly frictionless.[36] Assume that it is commonly known that replacement of the incumbent entails an adjustment cost, which we translate into a strictly positive per-voter cost denoted as Δ. Assuming that $LOSS^{RMV}(0) > \Delta + LOSS^{RMV}(\gamma^0)$, then the RMV would vote to replace a P who is known to be type L. Since, under Assumption 1, $LOSS^{RMV}(\gamma)$ is

[36] See Cohen (2019) for examples of difficulties faced by some of the recent crop of reform prosecutors elected to office; these difficulties stem from opposition from within the office from lower-level prosecutors as well as from higher-up officials, such as governors of the state involved.

monotonically decreasing, then $LOSS^{RMV}(1) < \Delta + LOSS^{RMV}(\gamma^0)$, and therefore the RMV would choose to retain a P who is known to be type H. Furthermore, the monotonicity of $LOSS^{RMV}(\gamma)$ implies that there will be a threshold value of $\hat{\gamma}$, denoted γ^{RMV}, where γ^{RMV} is the unique solution to $LOSS^{RMV}(\gamma^{RMV}) = \Delta + LOSS^{RMV}(\gamma^0)$. The implication for the replacement or retention of P is summarized in the following proposition.

Proposition 5. Under Assumption 1 and assuming that $LOSS^{RMV}(0) > \Delta + LOSS^{RMV}(\gamma^0)$:

a) $LOSS^{RMV}(\gamma)$ is monotonically decreasing in γ; and
b) there exists a unique $\gamma^{RMV} \in (0, \gamma^0)$, such that the RMV will choose reform (replacement of the prosecutor) if and only if $\hat{\gamma} \leq \gamma^{RMV}$.

Thus, depending upon the size of Δ, sufficiently small differences between $\hat{\gamma}$ and γ^0 will result in the incumbent being retained. It is straightforward to show that γ^{RMV} is increasing in h, k^P, and (for any given α), $m(\alpha)$; that is, an increase in the harm to a victim, in P's cost of prosecuting a case, or in the cost of investigation of a crime leads to an increased retention threshold (i.e., an increased likelihood that P will be voted out of office). Unfortunately, we have been unable to isolate the effects of changes in the other parameters, since they enter into the computation of γ^{RMV} in complex ways (i.e., directly and indirectly through equilibrium strategies and through distribution functions).

4. Robustness and Extensions of the Analysis

In this section we examine several robustness considerations. First, we describe the impact of alternative modeling assumptions regarding the behavior and rewards of attentive and inattentive prosecutors. Second, we examine the impact of a more refined information structure for voters; in particular, what if voters can distinguish ordinary acquittals at trial from fiascos? Third, we consider alternative timing for the voting decision; what if citizens vote before observing their benefit from a future crime? Fourth, we consider the replacement/retention decision being made by a central planner in contrast with that made by the majority of voters. We characterize how the model's implications are influenced by these alternative specifications; note that the discussion in each subsection is a comparison with the basic model developed in Sections 2 and 3 (that is, modifications are not cumulative).

4.1. *Alternative Assumptions about Attentive and Inattentive Prosecutors*

In the base model, we assume two fundamental kinds of prosecutor, attentive and inattentive. An inattentive P differs in two ways from an attentive one. First, an inattentive P pursues a conviction regardless of her knowledge of whether D is G or I (and thus she never uses a W who comes forward to report I); this is a difference in preferences concerning the conviction of innocent Ds. Second, an inattentive P is insufficiently diligent in discerning witness reliability in advance of trial; this is a difference in diligence. The difference in preferences provides a channel that affects the conviction of innocent Ds, as an inattentive P pursues a conviction despite a W who reports I, and this in turn reduces the participation of Ws who observed I. The difference in diligence provides a channel that affects the conviction of guilty Ds, as an inattentive P generates more overall acquittals of guilty Ds, both directly via the inadvertent production of fiascos (or by not using a W who would have proved reliable at trial), but also indirectly by deterring some Ws who observed G from coming forward.

There are plausible alternative specifications of inattentive and attentive Ps. For instance, what if the use of an unreliable witness at trial does not guarantee a fiasco? That is, what if the probability of conviction at trial is somewhat reduced by the inattentive P's reliance on an unreliable W at trial, but is not reduced all the way to zero. The impact of this modification is straightforward. Relative to the results from the base model, an inattentive P is more willing to use a W who reports G and a W who observes G is more willing to come forward. Thus, deterrence is still undermined (as compared to an attentive P), but to a lesser extent. In the limiting case wherein an unreliable W is simply ignored at trial (and thus the probability of winning the case remains π), an inattentive P will always use a W who reports G and the probability of winning at trial will be the same as that for an attentive P (as will the level of witness participation). That is, in this limiting case, deterrence is not undermined by P's inattentiveness. Finally, one could imagine the court imposing a penalty on P for having used (what is shown, by the defense attorney, to be) an unreliable witness at trial, over and above the loss of the case. In this scenario, an inattentive P would be less willing to use a W reporting G than in the base model (in order to avoid the penalty on P should W turn out to be unreliable), but not using W would result in fewer convictions (when W would have turned out to be reliable). Thus, an additional penalty on P for using an unreliable W at trial would further undermine deterrence (relative to the base model). Under all of these alternative scenarios about how the use of an unreliable W affects the trial outcome, the RMV would continue to prefer a higher-quality P, both to improve deterrence and to reduce the conviction of innocent defendants.

