Voluntary Disclosure of Evidence in Plea Bargaining

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Abstract

I study how voluntary disclosure of information affects outcomes in plea bargaining. A prosecutor negotiates a sentence with a defendant who privately knows whether he is guilty or innocent. The prosecutor can gather evidence regarding the defendant's type during negotiations, and a trial assigns payoffs depending on the evidence if they fail to reach an agreement. Voluntary disclosure induces endogenous second-order belief uncertainty. I show that a purely sentence-motivated prosecutor might disclose exculpatory evidence and that voluntary disclosure generates inefficient outcomes. Mandatory disclosure is socially preferable as outcomes are fairer and efficient. The prosecutor is better off under mandatory disclosure.

Keywords: Bargaining, plea bargain, second-order belief uncertainty, disclosure.
JEL classifications: C78, D82, D83, K40

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1 Introduction

1.1 Motivation and Results

In many bargaining situations, one party can gather information and keep the outcome private. A real estate agent who inspects a house for sale might decide to conceal information that would increase the price of the house. After reviewing a company, an investor might only reveal information that increases the return rate that she is asking. In plea bargaining (the context I examine in this paper), a prosecutor who finds exculpatory evidence might conceal it from the defendant. I study the disclosure decision of the newly informed party when the disclosure of new information is voluntary. I also examine whether mandatory, instead of voluntary, disclosure of information is socially desirable.

Plea bargaining is a case of particular relevance in the U.S. criminal system, in which more than 90% of criminal cases end in plea bargaining instead of a trial.[1] In plea bargaining, a prosecutor and a defendant negotiate for a sentence to avoid trial. During the negotiation, the prosecutor can search for evidence regarding the culpability of the defendant. In many circuit courts in the U.S., the disclosure of evidence is voluntary during plea bargaining; hence, the prosecutor can conceal exculpatory evidence during the negotiation but must disclose it at trial. If the prosecutor wants the judge to assign as high a sentence as possible, will she disclose exculpatory evidence? Even if she discloses it, is it socially desirable to impose mandatory disclosure of evidence in plea bargaining?

To answer these questions, I study a dynamic plea-bargaining model between a prosecutor (she) and a defendant (he). The defendant's type can be innocent or guilty, and the defendant is privately informed about his type. The prosecutor has inconclusive default evidence at the beginning of the game and to investigates for new conclusive hard evidence that can be exculpatory if the defendant is innocent or incriminating if the defendant is guilty. The investigation process is not perfect; with some probability, the prosecutor will not find new evidence.

If the prosecutor finds new evidence, she can voluntarily disclose it to the defendant. After the disclosure decision, the prosecutor offers a sentence to the defendant. If the offer is accepted, the game ends; if not, a new period starts. If they do not reach an agreement during a finite number of periods, they go to trial. I model the trial as a rule that assigns a sentence depending on the evidence the prosecutor gathered: Exculpatory evidence sets the defendant free, default evidence leads to a low sentence, and incriminating evidence leads to a high sentence.

The first main result shows that, in some cases, the prosecutor discloses exculpatory evidence. Suppose the prosecutor's prior belief about the defendant being guilty is low; if the prosecutor finds exculpatory evidence that exonerates the defendant, she conceals

[1] See American Bar Association (2023) and Devers (2011).

it and makes a low offer that the innocent defendant accepts. However, if the prior belief is high, she discloses exculpatory evidence and sets the defendant free in equilibrium.

The prosecutor is able to conceal exculpatory evidence because she induces second-order belief uncertainty in the innocent defendant when she investigates for new evidence, and the disclosure is voluntary. That is, the defendant does not know what evidence the prosecutor has. It implies that the innocent defendant is willing to accept a positive sentence because of the possibility of the prosecutor showing default evidence at the trial. To not reveal the evidence, when the prosecutor has exculpatory evidence, she needs to make the same offer she would have made if she had default evidence. It is optimal for the prosecutor to make that offer when the prior belief is low because the defendant will accept it. However, when the prior belief is high enough, the prosecutor's offer, if she had default evidence, is higher than what the innocent defendant is willing to accept. So, the prosecutor prefers to disclose the evidence because otherwise, the defendant will reject the offer and they will go to trial, which is costly. The second main result shows that mandatory disclosure of evidence is socially preferable to voluntary disclosure for the following reasons: First, from a utilitarian point of view, mandatory disclosure of evidence is efficient because an agreement is always reached during the plea bargaining process, and the prosecutor never incurs the cost of going to trial. There is a positive probability of going to trial when the prior belief about the defendant being guilty is high enough with voluntary disclosure. Second, the prosecutor is better off with mandatory disclosure of evidence because hiding exculpatory evidence has a downside; she cannot extract the entire surplus when she has default evidence. It produces a commitment effect; if the prosecutor can ex ante commit to disclose any evidence she found, she would do it. But with voluntary disclosure, this is not possible because if she gets exculpatory evidence, she will conceal it if she can. Third, the innocent defendant is better off, and the guilty defendant is worse off with mandatory disclosure of evidence.

For the voluntary and mandatory disclosure of evidence cases, the game presents a deadline effect. If the disclosure of evidence is voluntary, the deadline effect is as in Spier (1992): The prosecutor and defendant reach an agreement just at the deadline with a high probability compared to other periods, and in some cases, they do not reach an agreement and go to trial. If the disclosure of evidence is mandatory, they also have a higher probability of reaching an agreement at the deadline, but they never go to trial.

Outline: The plan of the paper is as follows. Section 1.2 provides background on the plea bargaining process, and Section 1.3 discusses the related literature. Section 2 introduces the model. Section 3 shows a one-period benchmark. Section 4 shows the general result for N periods. Section 5 describe the mandatory disclosure case, and Section 6 compares mandatory and voluntary disclosure case. Section 7 discusses some extensions of the model, and Section 8 presents the concluding remarks. Appendix A provides extensions of the model, and Appendix B contains the proofs.

In U.S. criminal law, plea bargaining is the pretrial process in which the prosecutor and the defendant negotiate an agreement in which the defendant pleads guilty in exchange for a lower sentence.[2] This agreement, called a plea bargain, allows the prosecutor and the defendant to avoid a trial and the associated cost and uncertainty. If they do not reach an agreement, the case goes to trial. The prosecutor's role is to represent society in the criminal case brought against the defendant.

During the trial, the prosecutor must disclose all of the evidence. The trial is protected by the Brady Rule, named for *Brady v. Maryland (1963)*, which requires prosecutors to disclose materially exculpatory evidence in their possession to the defendant.[3] The Brady Rule is not always extended to the plea bargaining process. According to Casey (2020), the Brady Rule is applied to the plea bargaining process in the Seventh, Ninth, and Tenth Circuit courts, while it is not applied to pretrial negotiations in the First, Second, Fourth, and Fifth Circuits. State courts are divided in a similar fashion.[4]

Applying the Brady Rule to the plea bargaining process is a policy question that has attracted scholars and the media attention.[5] Some arguments in favor of extending the Brady Rule to plea bargaining are related to the knowing and voluntary nature of a guilty plea; failure to disclose materially exculpatory evidence precludes a knowing and voluntary guilty plea. Consequently, the Brady Rule will likely reduce convictions of innocent defendants. Arguments against hold that extending the Brady Rule will result in higher costs and less efficiency.

The first main result of the paper shows that even when the Brady Rule does not apply to plea bargaining, the prosecutor might drop cases under certain circumstances. The second main result of the paper addresses whether the Brady Rule should apply during pretrial negotiations. I show that applying the Brady Rule to pretrial negotiations is desirable because the prosecutor and the defendant avoid costly trials by reaching an agreement. Also, the expected sentence is lower for the innocent defendant and higher for the guilty defendant, while the expected payoff for the prosecutor is higher with mandatory disclosure.

1.2 Related Literature

In my model, the prosecutor investigates seeking new evidence, and the voluntary disclosure generates second-order uncertainty on the defendant. Hence, this paper mainly relates to the literature on pretrial negotiations, bargaining with information arrival, and

[2]In the U.S. system, the judge has to agree with the plea bargain. In this paper, I assume the judge always agrees with it when the prosecutor and defendant agree.

[3]See *Brady v. Maryland*, 373 U.S. 83, 83 S. Ct. 1194, 10 L. Ed. 2d 215 (1963).

[4]There is no clear definition in the other Circuits courts.

[5]See Casey (2020); Daughety and Reinganum (2020); or Sanders (2019) for some references. See also a *New York Times* editorial, "Beyond the Brady Rule" https://www.nytimes.com/2013/05/19/opinion/sunday/beyond-the-brady-rule.html

higher-order uncertainty in bargaining.

