Prosecutor Quality, Witness Participation, Crime, and Reform*

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We develop a model wherein concerns about prosecutor quality reduce 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 chooses to replace the prosecutor with a challenger, in expectation of reform. We compare the majority's choice with that of a social planner. (JEL D82, K42)

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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

[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, official misconduct 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

likely to be concerned about the integrity of the system. We develop a model wherein such concerns induce a reduction in the willingness of witnesses (broadly defined) to volunteer evidence and cooperate with the prosecutor. This, in turn, increases the expected crime rate when criminals recognize that witness reticence will result in a reduced likelihood that criminal acts will be successfully-prosecuted. As witnesses can provide useful information on both rightly-accused criminals and wrongly-arrested innocents, such non-cooperation also yields an increase in wrongly-convicted innocent defendants. Finally, we embed this model in a larger context wherein citizens form beliefs about the prosecutor based on case dispositions and vote to retain or replace them.

We construct a model wherein the quality of the enforcement authority is summarized as a characteristic of the Chief Prosecutor (hereafter, "the prosecutor"), which is the prosecutor's private information. Thus, our model of the prosecutor is one of adverse selection. 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 equally concerned with pursuing conviction for an actual perpetrator) and is also more diligent in evaluating the evidence provided 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); later we relax this correlation in a section devoted to robustness. We show that witnesses are more likely to come forward, and potential perpetrators are less likely to commit crimes, when the prosecutor's perceived quality is higher. That is, a reputation of the enforcement authority for lower quality 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 for a voter as a function of the prosecutor's quality (as assessed by the voter). This involves aggregating the citizens' 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). We assume that there is a strict majority of citizens who will choose not to be criminals; all members of this majority will have the same expected net loss. 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 expected net loss is a decreasing function of the prosecutor's assessed quality, so the *RMV* prefers a higher-quality prosecutor.

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:

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[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.

individual choice to commit or refrain from a crime; the willingness of witnesses to provide relevant evidence to authorities; the quality reputation of the enforcement authority; and voter choice to retain or replace that authority.

Section I provides a review of related literature. Section II develops a model of crime commission by potential perpetrators, witness choice as to whether to volunteer information, and case disposition via pre-trial dismissal or trial. In Section III we embed this model in a larger context wherein citizens use the history of case dispositions to form posterior beliefs about the quality of the prosecutor and then to vote to retain or replace them. In Section IV we examine the robustness of the model's predictions to: 1) alternative representations of prosecutor quality; 2) finer case disposition information for voters; 3) changes in the timing of voting relative to citizens' receipt of relevant information; and 4) the decision rule for a social planner versus the *RMV*'s replacement decision rule. Section V summarizes the analysis and our primary results, and suggests some policy implications and possible extensions for future research.

I. Review of Related Literature

This paper is closely-related to several strands of literature. First, there is a substantial literature on deterrence wherein a potential offender chooses whether to commit a crime, anticipating the likelihood of apprehension and 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,

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

1999; and Daughety and Reinganum, 2020) 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 motivated primarily 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 through election, appointment, promotion, or private employment. Informal sanctions attenuate the incentive to win and move the prosecutor 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 prosecute a defendant they know to be innocent (pursuing the conviction at the expense of justice).[4]

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

[4] 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).

(2013) finds that this pressure can lead to more wrongful convictions (as more convictions are reversed on appeal).

Third, some other papers provide models that involve citizens as potential criminals and as taxpayers. For instance, in Furlong (1987) agents choose between being a criminal, a law enforcer, and a private-sector employee ("a legal citizen"). All agents interact randomly, with a crime being committed when a criminal encounters a legal citizen. When a law enforcer encounters a criminal, the criminal is arrested, and the victim and the criminal are restored to their pre-crime situations (this is plausible for the crime under consideration, which is theft, but it is not plausible for all crimes). A social planner chooses the tax rate and the distribution of agents among the three occupations, subject to the constraint that no agent has an incentive to change his occupation. Furlong finds that the optimum occurs at a corner solution wherein all crime is deterred.

Langlais and Obidzinski (2017) assume that voters (who may also be criminals) have preferences over the extent of enforcement, which is summarized by a fine and a probability of apprehension. Potential prosecutors (incumbent and challenger) compete for election, which results in them both proposing the median voter's preferred policy. The outcome of the election process coincides with what a social planner would choose except for a range of crimes of intermediate severity, where the electoral process results in under-enforcement (resp., over-enforcement) for less-severe (resp., more-severe) crimes.[5]

Our model differs in several ways from those of Furlong and Langlais and Obidzinski. In our model (as compared to Furlong) we assume that the criminal retains his personal benefit from a crime regardless of whether he is subsequently arrested (this is plausible for many crimes wherein the crime does not result in a simple financial transfer that can be reversed). Since a potential criminal's benefit from crime is drawn from an unbounded positive interval, no finite investment in law enforcement can deter all crime. In contrast to both Furlong and Langlais and Obidzinski, we include false arrests and witnesses who may be able to exonerate an innocent

[5] Obidzinski (2019) finds similar results when this model is re-cast to investigate the accuracy of the determination of whether a particular defendant is guilty or innocent. Mungan (2017) provides a related model wherein the median voter prefers a longer sentence than the mean voter. This model is used to investigate the effect of disenfranchising those convicted of a crime; disenfranchisement exacerbates the difference between the median and the mean voter in regard to the preferred sentence.

defendant and help to convict a guilty defendant. Moreover, we consider prosecutors with hidden quality, and this interacts with a witness's choice to come forward with evidence. We take taxes and enforcement parameters as given, but, we allow citizens to vote to retain or replace the prosecutor.