In the base model, an attentive P never relies on an unreliable W; she neither uses an unreliable W at trial nor does she drop the case based on an unreliable W's report of I. An alternative assumption is that an attentive P would drop the case even if a witness who comes forward to report I is deemed unreliable. That is, even though an attentive P would not use such a witness at trial, P believes the witness did observe I (since we have assumed that W always tells the truth, whether reliable or unreliable) and P would therefore drop the case in pursuit of justice. This alternative specification would not affect the crime rate (as it does not affect how an attentive P would use a W reporting G), but it would make a high-quality P even more attractive to citizens because greater attentiveness would reduce the extent of false arrest, encourage witness participation, and lower expected trial costs.

To summarize: 1) if a fiasco reduces, but does not eliminate, the likelihood that P wins her case, then deterrence is undermined, though to a lesser degree; and 2) if early detection of the unreliability of a witness nevertheless results in case dismissal by P before trial (when W reports that D is innocent), then the willingness of witnesses to come forward is enhanced. In both cases the RMV continues to prefer a high-quality P.

We have not, to this point, addressed the possibility that attributes reflecting the degree of justice-seeking and the degree of diligence in evaluating witnesses might be negatively correlated. Thus, what if Ps might be either career-concerned and diligent in evaluating witnesses, or justice-seeking but insufficiently diligent in evaluating witness reliability before using the witness in court? Then such a negative correlation between the prosecutorial attributes does not yield a clear quality ranking by voters. This is because, roughly speaking, diligence in evaluating witnesses enhances deterrence whereas justice-seeking reduces unjust convictions. Thus, with negatively-correlated attributes, the voting result will depend upon the specific distribution of voter tradeoffs of these two outcomes. Therefore, there can be no general prediction for this subcase.

4.2. *More Refined Information Structure*

In the base model, citizens could observe the number of convictions, the number of acquittals (that is, the sum of ordinary acquittals at trial plus the number of acquittals due to fiascos, but not the breakdown between these), and the number of dropped cases. The probability of each of these outcomes was denoted by (ρ_H, d_H, a_H) for a P of type H, and by (ρ_L, d_L, a_L) for a P of type L.

If voters can observe fiascos separately from ordinary acquittals, then the vector of dispositions is more informative. Let ψ_H denote the probability that the case ends in a fiasco when

P is type H; then $a_H^{net} \equiv a_H - \psi_H$ represents the probability of acquittal net of those that are due to a fiasco (and $a_L^{net} \equiv a_L - \psi_L$). Recall that an attentive P never uses an unreliable witness; moreover, when $\mu < \pi$, an inattentive P does not use W at all. Thus, when $\mu < \pi$, there are no fiascos and hence $a_H^{net} = a_H$ (and $a_L^{net} = a_L$). When $\mu \geq \pi$, an inattentive P does use the witness, and a fiasco occurs with probability $\psi_H < \psi_L$ (see the Appendix); that is, the risk of a fiasco is lower when P is type H rather than type L. This means that voters who observe fiascos should update their prior belief in the direction of type L. It is shown in the Appendix that $a_H^{net} - a_L^{net} > 0$ holds if and only if $\alpha > \mu F_I(\tilde{c}_I)/[\mu F_I(\tilde{c}_I) + (1 - \mu)F_G(\tilde{c}_G)]$, which is the same condition under which the equilibrium conviction probabilities (ρ_H and ρ_L) are ordered by P's type, so that $\rho_H > \rho_L$ (see Proposition 4(c)).

Thus, when $\mu < \pi$ a finer information structure yields no additional information (as there are no fiascos in equilibrium). When $\mu \geq \pi$, then $(\rho_H - \rho_L)(a_H^{net} - a_L^{net}) > 0$, meaning that convictions and ordinary acquittals are correlated given P's type: an H-type generates a higher probability of both convictions and ordinary acquittals, or a lower probability of both dispositions.

4.3. *Voting under a Veil of Ignorance Regarding Own Realized Benefit from Future Crime*

An alternative timing assumption would be that citizens vote before observing their benefit from a possible future crime. We now construct the payoff function for a randomly-chosen citizen who does not know whether she will be a potential perpetrator (that is, one of the N^+ citizens who draw a positive payoff from crime) and, if so, what her benefit from crime will be. This payoff will include the costs and benefits that were previously considered, but also the expected net benefits from committing a crime. We first construct the analog of the function $LOSS^{RMV}(\gamma)$ for a randomly-drawn citizen, which will be denoted $LOSS^{AVG}(\gamma)$. These two functions correspond very closely, but are not identical. For example, consider the event of being a victim. A citizen who is not a potential perpetrator is at risk of harm from N^+ potential perpetrators (as was the RMV), whereas a citizen who is herself a potential perpetrator is only at risk of harm from $N^+ - 1$ other potential perpetrators. Thus, a randomly-chosen citizen is at risk of harm from $[(N - N^+)/N](N^+) + [N^+/N](N^+ - 1) = [(N - 1)/N](N^+)$ potential perpetrators. Hence a randomly-chosen citizen faces an expected cost of being a victim of $[(N - 1)/N]EC(\text{victim}; \gamma)$, where $EC(\text{victim}; \gamma)$ is the expected cost of being a victim for the RMV (as defined in subsection 3.2.5).[37] The same logic applies to the expected cost of being falsely-arrested and the expected benefit of being a witness. Note that the expected cost of being a taxpayer is not sensitive to whether or not this randomly-chosen citizen is a potential perpetrator. To summarize:

$$LOSS^{AVG}(\gamma) = [(N - 1)/N]EC(\text{victim}; \gamma) + [(N - 1)/N]EC(\text{false arrestee}; \gamma) + EC(\text{taxpayer}; \gamma) - [(N - 1)/N]EB(\text{witness}; \gamma).$$

Note that the randomly-chosen citizen is slightly less-concerned than the RMV about P's quality, because the randomly-chosen citizen may be a potential perpetrator. Thus, $LOSS^{AVG}(\gamma)$ is less than $LOSS^{RMV}(\gamma)$ and, while both functions are decreasing in γ, $LOSS^{AVG}(\gamma)$ falls at a slower rate than $LOSS^{RMV}(\gamma)$.

The following preliminary result will be of use later. Let:

$$y(\gamma) \equiv LOSS^{AVG}(\gamma) - [\Delta + LOSS^{AVG}(\gamma^0)].$$

Assuming that $y(0) > 0$, then since $y(\gamma^0) = -\Delta$ and $y'(\gamma) < 0$, there is a unique γ^y in the interval $(0, \gamma^0)$ such that $y(\gamma^y) = 0$. Moreover, $\gamma^y < \gamma^{RMV}$; that is, ignoring the expected net benefits of being a criminal, a randomly-drawn citizen would tolerate a slightly worse P than would the RMV.

Of course, the randomly-chosen citizen will incorporate the expected net benefits of crime.

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[37] Note that N^+ already appears in the numerator of all the elements of $LOSS^{RMV}$.

Since a representative citizen will commit a crime only if she is a potential perpetrator and her $b \geq \tilde{b}(\gamma) \equiv \alpha(\pi S + k^D) + \alpha\omega F_G(\tilde{c}_G)S[\gamma_A\mu(1 - \pi) + (1 - \gamma_A)\max\{\mu - \pi, 0\}]$, this expected net benefit is:

$$EB(\text{criminal}; \gamma) \equiv [N^+/N]\int(b - \tilde{b}(\gamma))dZ^+(b), \text{ where the integral is over } [\tilde{b}(\gamma), \infty).$$

As remarked earlier, $\tilde{b}(\gamma)$ depends on γ through γ_A and through the threshold $\tilde{c}_G$, and $\tilde{b}(\gamma)$ is increasing in γ. Due to the threshold nature of $\tilde{b}(\gamma)$, the parameter γ only enters $\partial EB(\text{criminal}; \gamma)/\partial\gamma$ through $\tilde{b}(\gamma)$'s appearance in the integrand. That is,

$$\partial EB(\text{criminal}; \gamma)/\partial\gamma = [N^+/N]\int - \tilde{b}'(\gamma)dZ^+(b) = - [N^+/N]\tilde{b}'(\gamma)(1 - Z^+(\tilde{b}(\gamma))) < 0.$$

Thus, the expected benefit of being a future criminal is lower the higher the likelihood that P is H.

The overall loss function, given an arbitrary assessment γ, is now given by $LOSS^{AVG}(\gamma)$ - $EB(\text{criminal}; \gamma)$. Because $LOSS^{AVG}(\gamma)$ and $EB(\text{criminal}; \gamma)$ are both decreasing in γ, the effect of an increase in γ on the overall loss function is ambiguous. In order to decide whether to retain or replace P, the voter compares $LOSS^{AVG}(\hat{\gamma}) - EB(\text{criminal}; \hat{\gamma})$ to $\Delta + LOSS^{AVG}(\gamma^0) - EB(\text{criminal}; \gamma^0)$. Let:

$$Y(\gamma) \equiv LOSS^{AVG}(\gamma) - EB(\text{criminal}; \gamma) - [\Delta + LOSS^{AVG}(\gamma^0) - EB(\text{crime}; \gamma^0)],$$

meaning that $Y(\gamma) = y(\gamma) - [EB(\text{criminal}; \gamma) - EB(\text{criminal}; \gamma^0)]$. Then all voters will vote to replace P whenever $Y(\hat{\gamma}) \geq 0$.