Pretrial negotiations: Spier (1992) and Fuchs and Skrzypacz (2013) present pretrial bargaining models with incomplete information and a deadline that includes a rule to assign payoffs. They show that many agreements occur just at the deadline. Although there is a similar deadline effect in my model, I also focus on the disclosure of information. Garoupa and Rizzolli (2011) study a model in which the prosecutor might decide not to investigate before trial and conclude that innocent defendants may be worse off with the Brady Rule at trial. Daughety and Reinganum (2018) present a trial model in which a prosecutor with career concerns can violate the Brady Rule at trial. These papers focus on modeling the trials, while I focus on the pretrial negotiation and model the trial in reduced form.

In the literature on plea bargaining, Landes (1971) examines how the probability of winning at trial affects pretrial negotiations. Grossman and Katz (1983) and Reinganum (1988) study the welfare effects of plea bargaining, depending on the probability of conviction at trial. Baker and Mezzetti (2001) examine a model in which the prosecutor can choose the costly precision of a signal about defendant type. Bjerk (2007) presents a model in which new information can be revealed at trial. Vasserman and Yildiz (2019) present a model in which negotiating parties are optimistic about the decision at trial and anticipate a possible arrival of public information before the trial date. None of these papers allow for disclosing information or effects of the Brady Rule during pretrial negotiations. Ispano and Vida (2021) present a model of interrogations in which a law enforcer official and a suspect interchange messages regarding whether the suspect is innocent or guilty, and the law enforcer may disclose previously acquired evidence. Their paper focuses on the optimal interrogation policy to learn the suspect type, while I focus on the bargaining over the sentence.

Bargaining with information arrival: Duraj (2020) considers a bargaining model in which the buyer can choose how accurately she learns about her valuation of a good being traded, and she can disclose the updated valuation. Esö and Wallace (2019) consider a bargaining model in which the value of the good being traded is exogenously and privately revealed and can be disclosed. They show that the possibility of learning might result in a delay in reaching an agreement. Esö and Wallace (2014) analyze the effect of exogenously having verifiable and unverifiable evidence in a one-period bargaining model and show that the proposer is always better off with verifiable evidence. Hwang and Li (2017) present a model in which the buyer's outside option stochastically arrives and can be disclosed by the seller. If the outside option is private information, the buyer prefers never to reveal it, and there is delay in the game. These papers show that each party with new information conceals detrimental evidence and discloses beneficial evidence. In my model, the party with new information will disclose not just the beneficial information but also the detrimental information to the other party. I characterize conditions under which doing so is optimal.

Daley and Green (2020); Fuchs and Skrzypacz (2010); Hwang (2018); Lomys (2017); Ortner (2017); and Ortner (2020) consider variations of the Coase conjecture model with arrival of new information (private or public). They do not consider disclosure of private information. The focus of the present paper is the possibility of disclosing information and how that affects bargaining efficiency.

Higher-order uncertainty in bargaining: Feinberg and Skrzypacz (2005) study a bargaining model in which one party privately knows his type and the other party has a private belief about the type. This second-order uncertainty is exogenous, and there is no disclosure of information during the bargaining. The authors show that there is a delay in the agreement. In my model, the uncertainty is endogenous rather than exogenous, and one party can eliminate the uncertainty of the other party by revealing information.

Friedenberg (2019) studies an alternating-offer bargaining model in which delay in agreement may arise when players face strategic uncertainty—uncertainty about the opponent's play. There is no strategic uncertainty in my model; instead, there is uncertainty in the second-order belief. Also, I focus on the disclosure decision.

Disclosure of verifiable information: Dye (1985) studies a model with a similar evidence structure to the present paper. The receiver is uncertain about the sender's information endowment, and if there is information and the sender discloses it, it perfectly reveals the state of the world. There are several extensions of Dye's (1985) model. The closest is Acharya et al. (2011), which includes a dynamic setting. Dye (1985) shows there is no disclosure of detrimental information, while Acharya et al. (2011) shows that disclosure of negative information only happens after negative public news is exogenously revealed. In my paper, the prosecutor voluntarily reveals detrimental information. Additionally, in the mentioned papers, the receiver is originally uninformed about the state of the world. In my model, the defendant knows his type, and the prosecutor investigates it.

2 Model

There are two players: a prosecutor (she) and a defendant (he). The prosecutor's only objective is to assign the highest possible sentence to the defendant, regardless of the defendant's innocence, while the defendant wants the lowest possible sentence.[6] The

[6]This implies that even if the prosecutor knows the defendant is innocent, she still wants him to have the highest possible sentence. This should be interpreted as an extreme case, to show that (in

defendant is privately informed of his type α, which can be innocent ($\alpha = I$) or guilty ($\alpha = G$). The defendant's type is unknown to the prosecutor. Let $\theta \in (0, 1)$ denote the prior probability that the prosecutor assigns to $\alpha = G$. The game is divided into two phases: *plea bargaining* and *trial.* The game starts with the plea bargaining phase, in which the prosecutor investigates for new evidence and try to reach an agreement with the defendant to avoid trial. They move to the trial phase only if they fail to reach an agreement before a deadline. The trial is a reduced-form function that assigns reward to the prosecutor and loss to the defendant, depending on the prosecutor's evidence at that moment. The plea bargaining phase ends at time $T = 1$.[7] This phase is divided into $N \geq 1$ periods, with the length of each period equal to $\Delta = 1/N$. The set of evidence that exists in this environment is $y \in \{e, d, h\}$, where $y = e$ stands for *exculpatory evidence*, $y = h$ for *incriminating evidence*, and $y = d$ for *default evidence.*

The prosecutor investigates for new evidence at the beginning of each period, and she can voluntarily disclose the new evidence. At the end of each period, she makes an offer to the defendant. There is no discount factor or cost of delay during the plea bargaining phase for any player.

The timing within each period n is:

1. Investigation for new evidence: At the beginning of the game, the prosecutor has evidence $y = d$ and a prior belief $Pr(\alpha = G) = \theta \in (0, 1)$. At the start of each period $n = \{1, 2, ..., N\}$, the prosecutor investigates to obtain more evidence. Note that for simplicity, the investigation is not a decision, it is automatically trigger by starting a new period.[8] The probability of getting evidence follows an exponential distribution that depends on the length of each period; the probability of finding new evidence at each period n is equal to $1 - q^{\frac{1}{N}}$, where $q = e^{-\lambda}$ for $\lambda > 0$.[9]

The new evidence depends on the defendant's type: If $\alpha = I$ the investigation's outcome belongs to $y^I \in \{\emptyset, e\}$; if $\alpha = G$ the outcome belongs to $y^G \in \{\emptyset, h\}$. The implication is that after getting $y = e$ or $y = h$, the prosecutor updates her belief to $\theta' = 0$ and $\theta' = 1$, respectively. The prosecutor gets new evidence only once, and it replaces

the following Sections) even a purely sentence-motivated prosecutor will reveal exculpatory evidence. Although this is a simplification, many prosecutors seem to be motivated by high sentences rather than justice. Medwed (2004) notes that many prosecutors resist exonerating the innocent even when prisoners have presented overwhelming proof of their innocence. Also, Keenan et al. (2011) and Garrett (2017) argue that prosecutorial misconduct is a widespread problem in the U.S. and list cases in which prosecutors suppress exculpatory evidence at the trial. Finally, Pfaff (2017) argues that the criminal justice system provides incentives for prosecutors to seek an overly aggressive punishment, and Alschuler (2015) argues that the plea bargaining process tends to convict more innocent people than trials do. For a discussion of a more general utility function see Section 7.1.

[7] This is a normalization.

[8] I relaxed this assumption in Appendix A.1. The main results of the paper hold if the investigation is a decision at the beginning of each period. The only difference is that there is reduced investigation for very low values of the prior belief.

[9] Note that $q^{\frac{1}{N}} = e^{-\lambda\Delta}$.

default evidence. Note that the probability of finding new evidence is independent of the defendant's type; this implies that if the prosecutor does not get new evidence after the investigation, she does not update her belief about the defendant's type.[10]

The outcome of the investigation is private information for the prosecutor. I say that the prosecutor is y-type if she has evidence $y \in \{e, d, h\}$.

2. ***Disclosure of new evidence:*** After the outcome is realized, the prosecutor can choose to disclose the new evidence to the defendant. I assume that only new evidence can be disclosed.[11] I also assume that the disclosure of evidence is voluntary during the plea bargaining phase, but it is mandatory at trial. I discuss the case with mandatory disclosure of evidence during the plea bargaining phase in Section 5.

3. ***Offer:*** After the prosecutor decides whether to disclose, the prosecutor makes an offer $x \in \mathbb{R}$ to the defendant. An offer is a sentence that assigns utility $u_D = -x$ to the defendant and utility $u_P = x$ to the prosecutor if it is accepted.[12] If the offer is accepted, the game ends, and if the offer is rejected and $n < N$, a new period $n + 1$ starts. If the offer is rejected at $n = N$, they go to trial. Figure 1 shows the timing of a period n during the plea bargaining phase.