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

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 III. 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 heterogeneous 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[6]) 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 ("drop the case") or to pursue the case to trial. If the

[6] 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.

case is not dropped, 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, and so on).

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.[7] We assume that a majority of citizens draws a personal benefit from committing a crime in the future that is non-positive (so that the *RMV* will choose not 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.[8] 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.[9]

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[7] 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 IV we consider alternative timing wherein voting precedes the benefit draw.

[8] 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.

[9] 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).

A. 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, α is the probability that the perpetrator of the crime is correctly apprehended.[10] 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.[11]

A witness (she, denoted as W) exists with probability ω, which is exogenously determined and commonly known.[12] 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.[13] If W exists, she has evidence[14] 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 (whether D is G or I) is her private information. Further, we model such a witness as

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[10] To avoid repetitive statements, all exogenously-determined probabilities are assumed to be proper fractions.

[11] We return below, in footnote 28, 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. Note also that reliance on π as the probability of conviction means we are not using a Bayesian model to represent the court's decision process. Elsewhere we have discussed in detail how the rules of procedure and evidence specifically act to restrict a trial court's decision-making to be non-Bayesian, so as to reduce the influence of judge/juror prior beliefs on outcomes (see Daughety and Reinganum, 2000).

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

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

[14] 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.

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 by the court as reliable. 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 by the court as *R* or *U*. Most potential witnesses have little knowledge or experience with the judicial system, and would thus be unable to determine in advance how they would perform or be perceived should they provide testimony in court. 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.

Finally, if a witness is used at 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,[15] but the entire case is tainted, resulting in a "dismissal with prejudice" (denoted *DWP*); that is, *P* loses.[16] In Section IV we weaken the assumption that unreliable witnesses who testify result in a sure loss for *P*.

1.Modeling Prosecutor Quality.—We model a prosecutor 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: seeks justice), or as being *inattentive* to such goals due to focusing only on winning convictions (in short: pursues 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

[15] Notice that a reliable witness is therefore treated as if she is informative, while an unreliable witness is therefore treated as if she has 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.

[16] In the law, dismissal with prejudice means that the case is dismissed by the court and cannot be re-filed.

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 IV 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 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: $\gamma_A \equiv \gamma\theta_H + (1-\gamma)\theta_L$.[17] 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,[18] 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 *DWP*, thereby wasting the court's time and resources) and pursues the case at trial without[19] *W*, winning on the basis of the original evidence with probability π.

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[17] 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 $1 - \gamma_A = \gamma(1-\theta_H) + (1-\gamma)(1-\theta_L)$.

[18] Here we simply summarize *P*'s behavior; for utility functions that rationalize this behavior, see the Appendix.

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

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* based on the likelihood μ that *W* will later be deemed reliable at trial.[20] 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 *DWP* 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 *DWP*). 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 *DWP*, acquittal with *DWP*, conviction) are on the equilibrium path for both types of *P*: observing one such outcome does not reveal *P*'s type.

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 distribution $F_\tau(c_\tau)$ on the domain $[0, \infty)$, and observed privately by *W*.[21] We view this cost as being incurred when *W* comes forward,

[20] 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 *DWP*.

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

regardless of whether W is used at trial.[22] 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").[23] 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 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 maximizes wins, such a P 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 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

[22] 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.

[23] 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.

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 $F_I(\tilde{c}_I)$.[24]

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 a 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* 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* is $F_\tau(\tilde{c}_\tau)$, for τ = *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. 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, 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

[24] 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.

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, a worse reputation (i.e., an increased perception that *P* is 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.[25]

PROPOSITION 1: *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.*

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

$$\eta_{\tau T} \equiv \Pr\{D \text{ of type } \tau \text{ is arrested and convicted} | P \text{ is type } T\},$$

where $\tau = I, G$, and $T = H, L$. Thus, for example, η_{IH} is the probability that an innocent *D* is arrested and convicted when faced with a *P* that is an *H*-type. When an innocent *D* is arrested

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

and convicted we refer to this as an "unjust conviction," while a *D* that is *G* and is arrested and convicted is referred to as a "just conviction." These four probabilities are given in the Appendix. Then the following proposition is straightforward to show:

PROPOSITION 2:

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

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

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

$$\frac{\partial \eta_{IT}}{\partial \lambda} < 0 \; and \; \frac{\partial \eta_{GT}}{\partial \lambda} > 0.$$

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).

B. Analysis of Stage 1: Deciding to Commit a Crime

We now analyze Stage 1, wherein a citizen[26] decides about committing a crime, given how things will play out in Stage 2. We assume that all citizens might be perpetrators and/or 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

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

made in Stages 1 and 2 (we assume a second, independent[27] draw of b in Stage 3 before voting, as this will be used to estimate the future effects of an election). Recall that b can be negative, indicating that such an individual would refrain from crime even if he anticipated no formal sanction. This might reflect social, moral, and/or 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 zero. 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.[28] 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:

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

This expression is interpreted as follows. The first term in square brackets is the probability that either there is no W or that there is a W 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 W 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 W to raise the likelihood of conviction to 1 and will ignore an unreliable W, resulting in a conviction with probability π; this explains the first two terms in the second set of square brackets. The final

[27] We assume i.i.d. draws for Stages 1 and 3, but one could extend the analysis to allow correlated draws.