To characterize the set of γ-values that result in reform, note the following. Because $EB(\text{criminal}; \gamma)$ is decreasing in γ, the term $[EB(\text{criminal}; \gamma) - EB(\text{criminal}; \gamma^0)]$ is positive (resp., negative) for $\gamma <$ (resp., $>$) γ^0, and it is zero at $\gamma = \gamma^0$. Hence: (1) $Y(\gamma^0) = y(\gamma^0) = - \Delta$; (2) $Y(\gamma) < y(\gamma)$ for $\gamma < \gamma^0$; and (3) $Y(\gamma) > y(\gamma)$ for $\gamma > \gamma^0$. Thus, a sufficient condition for the set of γ-values that result in reform to be well-behaved is that $Y'(\gamma) < 0$. That is, even when a citizen anticipates that she might want to commit a crime in the future (in which case she would prefer to face a lower-quality P), under a veil of ignorance about her b-value she still prefers a society with a lower crime rate (in which she is less subject to being a victim, a false arrestee, or a witness, and expects to pays lower taxes).

Assuming that $Y'(\gamma) < 0$ (and $Y(0) > 0$), there exists a unique value of γ, denoted γ^Y, at which $Y(\gamma^Y) = 0$. Thus, all voters will vote for reform (replacement of P) if and only if $\hat{\gamma} \leq \gamma^Y$.[38] Moreover, it is evident that $\gamma^Y < \gamma^y$ and, a fortiori, $\gamma^Y < \gamma^{RMV}$; that is, all voters (when choosing under the veil of ignorance) will sometimes vote to retain a prosecutor that would be replaced by the RMV who is informed, *ex ante*, of her b-value (as she knows that she will not be committing a crime in the future period). Figure 1 illustrates the functions $y(\gamma)$ and $Y(\gamma)$, as well as the thresholds γ^{RMV}, γ^y, and γ^Y; for illustrative purposes, we have drawn the functions $y(\gamma)$ and $Y(\gamma)$ as being linear, but the only critical property is that they are everywhere strictly downward-sloping.

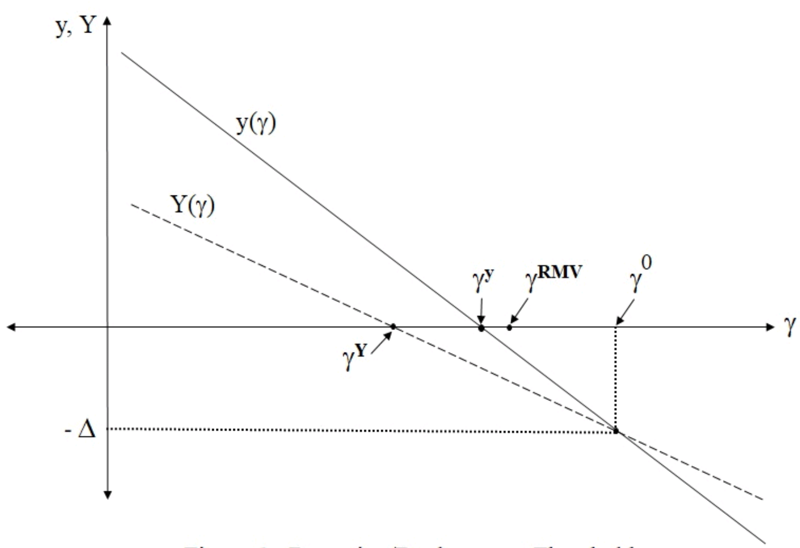

Figure 1: Retention/Replacement Thresholds

[38] If $Y(0) \leq 0$, then all voters will choose to always retain P even if they knew that P was of type L. Since our interest is the retention/replacement choice by voters, we have assumed this case does not occur.

4.4. *Comparing a Social Planner and the RMV*

Although individual voters might know their realized future b-value when they vote, it seems most plausible that a central planner will not know each citizen's realized value. Thus, we now consider a central planner who operates under a veil of ignorance, computes the *ex ante* expected welfare loss under replacement or retention of P, and implements its preferred replacement/retention decision.[39] As there is some debate about whether welfare should include criminals' perceived benefits from crime,[40] we consider three possible versions of a welfare loss function.

Case 1. The welfare loss function includes potential criminals' expected net benefits from crime (EB(criminal; γ) from subsection 4.3). In this case, the *ex ante* expected welfare loss for a representative citizen (when P's assessed quality is γ) is simply $LOSS^{AVG}(\gamma)$ - EB(criminal; γ), which is identical to the representative voter's loss function in subsection 4.3 (when the voter does not observe their future benefit from a crime before voting). Therefore, the function that governs the planner's choice to replace versus retain P is the function $Y(\gamma)$ from subsection 4.3, and the planner would choose to replace P if and only if $\hat{\gamma} \leq \gamma^Y$.

Case 2. Now assume that the welfare loss function excludes both the expected benefits from crime and the expected sanctions of potential criminals. In this case, the *ex ante* expected welfare loss for a representative citizen (when P's assessed quality is γ) is simply $LOSS^{AVG}(\gamma)$, which is nearly

[39] This decision is made at the same point at which voters would make this decision, and using the same posterior belief $\hat{\gamma}$ as voters would use. We assume that the planner is unable to make choices as to whether a witness will come forward or a crime will be committed by a citizen.