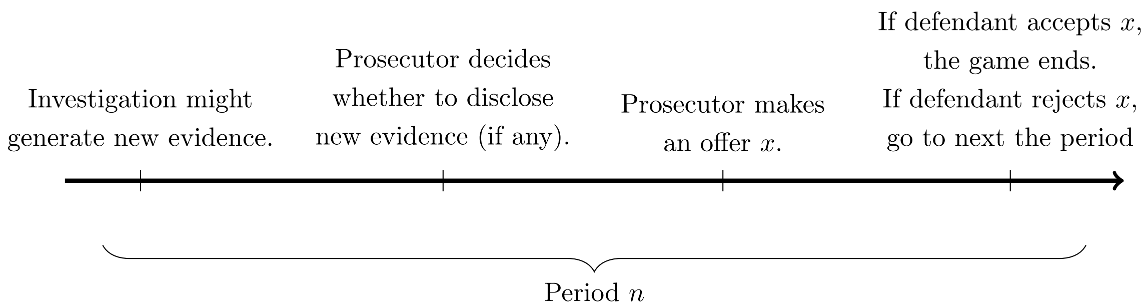

Figure 1: Timeline of a period n

This paper's focus is the plea bargaining phase. For this reason, I model the trial as a simple rule that assigns a sentence s to evidence.[13]

$$s = \begin{cases} 0 & \text{if } y = e \\ d & \text{if } y = d \\ h & \text{if } y = h. \end{cases}$$

[10]This is without loss of generality regarding the main contribution of the paper.
[11]I assume the evidence is hard; the prosecutor cannot show what she does not have.
[12]The zero-sum nature of the payoff is without loss of generality.
[13]An alternative way to model the trial is assuming that the sentence depends on the public posterior belief θ^T. The trial assigns $\theta^T h$ instead of d if the evidence is neither e nor h. This alternative modeling does not change the key insights regarding disclosure as long as there is investigation. However, the decision of whether to investigate is qualitatively different. I discussed this case in Appendix A.5.

where $0 < d < h$. The trial has a cost of c for the prosecutor.[14] Hence, the payoffs for the prosecutor and the defendant at the trial are: $u_P = s - c$ and $u_D = -s$.

I denote the expected payoff for the prosecutor as v^P, and I define *expected loss* to be the absolute value of the expected payoff for the defendant. I denote the expected loss as v^α, with $\alpha \in \{I, G\}$.

Histories and strategies. Call $\tilde{y} \in \{\emptyset, e, h\}$ the evidence disclosed by the prosecutor, where $\tilde{y} = \emptyset$ means that the prosecutor has not disclosed any evidence. At any period n before the agreement is reached, the prosecutor's history $h_n^P = \{y_n, \{\tilde{y}_s, x_s\}_{s \leq n}\}$ contains the evidence the prosecutor has, the disclosed evidence, and the offers she has made. The defendant's history $h_n^D = \{\alpha, \{\tilde{y}_s, x_s\}_{s \leq n}\}$ contains his type, the disclosed evidence, and the previous offers. A (pure) strategy for the prosecutor $\sigma^P : h_n^P \mapsto (\tilde{y}_n(y), x_n)$ maps prosecutor's history h_n^P to the disclosure decision after the outcome of the investigation is realized and an offer x to the defendant. A strategy for the defendant $\mu^D : h_n^D \times x_n \mapsto [0, 1]$ maps the defendant's history h_n^D to a probability of accepting the offer x_n.

Solution concept. An equilibrium is a *perfect Bayesian equilibrium (PBE)*. I impose the following restriction on the defendant's beliefs regarding the evidence that the prosecutor has: if at any history h_n^D the innocent defendant receives an offer that is lower than the offer that a proposer with evidence d makes on the equilibrium path, the innocent defendant assigns zero probability that the proposer has evidence d.

Equilibrium selection. For any PBE such that the proposer discloses exculpatory evidence and offers $x = 0$ to the defendant, there is an equivalent equilibrium in which the proposer does not disclose exculpatory evidence but still offers $x = 0$ to the proposer. I such cases, I focus on the equilibrium in which the proposer discloses exculpatory evidence.

3 One-Period Benchmark

I start the analysis by presenting the intuition of the main result of the paper in the simplest setting—the one-period model. I show that in any equilibrium, as defined above, the prosecutor discloses exculpatory evidence provided that the prior belief regarding the defendant being guilty is high enough.

As there is only one period of plea bargaining before the trial, the probability the

[14]This is without loss of generality. Given that the prosecutor makes the offer, including a cost for the defendant does not affect the results as the prosecutor would incorporate the defendant's cost in her offer.

prosecutor finds new evidence is $1-q$. I define:

$$\tilde{\theta} = 1 - \frac{d(1-q)}{c}$$

Proposition 1 *Disclosure decision: In equilibrium, if the prosecutor gets evidence $y = h$, she discloses it, and if the prosecutor gets evidence $y = e$, she discloses it if $\theta > \tilde{\theta}$ and conceals it if $\theta \leq \tilde{\theta}$.*

Throughout the paper, I assume that the cost of the trial is not negligible, that is $c > d(1-q)$.[15] It ensures that $\tilde{\theta} > 0$. The full characterization of the equilibrium that complements Proposition 1 is below.

Offers. The prosecutor's offer $x(y, \theta)$ is:[16]

$$x(y, \theta \leq \tilde{\theta}) = \begin{cases} h & \text{if } y = h \\ dq & \text{if } y \in \{e, d\} \end{cases} \quad \text{and} \quad x(y, \theta > \tilde{\theta}) = \begin{cases} h & \text{if } y = h \\ d & \text{if } y = d \\ 0 & \text{if } y = e \end{cases}$$

Acceptance decision. If there is disclosure of evidence, the guilty defendant accepts any $x \leq h$ and rejects any $x > h$, and the innocent defendant accepts any $x \leq 0$ and rejects any $x > 0$. If there is no disclosure, the guilty defendant accepts any $x \leq d$ and rejects any $x > d$, and the innocent defendant accepts any $x \leq dq$ and rejects any $x > dq$ if $\theta \leq \tilde{\theta}$, and accepts any $x \leq 0$ and rejects any $x > 0$ if $\theta > \tilde{\theta}$.

Beliefs. The innocent defendant's belief β^I regarding the prosecutor being d-type after no disclosure are described below.[17]

$$\beta^I(x, \theta \leq \tilde{\theta}) = \begin{cases} 0 & \text{if } x < dq \\ q & \text{if } x \geq dq \end{cases} \quad \text{and} \quad \beta^I(x, \theta > \tilde{\theta}) = \begin{cases} 0 & \text{if } x < d \\ 1 & \text{if } x \geq d \end{cases}$$

The intuition of the disclosure of exculpatory evidence (Proposition 1) is given the impossibility for the e-type prosecutor to imitate the behavior of the d-type prosecutor without revealing information to the defendant. The intuition is as follows:

[15] I relax this assumption in Appendix A.6.

[16] The offer described is assuming the prosecutor follows the disclosure decision. The off-the-equilibrium path offers regarding the disclosure decision are as follows: if the prosecutor does not disclose $y = h$ for any θ or she does not disclose $y = e$ for $\theta > \tilde{\theta}$, the same offers apply. If the prosecutor discloses $y = e$ for $\theta \leq \tilde{\theta}$, she offers $x = 0$.

[17] The guilty defendant's belief regarding the prosectuor being d-type after no disclosure is that the prosecutor is d-type for sure for any offer x, as the prosecutor with incriminating evidence always discloses it.

Disclosure of incriminating evidence. The prosecutor always discloses $y = h$ because it induces the guilty defendant to accept the offer $x = h$. The defendant accepts $x = h$ because he would receive the same loss at the trial if he rejects it.

Disclosure of exculpatory evidence. If the prosecutor gets exculpatory evidence, she would like to conceal the evidence and make an offer that satisfies two conditions: it does not reveal the prosecutor's evidence, and it is accepted (otherwise, the prosecutor faces a negative payoff at the trial). If the prosecutor's prior belief about the defendant being guilty is high enough, it is impossible to satisfy these two conditions. Then the e-type prosecutor reveals the evidence.

Consider, by contradiction, that the prosecutor does not disclose exculpatory evidence for any θ. The investigation and the nondisclosure of evidence induce second-order belief uncertainty in the innocent defendant because the innocent defendant does not know whether the prosecutor knows his type. The d-type prosecutor believes the defendant is guilty with probability θ, and the e-type prosecutor knows that the defendant is innocent. Assuming no disclosure of exculpatory evidence, the innocent defendant's belief about the prosecutor's type is the following:

$$\begin{aligned} P^I(d\text{-type prosecutor} \mid \text{no-disclosure }) &= \quad q \\ P^I(e\text{-type prosecutor} \mid \text{no-disclosure }) &= \quad 1-q \end{aligned}$$

The guilty defendant's belief the about prosecutor's type is

$$P^G(d\text{-type prosecutor} \mid \text{no-disclosure }) = 1.$$

Second-order beliefs affect the expected loss at trial. If there is no disclosure of evidence, the expected loss at trial for the innocent defendant, given these beliefs, is $dq + 0(1-q)$. The guilty defendant knows for sure that the prosecutor is d-type if there is no disclosure because the prosecutor always discloses $y = h$; therefore, his expected loss at trial is d.