[28] 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 $\pi S > k^P$. Note that this is the rationality restriction foreshadowed in footnote 11.

term represents what happens if *P* is inattentive; such a *P* uses *W* if and only if $\mu \geq \pi$ (and wins with probability μ when she uses *W* and with probability π when she does not use *W*). 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.[29] 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).[30]

1.*Comparative Statics of Deterrence.*—The parameters α, *S*, ω, and k^D enter the threshold $\tilde{b}$ only directly (where indicated above); 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

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[29] 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.

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

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:[31]

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

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 sanction.[32] 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 to committing a crime via the following proposition.

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[31] The expression for $\tilde{b}$ is continuous everywhere, and differentiable in π (except at $\pi = \mu$).

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

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.*

III. Assessment, Voting, and Reform

In Section II 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*.[33]

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 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 prior distribution of prosecutor types.

A. Voter's Posterior Assessment of P's Type

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

[33] Thus our model reflects sequentially-rational choice by voters, having observed the outcomes of multiple cases. Gordon and Huber (2002) treat the median voter as a principal who acts after observing the outcome of a single case, and the prosecutor as an agent. The voter pre-commits to a retention probability based on the case disposition.

convictions, number of acquittals, number of dropped cases).[34] 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 $\hat{\gamma}$:

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

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

We formalize this as follows. Let ρ_T denote the equilibrium probability that a *D* of unknown type is convicted, when *P* is type *T*, *T* = *H*, *L*. Similarly, let a_T denote the equilibrium probability that a *D* of unknown type is acquitted, when *P* is type *T*. Finally, let d_T denote the equilibrium probability that the case is dropped, when *P* is type *T*. In the Appendix we provide formulae for these expressions, and we show that the following proposition holds.[35]

PROPOSITION 4: *For a randomly-chosen defendant of unknown type:*

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

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[34] In subsection IV.B we allow *DWP*s to be observationally distinct from ordinary acquittals.

[35] For tractability, we assume that the crime-generation process reflects independent events, and the case dispositions are also independent events. Thus, we have ignored the possibility that crimes may be generated by, say, a gang that coordinates criminals and we have also ignored the possibility that prosecutors might face budget constraints (for consideration of this latter effect, see Landes, 1971, and Rasmusen, Raghav, and Ramseyer, 2009).

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

(iii) *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,* $\rho_H\ (>,=,<)\ \rho_L$ *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 (iii), 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:[36]

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

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.

Returning to the voters' updating process, suppose that a history Φ consists of *n* convictions, *m* acquittals, and q dropped cases, all of which are independent events. Then $\Pr\{\Phi|P\ is\ T\} = X(\rho_T)^n(a_T)^m(d_T)^q$, where $T = H,\ L$ and $X \equiv (n+m+q)!/(n!\,m!\,q!)$, 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 consider the

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

alternative timing (wherein voting occurs before voters learn their b-value for the upcoming period) in subsection IV.C, as an extension of the basic model. As will be shown in subsection IV.D, 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.

B. 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 expected sanction $\tilde{b}$, will entertain committing a crime). More precisely, let $Z^{-}(\cdot)$ be a continuously-differentiable cumulative distribution, with positive density $z^{-}(\cdot)$, of b-values on $(-\infty, 0]$. Also, let $Z^{+}(\cdot)$ be a continuously-differentiable cumulative distribution, with positive density $z^{+}(\cdot)$, of b-values on $(0, \infty)$.[37] 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 alternatively stated as $N^{+} < (N/2)-1$; that is, the N^{+} citizens will constitute a clear minority. 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.[38] We designate an arbitrary

[37] The Z^{+} support is open on the left end to emphasize that these values will be compared with the endogenously-determined expected sanction $\tilde{b}$, which is strictly positive.

[38] Austen-Smith and Banks (1996) discuss sincere versus strategic voting. Weakening our condition that no voter is pivotal means that strategic voting could become relevant; we return to this possible further extension in Section V.

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 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.

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 $1/(N-1)$.[39] 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:

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

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.

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

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 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 of 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:

$$(2) \qquad EC(false\ arrestee;\gamma)=\left[\frac{N^{+}\left(1-Z^{+}\left(\tilde{b}\right)\right)(1-\alpha)}{N-1}\right](\pi S+k^{D})(1-\gamma_A\omega F_I(\tilde{c}_I)\mu).$$

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.*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, total expected prosecution costs are $N^+\left(1-Z^+\left(\tilde{b}\right)\right)[1-(1-\alpha)\gamma_A\omega F_I(\tilde{c}_I)\mu]k^P$. 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:

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

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.

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.[40] 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 $[(N-2)/(N-1)][1/(N-2)] = 1/(N-1)$, 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

[40] 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.