[40] It is difficult to argue that the welfare function should accord value to a criminal's benefits from, for instance, assault, rape or murder. On the other hand, there may be prohibited actions that would actually (perhaps under limited circumstances) generate social benefits in excess of the harm.

identical to the RMV's loss function (especially for large N). Therefore, the function that governs the planner's choice to replace versus retain P is the function $y(\gamma)$ from subsection 4.3, and the planner would choose to replace P if and only if $\hat{\gamma} \leq \gamma^y$. Since $\gamma^y > \gamma^Y$, this means that there are values of $\hat{\gamma}$ such that replacement of P would be chosen under this case, but not under Case 1.

<u>Case 3</u>. The last case we consider is a welfare loss function that includes the expected sanctions of potential criminals (as these involve trial costs, the disutility of incarceration, and so on), but excludes their expected benefits from crime. In this case, the *ex ante* expected welfare loss for a representative citizen (when P's assessed quality is γ) is:

$$LOSS^{AVG}(\gamma) + [N^+/N]\tilde{b}(\gamma)(1 - Z^+(\tilde{b}(\gamma))).$$

In comparison with Case 2 above, the additional term represents the expected sanction when a crime is committed, $\tilde{b}(\gamma)$, times the likelihood that a crime is committed, $[N^+/N](1 - Z(\tilde{b}(\gamma)))$. In order to decide whether to replace or retain P, the planner evaluates the following function:

$$\Sigma(\gamma) \equiv LOSS^{AVG}(\gamma) + [N^+/N]\tilde{b}(\gamma)(1 - Z^+(\tilde{b}(\gamma))) - [\Delta + LOSS^{AVG}(\gamma^0) + [N^+/N]\tilde{b}(\gamma^0)(1 - Z^+(\tilde{b}(\gamma^0)))]$$

$$= y(\gamma) + [N^+/N]\{\tilde{b}(\gamma)(1 - Z^+(\tilde{b}(\gamma))) - \tilde{b}(\gamma^0)(1 - Z^+(\tilde{b}(\gamma^0)))\}.$$

The term $\tilde{b}(\gamma)$ is an increasing function of γ, whereas the term $1 - Z^+(\tilde{b}(\gamma))$ is a decreasing function of γ. Thus, the overall effect of γ on the product of these terms is potentially ambiguous, so it is unclear whether the second term adds or subtracts from $y(\gamma)$. In what follows, we provide some conditions that are sufficient for the existence of a positive threshold value of γ, denoted γ^Σ, and determine whether that threshold is larger or smaller than γ^y. For the remainder of this subsection, we assume that $\Sigma(\gamma)$ is a decreasing function of γ, and that $\Sigma(0) > 0$.

To see the effect of γ on $\Sigma(\gamma)$, note that $\tilde{b}(\gamma)$ is always a positive and finite number, and it lies in the interval $(\tilde{b}(0), \tilde{b}(1))$. Differentiating the expression $\tilde{b}(\gamma)(1 - Z^+(\tilde{b}(\gamma)))$ yields: $[1 - Z^+(\tilde{b}(\gamma))$ -

$\tilde{b}(\gamma)z^{+}(\tilde{b}(\gamma))]\tilde{b}'(\gamma)$. Since $\tilde{b}'(\gamma) > 0$, the sign of this expression is determined by the sign of the term in square brackets. Suppose that $[1 - Z^{+}(b) - bz^{+}(b)] > 0$ for all $b \in [\tilde{b}(0), \tilde{b}(1)]$. Then the *ex ante* expected sanction $\tilde{b}(\gamma)(1 - Z^{+}(\tilde{b}(\gamma)))$ is increasing in γ, so that $\Sigma(\gamma)$ (<, =, >) $y(\gamma)$ as γ (<, =, >) γ^0. Alternatively, suppose that $[1 - Z^{+}(b) - bz^{+}(b)] < 0$ for all $b \in [\tilde{b}(0), \tilde{b}(1)]$. Then the *ex ante* expected sanction $\tilde{b}(\gamma)(1 - Z^{+}(\tilde{b}(\gamma)))$ is decreasing in γ, so that $\Sigma(\gamma)$ (>, =, <) $y(\gamma)$ as γ (<, =, >) γ^0.

Let $\varepsilon(b)$ be the elasticity of the crime rate, evaluated at $b = \tilde{b}(\gamma)$, with respect to the sanction; then $\varepsilon(\tilde{b}(\gamma)) = - \tilde{b}(\gamma)z^{+}(\tilde{b}(\gamma))/(1 - Z^{+}(\tilde{b}(\gamma)))$. This means that $[1 - Z^{+}(\tilde{b}(\gamma)) - \tilde{b}(\gamma)z^{+}(\tilde{b}(\gamma))]$ (<, = , >) 0 as $\varepsilon(\tilde{b}(\gamma))$ (<, =, >) -1, which yields the following proposition.

Proposition 6. If, for all $\gamma \in (0, 1)$,

a) the elasticity of the crime rate with respect to the sanction is *inelastic* ($\varepsilon(\tilde{b}(\gamma)) > - 1$), then a social planner is willing to retain a somewhat worse prosecutor than would the RMV (i.e., $\gamma^{\Sigma} < \gamma^{y} < \gamma^{RMV}$);

b) the elasticity of the crime rate with respect to the sanction is *unit elastic* ($\varepsilon(\tilde{b}(\gamma)) = - 1$), then a social planner is willing to retain a somewhat worse prosecutor than would the RMV (i.e., $\gamma^{\Sigma} = \gamma^{y} < \gamma^{RMV}$); and

c) the elasticity of the crime rate with respect to the sanction is *elastic* ($\varepsilon(\tilde{b}(\gamma)) < - 1$), then $\gamma^{\Sigma} > \gamma^{y}$. Moreover, there exists a sufficiently large N such that a social planner is willing to replace a somewhat better prosecutor than would the RMV (i.e., $\gamma^{\Sigma} > \gamma^{RMV}$).