If the prosecutor is d-type, she cannot induce the defendant to accept $x = d$ because of the second-order belief uncertainty. The innocent defendant will not accept an offer higher than $x = dq$, while the guilty defendant will accept any offer lower or equal to $x = d$. The prosecutor prefers to make an offer $x = dq$ that both defendant types accept if the prior belief of being guilty is low, i.e., $\theta \leq 1 - \frac{d(1-q)}{c}$, while she prefers to offer $x = d$ that only the guilty defendant accepts if $\theta > 1 - \frac{d(1-q)}{c}$.

Suppose now the prosecutor is e-type. The prosecutor is able to conceal the exculpatory evidence if she makes the same offer as the d-type prosecutor. It is because the innocent defendant does not know the evidence that the prosecutor has, and if the d-type and the e-type make the same offer, the defendant cannot extract information from it.

It is optimal for the e-type prosecutor to make the same offer as the d-type if $\theta \leq \tilde{\theta}$ because the innocent defendant accepts it. However, it is not optimal to make the same offer as the d-type if $\theta > \tilde{\theta}$ because the innocent defendant rejects $x = d$, and the prosecutor gets a negative payoff at trial. It cannot be an equilibrium that the innocent defendant accepts d because, in that case, the e-type prosecutor offers d, which means that the innocent defendant's expected value at trial is dq. Hence, if $\theta > \tilde{\theta}$, the e-type prosecutor must make a lower offer than the d-type prosecutor, and this lower offer reveals her private information.

In equilibrium, the prosecutor discloses $y = e$ if $\theta > \tilde{\theta}$ and offers $x = 0$ because the innocent defendant will reject any offer $x > 0$.[18] The intuitive reason is that any offer $x < d$ is not sequentially rational for the d-type prosecutor. Therefore, if the innocent defendant receives an offer $x < d$, he updates his belief about the prosecutor's type to e-type with probability one.[19]

Inefficiency. In equilibrium, if the defendant is innocent and the prosecutor does not find new evidence, they go to trial when $\theta > \tilde{\theta}$. Going to trial is socially inefficient because it is costly for the prosecutor. If the disclosure of evidence were mandatory, there would not be inefficiency because the defendant knows what evidence the prosecutor has. Then the prosecutor always offers the same sentence the defendant would get at the trial. I discuss this case in Section 6. The voluntary disclosure of evidence is ex-ante inefficient when $\theta > \tilde{\theta}$ because with probability $q(1-\theta)$, the prosecutor and defendant go to trial.

Commitment Effect. Second-order belief uncertainty allows the prosecutor to conceal evidence for $\theta \leq \tilde{\theta}$; this benefits the e-type prosecutor. However, it has a downside for the d-type prosecutor because she gets an expected payoff lower than d in equilibrium. It generates a commitment effect for the prosecutor: If she could ex ante commit to disclosing any evidence, she would do it.

The reason is that, with voluntary disclosure of evidence, when $\theta \leq \tilde{\theta}$, the prosecutor gets a payoff of dq from having default evidence, no matter the defendant's type. When $\theta > \tilde{\theta}$, the prosecutor gets an expected payoff of $\theta d + (1-\theta)(d-c)$. In both cases, the prosecutor cannot extract the full surplus from the default evidence. This negative effect of the voluntary disclosure case outweighs the benefit of getting a payoff of dq if $y = e$ and $\theta \leq \tilde{\theta}$. Therefore, for any θ, the prosecutor is ex-ante better off if she can commit to disclosing any evidence she receives.

[18] If $c \leq d(1-q)$, the proposer discloses exculpatory evidence for any θ.

[19] There is a payoff equivalent equilibrium in which the prosecutor does not disclose $y = e$ and directly offers $x = 0$. The equilibrium selection in section 2 ruled out this equilibrium. Such equilibrium is equivalent to disclosing exculpatory evidence; if there is no disclosure and just an offer $x = 0$, the innocent defendant knows with probability one that the prosecutor has exculpatory evidence. The offer $x = 0$ is a perfect signal of $y = e$.

4 Multi-period Model

There are two important differences between the one-period benchmark and the multi-period setting. The first one is the is that the prosecutor can learn about the defendant's type through rejected offers with multiple rounds of offers. The second one is the prosecutor might decide to reach an agreement before in earlier rounds even if no new evidence is found. I show that the same intuition regarding the disclosure of exculpatory evidence remains in the presence of belief updating and the decision of early termination of the game.

I show that the prosecutor updates her belief through rejected offers only for a specific range of prior beliefs. This updating allows her to conceal evidence for a larger set of prior belief values than the one-period-case benchmark. I also show that the prosecutor prefers to reach an agreement in the first period for low values of θ.

4.1 Multiplicity of Equilibria

This game admits multiple equilibria. I use the following refinements to reduce the set of equilibria.

No-unnecessary-belief-update: The set equilibria includes equilibria in which the prosecutor updates her belief regarding the defendant being guilty through rejected offers. Not all the belief updates change the behavior of the players. For example, for low θ such that there is no disclosure of exculpatory evidence, a belief update such that $\theta' < \theta$ does not modify the disclosure decision, the offer, the acceptance decision, or payoffs. I focus on the equilibrium with belief updates that modify behavior and/or payoffs.

No-unnecessary-delay-agreement: There are multiple equilibria regarding the timing of reaching an agreement because of the absence of a discount factor. I focus on equilibria in which the prosecutor and defendant reach an agreement at time n if they are indifferent between doing so or moving to the next period.[20]

4.2 Disclosure decision for high prior belief value

The main result of this Section generalizes the result that the prosecutor discloses exculpatory evidence for high values of the prior belief. I define the following cutoff value of the prior belief:

$$\bar{\theta} = \frac{c - d(1 - q^{\frac{1}{N}})}{c + dq^{\frac{1}{N}}(1 - q^{\frac{N-1}{N}})}$$

[20]This selection is to rule out equilibria in which the prosecutor and defendant delay reaching an agreement with no change in information and payoffs. It can be interpreted as a weak form of players being impatient.

Proposition 2 *The following results regarding the disclosure of evidence hold:*

1. *The prosecutor discloses $y = h$ as soon as she gets it.*

2. *The prosecutor discloses $y = e$ as soon as she gets it for $\theta > \bar{\theta}$, and does not disclose it if $\theta \leq \bar{\theta}$.*

Proposition 2 is the multi-period version of Proposition 1. The prosecutor discloses exculpatory evidence if the prior belief regarding the defendant being guilty is high enough. The same intuition holds—the e-type prosecutor cannot imitate the behavior of the d-type because she knows an offer $x = d$ will be rejected.

I present the description of the possible equilibria below, and I analyze Proposition 2 as the equilibrium simultaneously.

Description of the Equilibrium. The main difference with the one-period benchmark equilibrium is that the prosecutor can update her beliefs regarding the defendant being guilty using the rejected offers. I show that for $\theta \leq \tilde{\theta}$ and for $\theta > \bar{\theta}$, there are no equilibria in which the proposer can benefit from belief updating. I separate the description of the equilibrium in three cases depending on the value of the prior belief θ, as shown in Figure 2. I first analyze the equilibrium for $\theta < \tilde{\theta}$ and $\theta > \bar{\theta}$, for which there is no belief updating, and then I analyze the case $\theta \in (\tilde{\theta}, \bar{\theta}]$, for which there is belief updating.

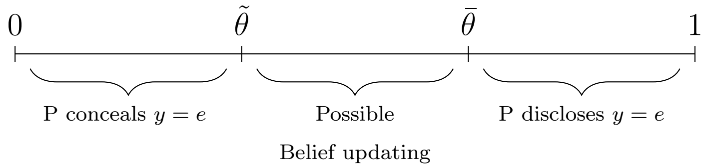

Figure 2: Equilibrium Characterization

1. No disclosure of exculpatory evidence and no belief updating. For $\theta \in [0, \tilde{\theta}]$, the description of the equilibrium that sustains no disclosure is as follows.

Offers. The prosecutor offers $x = h$ in each period $n < N$ for any evidence y, and makes the following offer in period $n = N$:

$$x_{n=N}(y) = \begin{cases} h & \text{if } y = h \\ dq & \text{if } y \in \{e, d\} \end{cases}$$

Beliefs. The innocent defendant's belief β^I regarding the prosecutor being d-type after no disclosure are described below.[21]

$$\beta^I(x) = \begin{cases} 0 & \text{if } x < dq \\ q^{\frac{n}{N}} & \text{if } x \geq dq \end{cases}$$

Acceptance decision. If there is disclosure of evidence, the guilty defendant accepts any $x \leq h$ and rejects any $x > h$, and the innocent defendant accepts any $x \leq 0$ and rejects any $x > 0$. If there is no disclosure, both defendant accepts any $x \leq dq^{\frac{n}{N}}$ and rejects any $x > dq^{\frac{n}{N}}$.