$(N-2)/(N-1)$ 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 c_G and comes forward whenever $c_G \leq \tilde{c}_G$. Thus, the *RMV*'s expected net benefits are given by the partial expectation of $V_G^W(\tilde{c}_G)$ 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 c_I and comes forward whenever $c_I \leq \tilde{c}_I$. Then her expected net benefits are given by the partial expectation of $V_I^W(\tilde{c}_I)$ 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 $\frac{\partial EV_G^W(\tilde{c}_G)}{\partial \tilde{c}_G} = 0$ and $\frac{\partial EV_I^W(\tilde{c}_I)}{\partial \tilde{c}_I} = 0$. 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 therefore write the *RMV*'s overall expected benefits *EB*(*witness*; γ) as follows:

$$EB(witness; \gamma) = \left[\frac{\omega N^+ \left(1 - Z^+(\tilde{b})\right)}{N-1}\right](\alpha EV_G^W(\tilde{c}_G) + (1-\alpha)EV_I^W(\tilde{c}_I)). \quad (4)$$

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.

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:

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

where the elements on the right-hand-side are given in equations (1) - (4) above. Recall that *EC*(*false arrestee*; γ) and *EC*(*taxpayer*; γ) are both decreasing in γ. Now consider the difference between the remaining terms, namely $EC(victim{:}\,\gamma) - EB(witness;\gamma)$. Under the assumption below (Assumption 1), 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: $h > \omega\{\alpha EV_G^W(\tilde{c}_G) + (1-\alpha)EV_I^W(\tilde{c}_I)\}$*; that is, the harm from being a victim exceeds the expected benefit (net of costs) from being a witness with probability* ω.

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*.

C. The RMV's Choice and Reform

We now consider a dynamic process, wherein at the beginning of the period discussed in Section II (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 III.A, 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.[41] 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 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* $LOSS^{RMV}(0) > \Delta + LOSS^{RMV}(\gamma^0)$*:*

(i) $LOSS^{RMV}(\gamma)$ *is monotonically decreasing in* γ*; and*

(ii) *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

[41] 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.

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).

IV. 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 *DWP*s? 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 base model (that is, modifications are not cumulative).

A. 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, in contrast with an attentive P, 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 reports *I*). This reflects a difference in <u>preferences</u> concerning the conviction of innocent *D*s. Second, an inattentive *P* is insufficiently diligent in discerning witness reliability in advance of trial; this reflects a difference in <u>diligence</u>. The difference in preferences provides a channel that affects the conviction of innocent *D*s, as an inattentive *P* pursues a conviction despite a *W* who reports *I*, and this in turn reduces the participation of *W*s who observed *I*. The difference in diligence provides a channel that affects the conviction of guilty *D*s, as an inattentive *P* generates more overall acquittals of guilty *D*s, both directly via the inadvertent production of *DWP*s (or by not using a *W* who would have proved reliable at trial), but also indirectly by deterring some *W*s who observed *G* from coming forward.

There are plausible alternative specifications of inattentive and attentive *P*s. For instance, what if the use of an unreliable witness at trial does not guarantee a loss? 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.

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 *P*s 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.

B. 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 *DWP*s, but not the breakdown between these), and the number of dropped cases. The probability of each of these outcomes was denoted by (ρ_T, d_T, a_T) for a *P* of type *T*, *T* = *H*, *L*.

If voters can observe *DWP*s separately from ordinary acquittals, then the vector of dispositions is more informative. Let ψ_T denote the probability that the case ends in a *DWP* when *P* is type *T*; then $a_T^{net} = a_T - \psi_T$ represents the probability of acquittal net of those that are due to a *DWP*. 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 *DWP*s and hence $a_T^{net} = a_T$. When $\mu \geq \pi$, an inattentive *P* uses the witness, and a *DWP* occurs (which happens with probability $\psi_H < \psi_L$; see the Appendix); that is, the risk of a *DWP* is lower when *P* is type *H* rather than type *L*. This means that voters who observe *DWP*s should update their prior belief in the direction of type *L*. It is shown in the Appendix that $a_H^{net} > a_L^{net}$ 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(iii)). Thus, 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.

C. Voting under a Veil of Ignorance

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 $\left[\frac{N-N^+}{N}\right](N^+) + \left[\frac{N^+}{N}\right](N^+ - 1) = [\frac{N-1}{N}](N^+)$ potential perpetrators. This randomly-chosen citizen faces an expected cost of being a victim of $[(N-1)/N]EC(victim; \gamma)$, where $EC(victim; \gamma)$ is the expected cost of being a victim for the *RMV* (as defined in subsection III.B.5).[42] 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:

$$LOSS^{AVG}(\gamma) \equiv \left[\frac{N-1}{N}\right][EC(victim;\gamma) + EC(false\ arrestee;\gamma) - EB(witness;\gamma)] + EC(taxpayer;\gamma).$$

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

Thus, the randomly-chosen citizen is slightly less-concerned (than the *RMV*) about *P*'s quality, because this citizen may be a potential perpetrator. Moreover, while both $LOSS^{AVG}(\gamma)$ and $LOSS^{RMV}(\gamma)$ are decreasing in γ, $LOSS^{AVG}(\gamma)$ decreases 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, under a veil of ignorance, the randomly-chosen citizen will incorporate the expected net benefits of crime. Recall that a citizen will commit a crime only if she is a potential perpetrator and her *b*-value is at least $\tilde{b}$; in what follows we make explicit the dependence of the expected sanction on γ by employing the notation $\tilde{b}(\gamma)$. The expected net benefit (of committing a crime) for a potential perpetrator who has drawn a future benefit of *b* is:

$$EB(criminal; \gamma) \equiv [\frac{N^+}{N}] \int (b - \tilde{b}\,(\gamma)) dZ^+(b),$$

where the integral is over $\left[\tilde{b}(\gamma), \infty\right)$. 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 $\partial EB(criminal; \gamma)/\partial\gamma$ through $\tilde{b}(\gamma)$'s appearance in the integrand. Thus:

$$\frac{\partial EB(criminal; \gamma)}{\partial \gamma} = \left[\frac{N^+}{N}\right] \int -\tilde{b}'\,(\gamma) dZ^+(b) = -\left[\frac{N^+}{N}\right] \tilde{b}'(\gamma)(1 - Z^+\left(\tilde{b}(\gamma)\right)) < 0$$