The reason this social planner's rule (replace whenever $\hat{\gamma} \leq \gamma^{\Sigma}$) diverges from the RMV's rule (replace whenever $\hat{\gamma} \leq \gamma^{RMV}$) is that the voter who knows their future value of b makes a decision which does not incorporate the effect of a higher quality P on the other voters (that is, the RMV does not consider increased expected sanctions that Ds might suffer under a better P).

5. Summary and Potential Extensions

The dynamics of the legal process (in the context of a crime) involve the actions of a number of agents, three of whom we have focused upon in this paper: a potential perpetrator, a potentially decisive witness, and a chief prosecutor (who has mixed motives and degrees of diligence). We consider a four stage game (together the stages comprise a period of play), with the first two stages starting with an arrest and ending with a case disposition (a dropped case, an acquittal, or a conviction), and the last two stages consisting of the marshaling by the voters of all of the case dispositions into an aggregate posterior assessment of the chief prosecutor. The representative majority voter (RMV) then decides whether to retain or replace the prosecutor based on the posterior quality assessment (and knowledge that she will not be a criminal in the next period). We also characterize the decision that a central planner would make, and compare it with that of the RMV.

We model prosecutors as being a mix of attentive (that is, motivated by social concerns of pursuing justice) and inattentive (that is, motivated by winning, independent of whether the defendant is actually guilty or innocent), wherein a high-quality prosecutor is more likely to be attentive than a low-quality prosecutor. We also assume that an attentive prosecutor is more diligent in discerning whether a witness is reliable or unreliable (the latter type of witness causing the prosecutor to lose the case at trial). Thus, the preferences of the prosecutor over serving justice versus winning cases acts as one channel that affects the likelihood of conviction of innocent defendants, while the diligence of the prosecutor acts as a second channel, one that affects deterrence. In equilibrium, if P is high-quality as compared with low-quality: 1) convictions of innocent defendants are less likely; 2) convictions of guilty defendants are more likely; 3) the probability of a dropped case for a defendant of unknown type is more likely; 4) the probability of an acquittal of a defendant of unknown type is lower; and 5) if the police are sufficiently accurate in their arrests, the probability of a conviction of a defendant of unknown type is higher.

We examine the net loss function for the RMV, which is comprised of the expected harm from being a victim, the expected cost of being falsely arrested, the expected tax burden for supporting the legal system, and the expected net benefit from being a witness who chooses whether to come forward to testify as to the observed guilt or innocence of the defendant. We show that this loss function is decreasing in the quality of the prosecutor; this is shown under a natural assumption that the magnitude of the harm from being a victim of a crime outweighs the expected benefit, net of costs, from being a witness with probability ω. The monotonicity of the loss function, in turn, provides a cutoff for the retention/replacement decision to be made by the RMV (or the planner). We consider alternative timing specifications regarding voting versus learning the voter's future value of the benefit of crime, and we consider alternative welfare functions, depending upon whether the criminal's expected benefits and/or costs are included or excluded in the analysis.

5.1 Potential Extensions

A potential extension involves making the model of the witness more sophisticated in its treatment of W's choices and behavior. Currently, W truthfully reveals what she observed, though we do allow for the issue of reliability of this witness, which affects the desirability of using W at trial. An interesting extension would be to allow W to purposely misrepresent (consciously lie about) what was observed. One might also wish to allow for unintentional errors in W's report; for example, there has been extensive documentation that eye-witness accounts can be in error. Another potential extension would involve the determination of the likelihood that the perpetrator is arrested (α) and the sanction (S). This could be modeled in a variety of ways, as the choice could arguably be influenced by a social planner (a bureaucrat or a legislature), the prosecutor, and the voters.

We model the prosecutor's behavior mainly in terms of a fixed type (although we have considered different versions of that behavior). A further extension would allow for prosecutors to be more strategic. In particular, might a P of type L try to imitate the behavior of a P of type H in anticipation of an election (e.g., by dropping more cases when inattentive)? Of course, a P of type H could then also drop more cases when inattentive, so the extent to which a P of type L could mimic a P of type H is limited. Moreover, a P of type L may care less about reelection, as an inference of being more career-concerned may improve outside alternatives (e.g., as an attorney in private practice). Thus, a more detailed model of prosecutor preferences and options would be needed to properly incorporate strategic prosecutors.

We employ a relatively simple model of electoral choice, wherein a representative majority voter (RMV) uses the posterior assessment of P's quality and compares this with an outside opportunity (captured by a draw from a stationary distribution of candidates for chief prosecutor), controlling for an exogenously specified adjustment cost. A more expansive model could involve candidates proposing platforms (see Duggan and Martinelli, 2017, for detail on such models), so they would not be *ex ante* indistinguishable (although their proposals might not be credible). One could also envision a model wherein crime is much more pervasive (e.g., tax evasion). In this case, the benefits accruing to voters who will be criminals (in the next period) could be involved in determining the outcome, and issues of strategic voting would be more relevant.