The equilibrium is qualitatively similar to the one-period benchmark. The prosecutor always discloses evidence $y = h$ but conceals evidence $y = e$. The dynamic of the game is as follows: the proposer makes an offer $x = h$ is she gets incriminating evidence. If the proposer gets exculpatory evidence or no new evidence, she makes high offers that are rejected in every period except the last one. In the last period the proposer offers $x = dq$ if $y \in \{e, d\}$ and $x = h$ if $y = h$. The e-type proposer, to conceal exculpatory evidence must wait until the last period to make an offer that is accepted.

At period $n = N$, the d-type proposer faces the same problem as in the one-period benchmark. The probability that the prosecutor got evidence $y = e$ conditional on the defendant being innocent is q. Therefore, the innocent defendant does not accept anything higher than dq. The proposer offers $x = dq$, which is accepted by both defendant types, as her expected payoff is higher than offering $x = d$, which is only accepted by the guilty type.

In periods $n < N$, the d-type proposer makes offers that are rejected for both defendant types. The defendant is not going to accept an offer higher than his continuation loss,[22], and for the proposer is not optimal to make offers that the defendant is willing to accept. The innocent defendant's continuation loss is $v_n^I = dq$, as he can ensure a loss of dq by rejecting all the offers higher than dq, and the guilty defendant's continuation loss is:

$$v_n^G = \left(1 - q^{\frac{N-n}{N}}\right)h + q^{\frac{N-n}{N}}dq,$$

as his loss increases to h if incriminating evidence is found.

The proposer continuation value is $v_n^P = \theta v_n^G + (1-\theta)v_n^I$; therefore, an offer $x \in (v_n^I, v_n^G)$ (only accepted by the guilty defendant), or $x \leq v_n^I$ (accepted by both defendant types) decreases the proposer's expected payoff.

Note that the proposer can update her belief by offering $x = v_n^G$, as long as the guilty defendant accepts it with some probability. However, in that case, there is no

[21]The guilty defendant's belief regarding the prosectuor being d-type after no disclosure is that the prosecutor is d-type for sure for any offer x, as the prosecutor with incriminating evidence always discloses it.

[22]The negative of the continuation value

change in continuation values for any player; that is, that equilibrium is ruled out by the no-unnecessary-update criteria.

The optimal strategy for a e-type prosecutor is to mimic the offers of the d-tyoe prosecutor. It means that if the prosecutor gets exculpatory evidence at $n < N$, she has to wait until period $n = N$ to make an offer that will be accepted.

2. ***Disclosure of exculpatory evidence and no belief update.*** For $\theta \in (\bar{\theta}, 1]$, the offers, beliefs, and acceptance decisions are as follows:

Offers. In equilibrium, the prosecutor's offer is:

$$x_{n<N}(y) = \begin{cases} h & \text{if } y \in \{d, h\} \\ 0 & \text{if } y = e \end{cases} \quad \text{and} \quad x_{n=N}(y) = \begin{cases} h & \text{if } y = h \\ d & \text{if } y = d \\ 0 & \text{if } y = e \end{cases}$$

Beliefs. The innocent defendant's belief β^I regarding the prosecutor being d-type after no disclosure are described below.[23]

$$\beta^I_{n<N}(x) = \begin{cases} 0 & \text{if } x < d \\ q^{\frac{n}{N}} & \text{if } x \geq d \end{cases} \quad \text{and} \quad \beta^I_{n=N}(x) = \begin{cases} 0 & \text{if } x < d \\ 1 & \text{if } x \geq d \end{cases}$$

Acceptance decision. If there is disclosure of evidence, the guilty defendant accepts any $x \leq h$ and rejects any $x > h$, and the innocent defendant accepts any $x \leq 0$ and rejects any $x > 0$. If there is no disclosure, the guilty defendant accepts any $x \leq d$ and rejects any $x > d$, and the innocent defendant accepts any $x \leq 0$ and rejects any $x > 0$.

This case is analogous to the disclosure of exculpatory evidence in the one-period benchmark. The proposer discloses new evidence as soon as she gets it. If no new evidence is found, the proposer makes offers that are rejected, until the last period in which she offers $x = d$ which is accepted by the guilty defendant and rejected by the innocent defendant.

If there is no new evidence at period $n = N$, then the prosecutor offers $x = d$, which is accepted for the guilty defendant and rejected by the innocent as described in the one-period benchmark.[24] At $n < n$, as long as there is no new evidence, the proposer makes offers that are rejected by both defendant types, and no belief update is conducted.

The innocent defendant and the guilty defendant's continuation loss for $n < N$,

[23]The guilty defendant's belief regarding the prosectuor being d-type after no disclosure is that the prosecutor is d-type for sure for any offer x, as the prosecutor with incriminating evidence always discloses it.

[24]This is valid for $\theta > \tilde{\theta}$, and in particular $\bar{\theta} > \tilde{\theta}$.

respectively, are:

$$v_n^I = q^{\frac{N-n}{N}} d \quad \text{and} \quad v_n^G = \big(1 - q^{\frac{N-n}{N}}\big) h + q^{\frac{N-n}{N}} d,$$

and the prosecutor's continuation value is:

$$v_n^P = \theta v_n^G + (1-\theta) q^{\frac{N-n}{N}} (d - c).$$

In this case, if the proposer makes an offer that the guilty defendant accepts with some probability and the innocent defendant rejects it, the proposer can update (decrease) her belief regarding the defendant being guilty. The belief update to be effective has to be such that the updated belief θ' is such that $\theta' \leq \tilde{\theta}$, and the prosecutor conceals exculpatory evidence, otherwise it does not change behavior nor payments. Such belief update is not optimal for the prosecutor if $\theta > \bar{\theta}$:

$$\theta v_n^G + (1-\theta) q^{\frac{N-n}{N}} (d-c) > \theta\Big(\big(1 - q^{\frac{N-n}{N}}\big) h + q^{\frac{N-n}{N}} dq\Big) + (1-\theta) q^{\frac{N-n}{N}} dq \iff \theta > \bar{\theta}.$$

The offer that the proposer makes to the guilty defendant such that the guilty defendant is indifferent between accepting and rejecting it, and such that if it is rejected, the prosecutor updates her belief to $\theta' \leq \tilde{\theta}$, is

$$x = \big(1 - q^{\frac{N-n}{N}}\big) h + q^{\frac{N-n}{N}} dq,$$

which is equivalent to the guilty defendant's continuation loss for $\theta \leq \tilde{\theta}$.

The e-type proposer is indifferent between disclosing the exculpatory evidence as soon as she gets it or at a later period. Following the no-unnecessary-delay refinement, I select the equilibrium in which the proper discloses it as soon as she gets it.

3. No disclosure of exculpatory evidence and belief update. For $\theta \in (\tilde{\theta}, \bar{\theta}]$, the equilibrium description is as follows.

Offers. In period $n = 1$, the proposer offers

$$x_{n=1}(y) = \begin{cases} h & \text{if } y = h \\ (1 - q^{\frac{N-1}{N}}) h + q^{\frac{N-1}{N}} dq & \text{if } y \in \{e, d\} \end{cases}$$

Beliefs. The innocent defendant's belief β^I regarding the prosecutor being d-type after no disclosure in period $n = 1$ is described below.[25]

$$\beta^I(x) = \begin{cases} 0 & \text{if } x < v^G(1) \\ q^{\frac{1}{N}} & \text{if } x \geq v^G(1) \end{cases}$$

Acceptance decision. In period $n = 1$, if there is the disclosure of evidence, the guilty defendant accepts any $x \leq h$ and rejects any $x > h$, and the innocent defendant accepts any $x \leq 0$ and rejects any $x > 0$. If there is no disclosure, the guilty defendant accepts any $x < dq^{\frac{1}{N}}$, rejects any $xdq^{\frac{n}{N}}$, and accepts $x = (1-q^{\frac{N-1}{N}})h + q^{\frac{N-1}{N}} dq$ with probability $\frac{\theta-\tilde{\theta}}{\theta(1-\tilde{\theta})}$.

For $n > 1$, the equilibrium is the same than for $\theta \in [0, \bar{\theta}]$.

In this case, in the first period, unless the proposer gets incriminating evidence, she makes an offer that is accepted with some probability μ_I for the guilty defendant and rejected for the innocent defendant. It implies that is the offers is rejected, starting the second period the proposer has an updated belief $\theta' = \tilde{\theta}$. From the second period onwards, the equilibrium is the same as in the $\theta \leq \tilde{\theta}$ case.