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

The overall loss function, for an arbitrary γ, is now given by $LOSS^{AVG}(\gamma) - EB(criminal;\gamma)$. Because $LOSS^{AVG}(\gamma)$ and $EB(criminal;\gamma)$ 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 $LOSS^{AVG}(\hat{\gamma}) - EB(criminal;\hat{\gamma})$ to $\Delta + LOSS^{AVG}(\gamma^0) - EB(criminal;\gamma^0)$. Let:

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

meaning that $Y(\gamma) \equiv y(\gamma) - [EB(criminal;\gamma) - EB(criminal;\gamma^0)]$. Then voters will unanimously 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 $EB(criminal;\gamma)$ is decreasing in γ, the term $[EB(criminal;\gamma) - EB(criminal;\gamma^0)]$ is positive (resp., negative) for $\gamma < (resp.,) > \gamma^0$, 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, 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 $\hat{\gamma} \leq \gamma^Y$.[43] 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 who would be chosen for replacement 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.

[43] 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.

[Insert Figure 1 Here]

D. 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.[44] As there is some debate about whether welfare should include criminals' perceived benefits from crime,[45] we consider three possible versions of a welfare loss function.

Case 1. The welfare loss function includes potential criminals' expected net benefits from crime ($EB(criminal; \gamma)$ from subsection IV.C). In this case, the *ex ante* expected welfare loss for a representative citizen (when *P*'s assessed quality is γ) is simply $LOSS^{AVG}(\gamma) - EB(criminal; \gamma)$, which is identical to the representative voter's loss function in subsection IV.C (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 IV.C, 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 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 IV.C, and the planner would choose to replace *P* if and only if $\hat{\gamma} \leq \gamma^{y}$. Since

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[44] 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.

[45] 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.

$\gamma^y > \gamma^Y$, 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.

Case 3. 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. Denote the *ex ante* expected sanction for a single criminal by $B(\gamma) \equiv \tilde{b}(\gamma)[1 - Z^+\left(\tilde{b}(\gamma)\right)]$. Then the *ex ante* expected welfare loss for a representative citizen (when *P*'s assessed quality is γ) is $LOSS^{AVG}(\gamma) + [N^+/N]B(\gamma)$. In comparison with Case 2 above, the additional term represents the voter's share of the expected sanctions borne by criminals. In order to decide whether to replace or retain *P*, the planner evaluates the following function:

$$\Sigma(\gamma) = LOSS^{AVG}(\gamma) + \left[\frac{N^+}{N}\right]B(\gamma) - [\Delta + LOSS^{AVG}(\gamma^0) + \left[\frac{N^+}{N}\right]B(\gamma^0)]$$

$$= y(\gamma) + \left[\frac{N^+}{N}\right][B(\gamma) - B(\gamma^0)].$$

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, $B(\gamma)$, is potentially ambiguous, so it is unclear whether the second term adds or subtracts from $y(\gamma)$. In what follows we assume that $\Sigma(\gamma)$ is a decreasing function of γ, and that $\Sigma(0) > 0$. These conditions are sufficient for the existence of a positive threshold value of γ, denoted γ^Σ, and analogous to our previous discussion, the central planner's decision rule is to replace *P* if and only if $\hat{\gamma} \leq \gamma^\Sigma$. Below, we determine whether that threshold is larger or smaller than γ^y.

To see the effect of $\gamma \in (0,1)$ 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 $B(\gamma)$ yields: $[1 - Z^+\left(\tilde{b}(\gamma)\right) - \tilde{b}(\gamma)z^+\left(\tilde{b}(\gamma)\right)]\tilde{b}'(\gamma)$. Since $\tilde{b}'(\gamma) > 0$, the sign of the overall 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 $B(\gamma)$ is increasing in γ, so $\Sigma(\gamma)\ (<, =, >)\ y(\gamma)$ as $\gamma\ (<, =, >)\ \gamma^0$. On the

other hand, suppose that $[1 - Z^{+}(b) - bz^{+}(b)] < 0$ for all b in $(\tilde{b}(0), \tilde{b}(1))$. Then $B(\gamma)$ is decreasing in γ, so $\Sigma(\gamma)$ $(>, =, <)$ $y(\gamma)$ as γ $(<, =, >)$ γ^{0}.

An alternative, and possibly more economically meaningful, way of interpreting the foregoing relationships is via $\varepsilon(b)$, the elasticity of the crime rate with respect to the expected sanction, evaluated at $b = \tilde{b}(\gamma)$. Thus, $\varepsilon\left(\tilde{b}(\gamma)\right) = -\tilde{b}(\gamma)z^{+}(\tilde{b}(\gamma))/[1 - Z^{+}\left(\tilde{b}(\gamma)\right)]$. This means that $\left[1 - Z^{+}\left(\tilde{b}(\gamma)\right) - \tilde{b}(\gamma)z^{+}\left(\tilde{b}(\gamma)\right)\right]$ $(<, =, >)$ 0 as $\varepsilon\left(\tilde{b}(\gamma)\right)$ $(<, =, >)$ -1, which yields the following proposition.