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Appendix

Effects on Threshold Levels of Anticipation of Tax Burdens. Anticipating how choices may affect tax burdens faced by citizens occur in two places in the text. In the analysis in subsection 2.2.2, a W who has observed I and comes forward will induce an attentive P to drop the case, should W be found to be reliable; a fraction 1/N of this cost-saving accrues to W through decreased taxes. This additional benefit to W is $\gamma_A \mu k^P/N$, where k^P is P's trial cost. This would result in a threshold of $\tilde{c}_I' \equiv \tilde{c}_I + \gamma_A \mu k^P/N$, which is only slightly larger than $\tilde{c}_I$ as N is plausibly-viewed as being large. The comparative statics results reported in Proposition 1 are unchanged.

Similarly, in the analysis in subsection 2.3, a citizen who commits a crime will trigger an investigation and – unless someone else is falsely-arrested for the crime and a W exists, comes forward, and is deemed reliable by an attentive P – also generates a trial. Thus, committing a crime generates an increase in the offender's tax burden of $\{m(\alpha) + [1 - (1 - \alpha)\omega F_I(\tilde{c}_I)\gamma_A \mu]k^P\}/N$, where $m(\alpha)$ is the cost of an investigation. This raises the threshold for committing a crime to $\tilde{b}' \equiv \tilde{b} + \{m(\alpha) + [1 - (1 - \alpha)\omega F_I(\tilde{c}_I)\gamma_A \mu]k^P\}/N$, which is only slightly larger than $\tilde{b}$ as N is plausibly-viewed as being large. The comparative statics results reported in Proposition 3 are unchanged, provided that N is sufficiently large.

Proof of Proposition 2. The *ex ante* likelihood of an unjust conviction (wherein an I is convicted), for a P of type H, is given by $\eta_{IH} = \Pr\{\text{I is convicted} \mid \text{P is H}\} = (1 - \alpha)\pi[1 - \theta_H \omega F_I(\tilde{c}_I)\mu]$. Similarly, $\eta_{IL} = \Pr\{\text{I is convicted} \mid \text{P is L}\} = (1 - \alpha)\pi[1 - \theta_L \omega F_I(\tilde{c}_I)\mu]$. This is because an inattentive P always suppresses a W reporting I, so the probability of conviction remains π; whereas, an attentive P goes to trial unless a reliable witness comes forward to report I, in which event the case is dropped. Thus, the *ex ante* likelihood of an unjust conviction is lower when P is H than when P is L. It is tedious, but straightforward, to prove that these probabilities decrease as ω, μ, and α increase.

The *ex ante* likelihood of a just conviction (wherein a G is convicted), for a P of type H, is:

$$\eta_{GH} = \Pr\{G \text{ is convicted} \mid P \text{ is } H\} = \alpha\{\theta_H[(1 - \omega F_G(\tilde{c}_G)\mu)\pi + \omega F_G(\tilde{c}_G)\mu] + (1 - \theta_H)[(1 - \omega F_G(\tilde{c}_G))\pi + \omega F_G(\tilde{c}_G)\max\{\mu , \pi\}]\}.$$

The *ex ante* likelihood of a just conviction (wherein a G is convicted), for a P of type L is:

$$\eta_{GL} = \Pr\{G \text{ is convicted} \mid P \text{ is } L\} = \alpha\{\theta_L[(1 - \omega F_G(\tilde{c}_G)\mu)\pi + \omega F_G(\tilde{c}_G)\mu] + (1 - \theta_L)[(1 - \omega F_G(\tilde{c}_G))\pi + \omega F_G(\tilde{c}_G)\max\{\mu , \pi\}]\}.$$

When P is attentive, the probability of conviction remains π unless a reliable witness comes forward to report G, in which case the probability of conviction rises to 1. When P is inattentive, the probability of conviction remains π when no witness comes forward, or when a witness comes forward but P does not use the witness. If a witness comes forward and P does use the witness, then the probability of conviction becomes 1 with probability μ (and zero with probability $1 - \mu$). Collecting terms and simplifying shows that the *ex ante* likelihood of a just conviction is higher when P is H than when P is L. It is tedious, but straightforward, to prove that these probabilities increase as ω, μ, and α increase.