In the description of the equilibrium, I chose a μ_I such that $\theta' = \tilde{\theta}$ but any μ_I such that $\theta' \leq \tilde{\theta}$ is a payoff equivalent equilibrium. From the second period onwards, the game is equivalent to the case $\theta \leq \tilde{\theta}$. That is, there is no more belief updating as it would not increase payoff nor change behavior.

The belief updating in the first period is an equilibrium because the proposer benefits from making such an offer:

$$\theta\Big((1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}} d\Big) + (1-\theta)q^{\frac{N-n}{N}}(d-c) \leq \theta\Big((1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}} dq\Big) + (1-\theta)q^{\frac{N-n}{N}} dq,$$

for $\theta \leq \bar{\theta}$. Intuitively, the tradeoff between concealing and disclosing exculpatory evidence is:

Concealing exculpatory evidence: the proposer induces the defendant to accept an offer $x = dq$ even when having exculpatory evidence but can only induce the guilty defendant to accept dq when having $y = d$.

Disclosing exculpatory evidence: the proposer cannot induce the defendant to accept an offer $x > 0$ when having exculpatory evidence but can induce the guilty defendant to accept $x = d$ when having $y = d$.

For this case, $\theta \in (\tilde{\theta}, \bar{\theta}]$, the probability that the defendant is guilty is *not very high*,

[25] The guilty defendant's belief regarding the prosectuor being d-type after no disclosure is that the prosecutor is d-type for sure for any offer x, as the prosecutor with incriminating evidence always discloses it.

and then the effect of being able to induce the innocent defendant to accept an offer $x = dq$ even when having exculpatory evidence dominates the effect of inducing the guilty defendant to accept $x = d$ but not being able to induce the innocent defendant to accept $x > 0$.

4.3 Efficiency

The prosecutor and the defendant fail to reach an agreement if $\theta > \bar{\theta}$ and $y = d$ because the innocent defendant does not accept the offer the prosecutor makes. In this case, the prosecutor goes to trial if the defendant is innocent. Formally, the probability of going to trial is

$$P(trial) = \begin{cases} 0 & \text{if } \theta \leq \bar{\theta} \\ q(1-\theta) & \text{if } \theta > \bar{\theta}. \end{cases}$$

Note that $\underline{\theta}$ and $\bar{\theta}$ increase with N. Hence the range of values in which the prosecutor discloses exculpatory evidence is smaller when the negotiation period is divided into more periods, and the range of values in which the prosecutor and defendant reach an agreement in the first period for sure is larger. In other words, the equilibrium outcome is less inefficient when N increases.

4.4 Payoffs

The value $\bar{\theta}$ is increasing in N, with a limit of $\bar{\theta}^{\infty} = \frac{c}{c+d(1-q)}$ for $N \to \infty$. The prosecutor's expected payoff, for a given θ, is weakly increasing in the number of periods for $\theta \in [\tilde{\theta}, \bar{\theta}^{\infty}]$, and the guilty defendant's expected loss is weakly decreasing in the same range of values.

Corollary 1 *The prosecutor's expected payoff is maximized at $N \to \infty$, the guilty defendant's expected loss is minimized at $N \to \infty$, and the innocent defendant's expected loss remains constant with respect to N.*

As an example, Figure 3 compares the cases when the length T of the plea bargaining phase is divided into one, two, and infinite periods (i.e., $N \to \infty$). For higher N, the prosecutor is better off for low values of θ because, after investigating in the first period, she can make an offer that both defendant types accept, and this offer is higher if there are more periods. The prosecutor is also better off with more periods if θ belongs to the interval $(\tilde{\theta}, \bar{\theta}]$ because she can make an intermediate offer that increases the θ threshold in which she can conceal evidence and transfer a higher loss from the guilty defendant to the innocent defendant.

The innocent defendant's expected loss remains constant with respect to N because, for θ such that the prosecutor conceals exculpatory evidence, the innocent defendant loss is dq and for θ such that there is disclosed of $y = e$, the prosecutor gets evidence $y = e$

with probability $(1-q)$, and no new evidence with probability q. Therefore, the innocent defendant's expected loss is dq for all θ, and it implies that N does not play any role. The guilty defendant is better off with more periods of plea bargaining because the range of θ values in which the prosecutor discloses exculpatory evidence is smaller. It affects the guilty defendant because if the prosecutor conceals exculpatory evidence, she makes a lower effort when $y = d$ than when she discloses it.

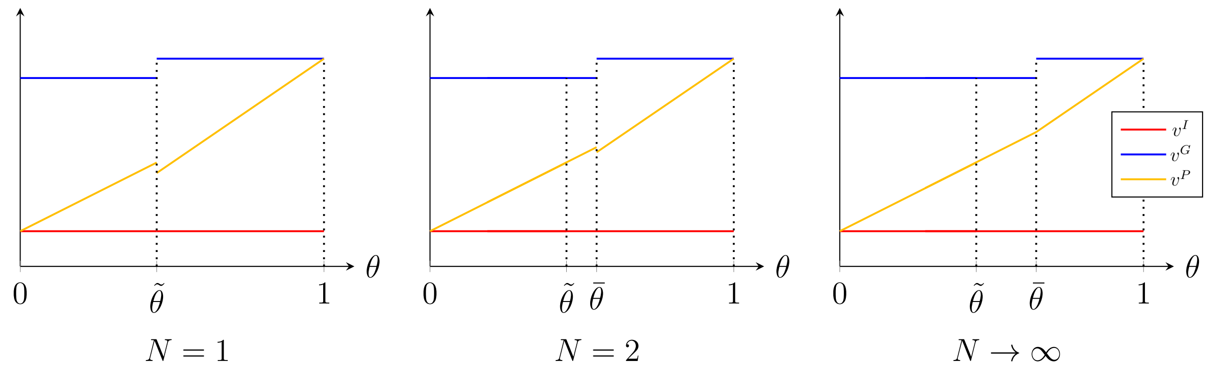

Figure 3: Expected payoffs and loss comparison between $N = 1$, $N = 2$, and $N \to \infty$.

5 Mandatory Disclosure of Evidence

The Brady Rule is the legal requirement that the prosecutor must disclose all evidence she has—default, incriminating or exculpatory—to the defendant at trial. The Brady Rule is not always extended to pretrial negotiations; the Fifth Circuit court recently[26] joined the First, Second, and Fourth Circuits by ruling that criminal defendants are not constitutionally entitled to exculpatory evidence prior to entering a guilty plea.[27] The Seventh, Ninth, and Tenth Circuits have ruled that exculpatory evidence must be disclosed before entering a guilty plea. The United States Supreme Court has not ruled on the issue.[28]

In this Section, I assume the Brady Rule applies to the pretrial negotiation process as well as the trial. I compare the equilibrium under the Brady Rule (mandatory disclosure of evidence during plea bargaining) and voluntary disclosure of evidence. I suggest that the Brady Rule should be extended to pretrial negotiations because it improves efficiency. I also show that the Brady Rule case's outcomes are closer to assigning a high loss to the defendant if he is guilty and setting the defendant free if he is innocent. In the following, I refer to the mandatory disclosure of evidence during plea bargaining as the Brady Rule case.

[26]In 2018, in deciding *Alvarez v. City of Brownsville.*
[27]See Petegorsky (2012); Grossman (2016); and Casey (2020).
[28]See Casey (2020).

5.1 The Brady Rule: Mandatory Disclosure

The prosecutor does not induce second-order belief uncertainty in the defendant when she investigates because the defendant knows the evidence the prosecutor has before any offer. Therefore, the prosecutor ends the game if she gets evidence $y = e$ or $y = h$ by offering $x = 0$ and $x = h$, respectively.

Lemma 1 *If the prosecutor gets $y = e$ or $y = h$ at any period n, she offers $x = 0$ and $x = h$, respectively, and the defendant accepts the offer. If she does not get new evidence at $n < N$, she offers $x = h$, which is rejected for sure by both defendant types. If she does not get new evidence at $n = N$, she offers $x = d$, which is accepted for sure by both defendant types.*

Lemma 1 says that a d-type prosecutor waits until the end of the plea bargaining process to reach an agreement. The d-type prosecutor makes an offer $x = d$ at $n = N$ that the defendant accepts. Hence, the prosecutor and the defendant always reach an agreement in the plea bargaining phase with the Brady Rule, which implies that there are no inefficiencies related to going to trial.

Corollary 2 *The equilibrium under the Brady Rule is efficient: The prosecutor and the defendant never go to trial.*

Figure 4 shows the payoffs and loss with mandatory disclosure of evidence.