PROPOSITION 6: *If, for all* $\gamma \in (0,1)$,

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

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

(iii) *the elasticity of the crime rate with respect to the sanction is* ***elastic*** *($\varepsilon\left(\tilde{b}(\gamma)\right) < -1$), 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., $\gamma^{\Sigma} > \gamma^{RMV}$).*

In all three cases the reason that the social planner's decision rule diverges from the *RMV*'s rule 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 *D*s might suffer under a better *P*).

V. Summary, Policy Implications, 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 mixture of attentive and inattentive, wherein an attentive prosecutor pursues justice, whereas an inattentive prosecutor simply pursues convictions. Moreover, an attentive prosecutor is more diligent in discerning whether a witness is reliable or unreliable (the latter type of witness causes the prosecutor to lose the case at trial). Our underlying type space concerns the quality (high versus low) of prosecutors, with a high-quality prosecutor being more likely to be attentive than a low-quality prosecutor. We show that the prosecutor's preferences 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) unjust convictions are less likely; and 2) just convictions are more likely. Moreover, for a randomly-chosen defendant of unknown type: 3) the probability that the case is dropped is higher; 4) the probability that the defendant is acquitted is lower; and 5) if police are sufficiently accurate in their arrests, then the probability that the defendant is convicted is higher.

We examine the representative majority voter's expected net loss function, 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.

V.A. Policy Implications

The core of our model involves the interaction between prosecutors and potential witnesses (or other sources of post-arrest evidence that may be inculpatory or exculpatory). If there were no potential witness (that is, $\omega = 0$), then the distinction between attentive and inattentive prosecutors vanishes, and there is no quality variation among prosecutors. If a witness comes forward with an exogenous probability, then the results of the base model go through. However, the full scope of this relationship between the prosecutor and the witness becomes apparent when the witness chooses whether to come forward, based on her cost (e.g., disutility, or fear of stigma or retribution) of doing so. In particular, lower perceived prosecutor quality tends to discourage witness participation.

This suggests three policy implications that center on information policies, two designed to affect witness participation and a third designed to affect prosecutor performance. First, in order to know that one is a witness, it is important to know that a crime was committed, when and where it was committed, and who has been arrested for that crime. We have assumed that a witness automatically knows whether or not she has relevant evidence; implicitly, she knows that a crime was committed and a particular defendant was arrested. In reality, whether a witness exists (and chooses to come forward) depends on whether a person is in a position to observe the crime, or in a position to observe the defendant elsewhere at the time of the crime. This suggests that (in order to increase ω) such information should be routinely- and broadly-disseminated, so that someone realizes whether she has relevant evidence. Radio and television news programs do distribute such information, particularly for serious crimes; local newspapers (print and

online) may provide more complete lists. Local police departments also provide a comprehensive list, but greater public awareness of this information is desirable.[46]

The second relevant information policy is one involving the identities of witnesses. We view the witness' cost of coming forward as involving the risk of stigma or retribution from third parties (either for aiding in the conviction or the exoneration of the defendant, depending on the outcome the third parties prefer). These costs can be significant barriers to witnesses coming forward (recall our earlier example in footnote 23 concerning an example of serious witness intimidation). Therefore, a policy that conceals – to the greatest extent possible – the witness' identity will result in stochastically-lower witness participation costs. There are clear examples of this, such as federal witness protection programs, but even in the case of more mundane crimes, witness information can be protected until trial (e.g., name and address; see *U.S. v. Higgs,* 713 F.2d 39, 1983).

Third, with respect to information policies affecting prosecutor performance, in subsection II.A.1 we argued that attentive prosecutors were those that acted so as to avoid convicting innocent defendants and were more diligent in assessing witnesses. This was implemented in the model via the parameter θ_T, $T = H, L$, which was the probability that an T-type P is attentive to the above pro-social goals, with $1 > \theta_H > \theta_L > 0$. That is, both quality types (H and L) are probabilistically attentive, and it is clear from the analysis in the rest of the paper that the greater the likelihood that a P of either type is attentive, the better off society is. While improvements in the training of future lawyers (especially those planning on becoming prosecutors) and the requirement of continuing legal education with respect to these pro-social goals might contribute to higher likelihoods of them focusing effort on being attentive, prosecutorial offices will be a composite of H- and L-type Ps, and thus a mix of attentive and inattentive Ps. Therefore, a policy implication of our analysis is that monitoring prosecutor performance, both via internal

[46] For instance, the Nashville Police Department's Daily Booking List provides a PDF file showing (for recent dates) the date, the charge, the first and last name of the person arrested, and the street location of the crime. https://www.nashville.gov/Police-Department/News-and-Reports/Daily-Booking-List.aspx; last accessed May 8, 2020.

office review by the chief prosecutor and via an outside state-level agency[47] could lead to enhanced efforts to increase θ_H and θ_L.

V.B. Potential Extensions

There are several ways in which the base model could be further extended. One 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 have also abstracted from plea bargaining in this paper. To the extent that an attentive *P* and an inattentive *P* might make different plea offers (or settle cases at different rates) then such settlements would be another case disposition that would affect voters' updating of beliefs about *P*'s quality.