Proof of Proposition 4. Let ρ_H be the equilibrium probability that a D of unknown type is convicted, when P is type H. Then:

$$\rho_H = \{\alpha(1 - \omega F_G(\tilde{c}_G)) + (1 - \alpha)(1 - \omega F_I(\tilde{c}_I))\}\pi + \alpha\omega F_G(\tilde{c}_G)[\theta_H(\mu + (1 - \mu)\pi) + (1 - \theta_H)\max\{\mu, \pi\}] + (1 - \alpha)\omega F_I(\tilde{c}_I)[\theta_H(1 - \mu)\pi + (1 - \theta_H)\pi].$$

This expression is interpreted as follows. The first term (in the curly brackets), indicates that the probability of conviction remains π if the defendant is type G, as long as no witness comes forward, or if the defendant is type I, as long as no witness comes forward. The second term reflects what happens if D is guilty and there is a witness who comes forward. With probability θ_H, P is attentive; if W is reliable (which has probability μ), then the probability of conviction becomes unity, whereas if W is unreliable then an attentive P excuses the witness and the probability of conviction remains π. With probability $1 - \theta_H$, P is inattentive; she uses the witness if $\mu \geq \pi$ (and wins with probability μ), whereas she excuses the witness if $\mu < \pi$ (and wins with probability π). Finally, the third term reflects what happens if D is innocent and there is a witness who comes forward. With probability θ_H, P is attentive; if W is reliable (which has probability μ), then P drops the case, whereas if W is unreliable then an attentive P excuses the witness and the probability of conviction remains π. With probability $1 - \theta_H$, P is inattentive; an inattentive P does not use a witness reporting I (she goes for the win regardless), so the probability of conviction remains π.

Now let ρ_L be the equilibrium probability that a D of unknown type is convicted, when P is type L. The formula for ρ_L is the same as that for ρ_H, but with the substitution of θ_L for θ_H. Thus,

$$\rho_H \ (>, =, <) \ \rho_L \text{ as } \alpha F_G(\tilde{c}_G)[\mu + (1 - \mu)\pi - \max\{\mu, \pi\}] \ (>, =, <) \ (1 - \alpha)F_I(\tilde{c}_I)\mu\pi.$$

Let d_H be the equilibrium probability that a case is dropped, when P is type H. Recall that a case is dropped only if P is attentive (and type H is attentive with probability θ_H), D is innocent, and a reliable witness comes forward to verify D's innocence. Thus, $d_H = (1 - \alpha)\omega F_I(\tilde{c}_I)\theta_H\mu$. Let d_L be the equilibrium probability that a case is dropped, when P is type L; then $d_L = (1 - \alpha)\omega F_I(\tilde{c}_I)\theta_L\mu$. Clearly, $d_H > d_L$; citizens who observe a dropped case should update their prior belief in the direction of type H.

Let a_H be the equilibrium probability that a D of unknown type is acquitted, when P is type H. We will compute the "gross" probability of acquittals, including those that result in fiascos; see below for a subdivision of acquittals into "normal acquittals" and "fiascos." We can compute a_H as the residual category: $a_H = 1 - \rho_H - d_H$ and $a_L = 1 - \rho_L - d_L$. It is straightforward to show that $a_H < a_L$; that is, citizens who observe an acquittal should update their prior belief in the direction of type L.

Fiascos versus ordinary acquittals. We can further subdivide acquittals into "ordinary" acquittals and fiascos. If citizens can observe fiascos separately from ordinary acquittals, then the vector of dispositions is more informative. Let ψ_H denote the probability that the case ends in a fiasco when P is type H; then $a_H^{net} \equiv a_H - \psi_H$ represents the probability of acquittal net of those that are due to fiasco (and $a_L^{net} \equiv a_L - \psi_L$). Recall that an attentive P never uses an unreliable witness; moreover, when $\mu < \pi$ an inattentive P does not use W at all. Thus, when $\mu < \pi$, there are no fiascos and thus $a_H^{net} = a_H$ (and $a_L^{net} = a_L$). On the other hand, when $\mu \geq \pi$, an inattentive P does use the witness, and a fiasco occurs with probability $\psi_H = (1 - \theta_H)\alpha\omega F_G(\tilde{c}_G)(1 - \mu)$, resulting in $a_H^{net} = 1 - d_H - \rho_H - \psi_H$. Similarly, $a_L^{net} = 1 - d_L - \rho_L - \psi_L$, where $\psi_L = (1 - \theta_L)\alpha\omega F_G(\tilde{c}_G)(1 - \mu)$. Note that $\psi_H - \psi_L < 0$; that is, the risk of a fiasco is lower when P is type H rather than type L. Then: $a_H^{net} - a_L^{net}$ (>, =, <) 0 as

$$- \{(1 - \alpha)\omega F_I(\tilde{c}_I)\mu\} - \{\alpha\omega F_G(\tilde{c}_G)[\mu + (1 - \mu)\pi - \max\{\mu , \pi\}] + (1 - \alpha)\omega F_I(\tilde{c}_I)(- \mu\pi)\}$$

$$+ \{\alpha\omega F_G(\tilde{c}_G)(1 - \mu)\} \ (>, =, <)\ 0.$$

Simplifying, we find that $a_H^{net} - a_L^{net} > 0$ holds if and only if $[\alpha/(1 - \alpha)][(1 - \mu)/\mu] > F_I(\tilde{c}_I)/F_G(\tilde{c}_G)$, which is the same condition under which $\rho_H > \rho_L$ when $\mu \geq \pi$. Thus, when $\mu \geq \pi$, $(\rho_H - \rho_L)(a_H^{net} - a_L^{net}) > 0$; either a P of type H generates a higher probability of both convictions and ordinary acquittals, or a lower probability of both convictions and ordinary acquittals.