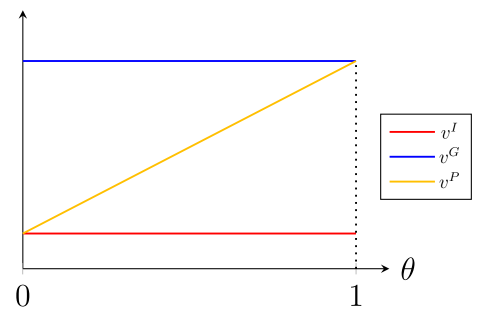

Figure 4: Expected payoff and loss with mandatory disclosure of evidence.

6 Voluntary versus Mandatory Disclosure

In this Section I compare the voluntary disclosure case with the mandatory disclosure case. I show three important results and policy implications: Mandatory disclosure of evidence is more efficient, the outcome under mandatory disclosure is *fairer*, and there is a commitment effect.

1. Efficiency. As shown in Section 4.4, the game is inefficient under voluntary disclosure of evidence. With a positive probability for higher values of θ, the prosecutor and defendant go to trial, which is costly for the prosecutor. It is not the case in the mandatory disclosure of evidence case (as shown in Section 6.1), as they always reach an agreement before the trial.

2. Fairness. A policy-relevant question is which system generates outcomes closer to a fair system. I define a fair system as the one who gives sentence of 0 to the innocent defendant and a sentence of h to the guilty defendant. In this Section, I show the mandatory disclosure of evidence generates outcomes closer to a fair system compared to the voluntary case, therefore is socially desirable from a normative point of view.

Proposition 3 *For any number of periods of plea bargaining before the trial,* $N \in \{1, 2, 3, ...\}$*:*
1. The innocent defendant's expected loss is the same for mandatory and voluntary disclosure of evidence .
2. The guilty defendant's expected loss is higher under mandatory disclosure of evidence for $\theta < \bar{\theta}$*, and the same for mandatory and voluntary disclosure for* $\theta \geq \bar{\theta}$*.*

The guilty defendant is better off with voluntary disclosure of evidence as, in this case, there are fewer investigation periods and lower offers. The guilty defendant's expected loss is lower under voluntary disclosure in the range of values in which the prosecutor conceal exculpatory evidence because the prosecutor offers him a lower sentence when she has default evidence. The guilty defendant gets the same loss in both disclosure cases when the prosecutor discloses exculpatory evidence.

Figure 5 graphically compares the mandatory disclosure case with the voluntary case.

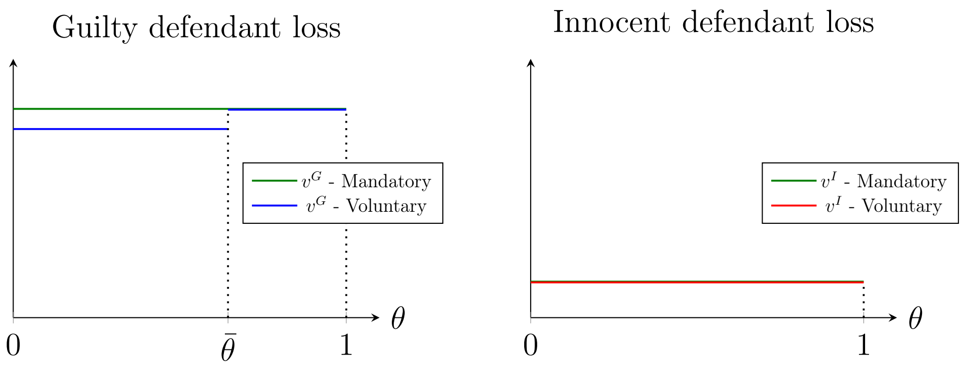

Figure 5: Comparison of loss with voluntary disclosure and mandatory disclosure of evidence.

3. Commitment Effect. If the prosecutor can choose which disclosure case and commit to that one, which one will she choose? In this Section, I show that the prosecutor prefers the mandatory disclosure case. That is, the prosecutor is better off without the ability to decide whether to disclose evidence after observing it.

Proposition 4 *The prosecutor is weakly better off with mandatory disclosure of evidence.*

The prosecutor is better off with mandatory disclosure of evidence because she extracts the full surplus from each defendant type. That is, in the voluntary case, for $\theta < \bar{\theta}$, the proposer with evidence $y = d$ cannot induce any defendant to accept d. It implies the expected payoff she conditional on the defendant being guilty is $qh + (1 - q)dq$ instead of $qh + (1 - q)d$.

The prosecutor extracts all the surplus under the Brady Rule. If the disclosure of evidence is mandatory, the agreement reached by the prosecutor and the defendant is either h if the evidence is incriminating, d if it is the default, or zero if it is exculpatory. It implies that the prosecutor gets the full expected payoff for each defendant type. If the disclosure of evidence is voluntary, there are two options. First, if the prior belief is below $\bar{\theta}$, the prosecutor conceals exculpatory evidence. Second, if the prior belief is above $\bar{\theta}$, she discloses exculpatory evidence.

i) If the prosecutor conceals exculpatory evidence, she gets the same expected payoff if the defendant is innocent compared to the mandatory disclosure of evidence case. The prosecutor and the defendant agree on a sentence equal to dq, which is equal to the expected loss in the mandatory case. However, the prosecutor gets a lower payoff compared to the mandatory case if the defendant is guilty. In the voluntary case, they agree on a sentence h if the evidence is incriminating or dq if the prosecutor has default evidence.

ii) If the prosecutor discloses exculpatory evidence, the prosecutor gets the same payoff from the guilty defendant in the mandatory and voluntary cases. If the prior belief is high enough, she offers d when she has default evidence, and the defendant accepts the offer. However, she gets zero payoff if the defendant is innocent because she either discloses the exculpatory evidence, resulting in a payoff of zero, or her offer of d is rejected by the defendant, ending in a payoff of zero at trial.

The analysis above implies that there is a commitment effect for the prosecutor: If the prosecutor could credibly commit at the beginning of the game to disclose all her evidence, she would do it. Because the prosecutor cannot commit to disclosing evidence in the voluntary disclosure case, she has the incentive to conceals exculpatory evidence if she gets it. However, the defendant anticipates this, impeding the prosecutor's ability to extract the full surplus. Therefore, the prosecutor is better off with mandatory disclosure of evidence.

Figure 6 graphically compares the voluntary and mandatory disclosure cases.

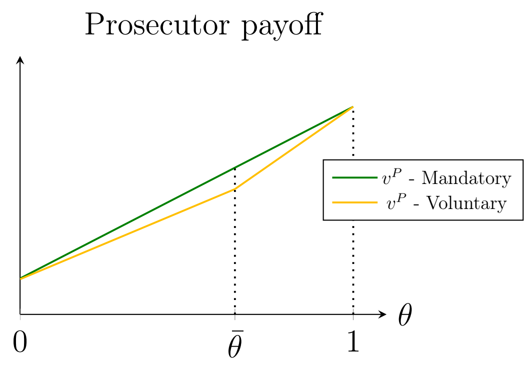

Figure 6: Comparison of payoffs with voluntary disclosure and mandatory disclosure of evidence.

7 Frequent-offer Limit and Deadline Effect

In this Section, I consider the frequent-offer limit case, that is, $N \to \infty$ for a constant T. The implication is that the probability of finding new evidence at each period is arbitrarily low because $\Delta \to 0$.

The analysis of this case is important because the high-frequency limit provides intuition on a continuous investigation by the prosecutor, whereby she can interrupt the investigation to make an offer at any point, or even considering that the prosectuor starts the game by making an offer (before investigation). It also simplify the comparison regarding deadline effects without conditioning in the number of periods N. The limit value of the θ cutoffs for $N \to \infty$ is

$$\lim_{N \to \infty} \bar{\theta} = \frac{c}{c + d(1-q)} \equiv \bar{\theta}^{\infty}.$$

The time the game ends depends on the evidence and the value of θ because the prosecutor uses different strategies depending on θ. I show that the game has a deadline effect—the probability of ending the game has a mass point at the deadline T.

7.1 The Path of Agreements.

Deadline effects in pretrial negotiation have been studied in Spier (1992); Ma and Manove (1993); Fuchs and Skrzypacz (2013); and Vasserman and Yildiz (2019). They have also been observed in experimental studies by Roth et al. (1988) and Güth et al. (2005).[29]

7.1.1 Voluntary Disclosure of Evidence

For voluntary disclosure de evidence:

[29]Other papers that find a deadline effect are Cramton and Tracy (1992); and Fershtman and Seidmann (1993).