We model the prosecutor's behavior via use 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 some 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.

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[47] For more detail, see our discussion of the need for state-level prosecutorial conduct commissions, as parallel to existing judicial conduct commissions that review complaints about judges, in Daughety and Reinganum (2018).

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. An extension might involve a challenger who decides whether to run against an incumbent; if the challenger has private information about the incumbent's quality or his own, then the decision to challenge the incumbent is informative. For instance, Gordon, Huber and Landa (2007) provide a model of voting to retain or replace an incumbent office-holder (not necessarily a prosecutor). The model assumes that the incumbent's ability to implement a policy desired by voters depends on the office-holder's quality ("competence"). A potential challenger has private information about the incumbent's (and his own) quality. As challenges are costly to mount, entry into the race is a signal to voters. McCannon and Pruitt (2018) provide a related model that focuses on prosecutor elections wherein the challenger is a member of the prosecutor's staff. In this event, there is good reason to believe that the challenger has private information about the quality of the prosecutor, and it is costly to challenge the incumbent as a loss is likely to result in termination. In equilibrium, an insider's decision to challenge an incumbent is informative to (uninformed) voters; moreover, a low-quality incumbent may choose not to run. The model's predictions are qualitatively consistent with empirical regularities in prosecutorial elections. Finally, another potential extension could involve candidates proposing platforms (see Duggan and Martinelli, 2017, for detail on such models), so they may not be *ex ante* indistinguishable (although their proposals might not be credible).[48] One could also envision a model wherein crime is much more pervasive (e.g., tax evasion) than we have allowed for (recall, over one-half of our voters obtain non-positive draws of their future value from a crime). 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.

[48] Langlais and Obidzinski (2017) provide a complete information model of law enforcement policy choice with electoral competition.

APPENDIX

Utility functions for P that yield behavior for attentive and inattentive P. Here we provide utility functions that rationalize the behavior specified in the text. First, consider an inattentive *P*; recall that such a *P* cannot observe whether a witness is reliable or unreliable in advance of trial. An inattentive *P* pursues the case vigorously, given her information; by "vigorously," we mean making optimal use of a witness. The inattentive *P*'s utility function is: $\Pr\{conviction|P's\ information\}S - k^P$. If there is no *W*, then the probability of conviction is π. An inattentive *P* takes the case to trial when the probability of conviction is π, rather than dropping it, as we have assumed that $\pi S > k^P$ and the payoff from dropping the case is zero. If there is a *W* who reports *I*, then the inattentive *P* maximizes $\Pr\{conviction|W\ reports\ I\}$ by taking the case to trial without *W*, so the probability of conviction remains π. If there is a *W* who reports *G*, then the inattentive *P* maximizes $\Pr\{conviction|W\ reports\ G\}$ by taking the case to trial with *W* if $\mu \geq \pi$, and by taking the case to trial without *W* otherwise. Since the inattentive *P* values a conviction even if *D* is innocent, the inattentive *P* always takes the case to trial rather than dropping it.

Next, consider an attentive *P*; recall that such a *P* observes whether a *W* is reliable or unreliable in advance of trial. An attentive *P* pursues the case vigorously, given her information, unless she has reliable evidence that *D* is *I*. Thus, the attentive *P*'s utility function is: $\Pr\{conviction|P's\ information\}S - k^P$, for *P*'s information being that: 1) there is no *W*; 2) *W* exists but is unreliable; or 3) *W* exists, is reliable, and reports that *D* is *G*. In cases 1 and 2, the probability of conviction remains π (as *P* does not use the witness when *W* is unreliable), whereas in case 3, *P* uses *W* at trial and the probability of conviction is increased from π to 1. In all three cases, this payoff exceeds zero, so *P* will pursue the case rather than dropping it. However, an attentive *P* does not want to convict someone she knows is innocent; her payoff would be: $-\Pr\{conviction|W\ is\ R\ and\ reports\ I\}S - k^P$. That is, her payoff is reduced by a conviction when *W* is *R* and reports *I*. In this event, an attentive *P* prefers to drop the case and receive a payoff of zero.

Effects on threshold levels of anticipation of tax burdens. Choices may affect tax burdens faced by citizens in two places in the text. In the analysis in subsection II.A.2, a *W* who has observed *I*

and comes forward will induce an attentive P to drop the case, if P assess W 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 $\tilde{c}_I{}' = \tilde{c}_I + \gamma_A \mu k^P/N$, 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 subsection II.B, a citizen who commits a crime triggers 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, if N is sufficiently large.

PROOF OF PROPOSITION 2: The *ex ante* likelihood of an unjust conviction (wherein an I is arrested and convicted), for a P of type T, is given by $\eta_{IT} = (1-\alpha)\pi[1 - \theta_T \omega F_I(\tilde{c}_I)\mu]$, T= H, L. This is because an inattentive P always suppresses a W reporting I, so the probability of conviction remains π. An attentive P goes to trial unless a reliable witness comes forward to report I, in which event the case is dropped. Comparing η_{IH} and η_{IL} shows that 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 arrested and convicted), for a P of type T, is:

$$\eta_{GT} = \alpha\{\theta_T[(1 - \omega F_G(\tilde{c}_G)\mu)\pi + \omega F_G(\tilde{c}_G)\mu] + (1-\theta_T)\big[\big(1 - \omega F_G(\tilde{c}_G)\big)\pi + \omega F_G(\tilde{c}_G)\max\{\mu, \pi\}\big]\}.$$

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 $1-\mu$). Comparing η_{GH} and η_{GL} 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_T be the equilibrium probability that a *D* of unknown type is convicted, when *P* is type *T*, *T* = *H*, *L*. Then:

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

This expression is interpreted as follows. The first term in 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_T, *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 $1-\theta_T$, *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_T, *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 $1-\theta_T$, *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. Thus,

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

Similarly, let d_T be the equilibrium probability that a case is dropped, when *P* is type *T*. Since a case is dropped only if *P* is attentive (and type *T* is attentive with probability θ_T), *D* is

innocent, and a reliable witness comes forward to verify *D*'s innocence, $d_T = (1-\alpha)\omega F_I(\tilde{c}_I)\theta_T\mu$. Clearly, $d_H > d_L$; citizens who observe a dropped case update their prior belief in the direction of type *H*.

Finally, let a_T be the equilibrium probability that a *D* of unknown type is acquitted, when *P* is type *T*. We compute the "gross" probability of acquittals, including those that arise from *DWP*s; see below for a subdivision of acquittals into "normal acquittals" and "*DWP*s." We can compute a_T as the residual category: $a_T = 1 - \rho_T - d_T$. 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*.

DWPs versus ordinary acquittals. If citizens can observe *DWP*s separately from ordinary acquittals, then the vector of dispositions is more informative. 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 *DWP*s. On the other hand, when $\mu \geq \pi$, an inattentive *P* does use *W*, and a *DWP* occurs with probability $\psi_T = (1-\theta_T)\alpha\omega F_G(\tilde{c}_G)(1-\mu)$, resulting in ordinary acquittals of $a_T^{net} = 1 - d_T - \rho_T - \psi_T$, for *T* = *H*, *L*. Note that $\psi_H < \psi_L$; that is, the risk of a *DWP* is lower when *P* is type *H* rather than type *L*. Then: $a_H^{net}\ (>,=,<)\ a_L^{net}$ as

$$\left[\frac{\alpha}{1-\alpha}\right]\left[\frac{1-\mu}{\mu}\right]\ (>,=,<)\ \frac{F_I(\tilde{c}_I)}{F_G(\tilde{c}_G)},$$

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.

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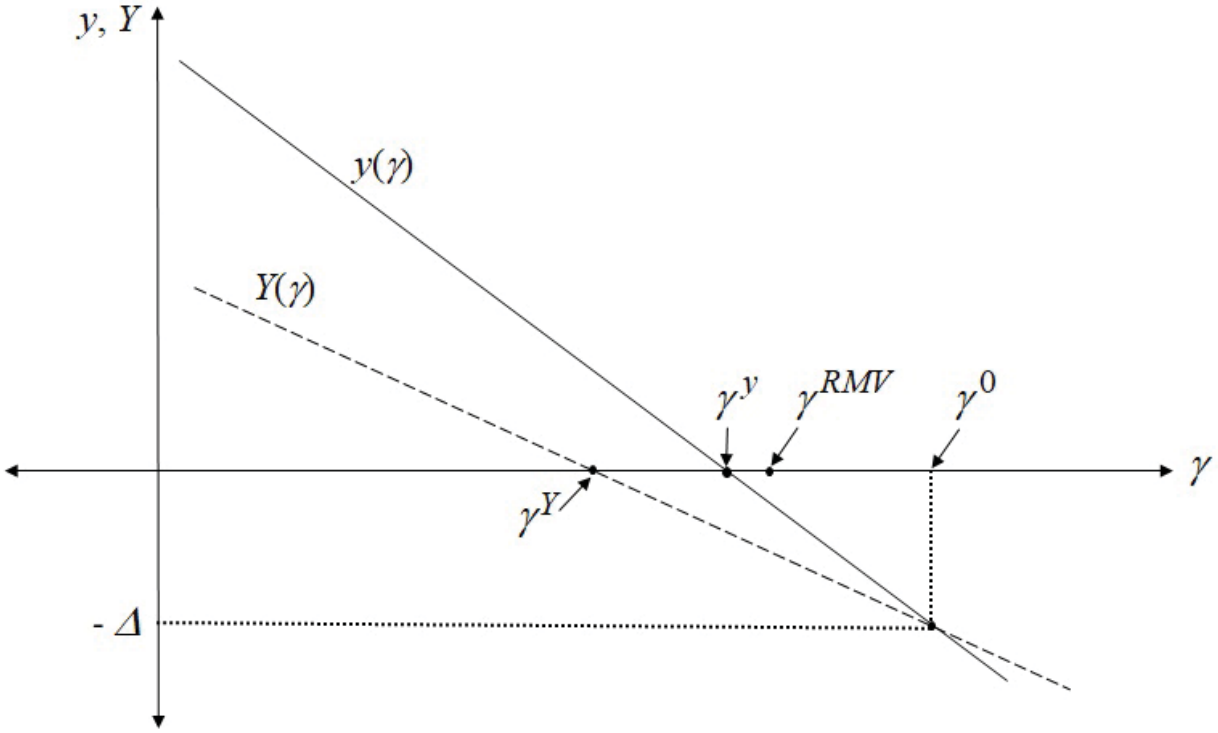

FIGURE 1. RETENTION/REPLACEMENT THRESHOLDS