Proposition 5 *There is a deadline effect under voluntary disclosure de evidence: The probability of reaching an agreement has a mass point at T. The game ends by T with probability 1 for $\theta \in [0, \bar{\theta}^*]$ for both defendant types, and ends by T with probability 1 for $\theta \in (\bar{\theta}^*, 1]$ if the defendant is guilty.*

Under voluntary disclosure of evidence, ff $\theta \in [0, \bar{\theta}^\infty]$, the prosecutor conceals exculpatory evidence; therefore, if the defendant is innocent, the game ends at time T. Hence the prosecutor ends the game at the deadline. If the defendant is guilty, she ends the game as soon as she gets evidence $y = h$ or at time T if she never gets new evidence; therefore, there is also a deadline effect. If $\theta \in (\tilde{\theta}, \bar{\theta}^\infty]$, the prosecutor makes an initial offer that is rejected by the innocent defendant and accepted by the guilty defendant with probability μ^G. Let τ be the time by which the game ends. The probability that τ is less than t when the defendant is guilty is given by:

If $\theta \in [0, \tilde{\theta}]$, then

$$P_G\big(\tau \leq t\big) = \begin{cases} 1 - e^{-\lambda \frac{t}{T}} & \text{if } t < T \\ 1 & \text{if } t = T. \end{cases}$$

If $\theta \in (\tilde{\theta}, \bar{\theta}^\infty]$, then

$$P_G\big(\tau \leq t\big) = \begin{cases} \mu^G & \text{if } t = 0 \\ 1 - e^{-\lambda \frac{t}{T}}(1 - \mu^G) & \text{if } t \in (0, T) \\ 1 & \text{if } t = T. \end{cases}$$

And for the innocent defendant for $\theta \in [0, \bar{\theta}^\infty]$:

$$P_I\big(\tau \leq t\big) = \begin{cases} 0 & \text{if } t < T \\ 1 & \text{if } t = T. \end{cases}$$

For $\theta > \bar{\theta}^\infty$, the prosecutor reveals any new evidence. Nevertheless, if she does not get new evidence, the game ends at T only if the defendant is guilty; if the defendant is innocent, they go to trial. This means that there is a deadline effect only when the defendant is guilty. The probability that the game ends by time t when the defendant is guilty for $\theta > \bar{\theta}^\infty$ is

$$P_G\big(\tau \leq t\big) = \begin{cases} 1 - e^{-\lambda \frac{t}{T}} & \text{if } t < T \\ 1 & \text{if } t = T. \end{cases}$$

And for the innocent defendant for $\theta > \bar{\theta}^\infty$:

$$P_I\big(\tau \leq t\big) = 1 - e^{-\lambda \frac{t}{T}} \quad \text{for } t \leq T.$$

I consider the trial to be at period $T+1$. If the probability of ending the game at or before T is less than one, the game ends at trial at time $T+1$ with the remaining probability.

Figure 7 illustrates the probability of ending the game by time t depending on the defendant's type and the prior belief.

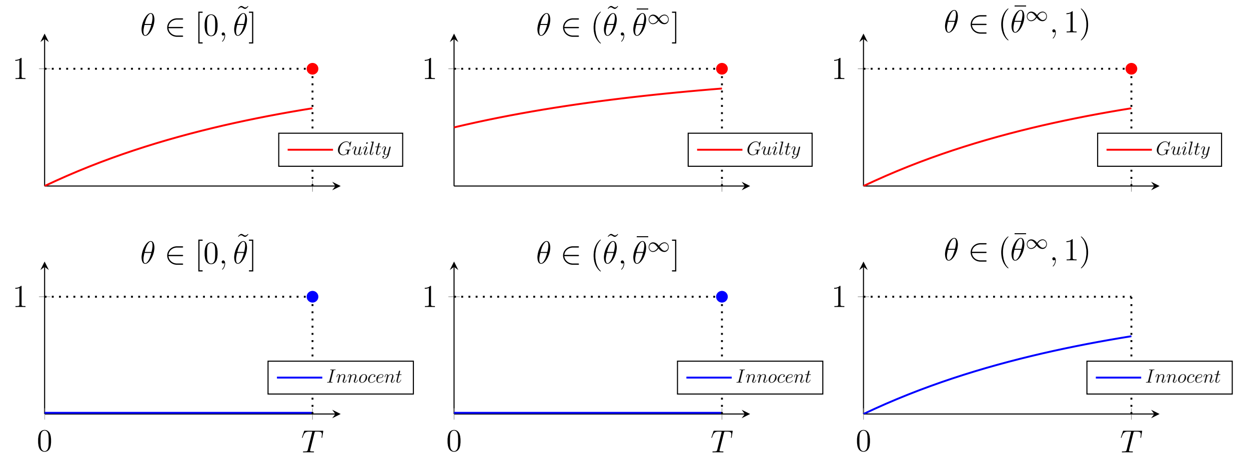

Figure 7: Probability of ending the game by time $t \leq T$.
Values: $\mu = 0.5$, $\lambda = 0.8$, $T = 30$, $q = 0.55$.
Left: $\theta \in [0, \tilde{\theta}]$, middle: $\theta \in (\tilde{\theta}, \bar{\theta}^{\infty}]$, right: $\theta \in (\bar{\theta}^{\infty}, 1]$.

7.1.2 Mandatory Disclosure of Evidence

In the Brady Rule case, there also is a deadline effect. However, in this case, it is the same for both the guilty and the innocent type. The prosecutor and the defendant reach an agreement either as soon as the prosecutor gets new evidence or at the deadline if she does not get new evidence.

Considering the limit-offer case (i.e., $N \to \infty$), let τ^{BR} denote the time at which the prosecutor and defendant reach an agreement. The probability that the game ends by t is given by

$$P\left(\tau^{BR} \leq t\right) = \begin{cases} 1 - e^{-\lambda \frac{t}{T}} & \text{if } t < T \\ 1 & \text{if } t = T \end{cases}$$

Figure 8 graphically shows the path of agreements when $\theta > \underline{\theta}^{BR}$. There are two main differences between the voluntary case and the Brady Rule case. First, in the voluntary case, the probability of ending the game by t is different for the innocent and the guilty types, while in the Brady Rule case is the same for both types. And second, there is a positive probability of no agreement in the voluntary disclosure case at the plea bargaining phase, while under Brady Rule, the prosecutor and the defendant always reach an agreement.

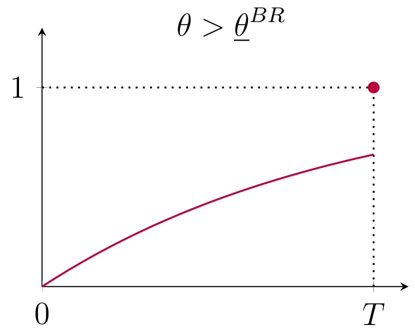

Figure 8: Probability of ending the game by time $t \leq T$ for both defendant types. Values: $\lambda = 0.8$, $T = 30$, $q = 0.55$.

8 Concluding Remarks

With voluntary disclosure of evidence in plea bargaining, in equilibrium, the prosecutor hides exculpatory evidence when the prior belief about the defendant being guilty is low. However, she discloses the exculpatory evidence when the prior belief about the defendant being guilty is high enough. It means that a prosecutor who is purely sentence-motivated may still disclose exculpatory evidence.

Nevertheless, even though there is disclosure of exculpatory evidence if disclosure is voluntary during the plea bargaining phase, the mandatory disclosure protocol during plea bargaining is, from a normative point of view, socially desirable for two reasons: It is efficient in the sense that the prosecutor and defendant always reach an agreement before trial, and because the defendant gets a higher sentence if he is guilty and a lower sentence is he is innocent. Finally, I showed that the prosecutor prefers the mandatory disclosure case.

The main results of the paper are robust to several alternative specifications such as: the investigation is a prosecutor's decision (either private or public decision), the prosectuor cares about fairness, the evidence is inconclusive, and the trial is a bayesian trial. I discuss these extensions in the Appendix.

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Appendices

A Extensions

A.1 Investigation is a prosectuor's decision

In this Section, I assume the investigation at the beginning of each period is the proposer's private decision. Throughout this section, I maintain the following assumption.

Assumption 1. The payoff of getting incriminating evidence is large enough to be attractive, that is:

$$h > d\Big(q + \frac{c}{c - d(1-q)}\Big).$$

Assumption 1 provides clearer and simpler results and does not affect the main result of the paper. I discuss the case these assumptions are not satisfied in Appendix A.6.

The main difference with the automatic investigation case is that the proposer prefers not to investigate for low values of θ. Investigating decreases the innocent defendant belief regarding the prosectuor being d-type, as more investigation implies that he probbaility of having found exculpatory evidence is higher. By no investigating, the proposer can induce the defendant to accept an offer closer to d.

For higher values of the prior belief the prosecutor prefers to investigate each period. And in that case the equilibrium is the than the model with automatic investigation described in the main part of the paper. Therefore, in this section I focus only on los values of the prior belief θ.

There are two qualitatively different equilibria for low values of the prior belief. In the first one, there is an immediate agreement for low values of θ, and in the second, there is no investigation for low values of θ, but the agreement is reached at the end of the plea bargaining for low values of θ.

A.1.1 Inmediate-agreement for low values of the prior belief

Given that the investigation induces second-order belief uncertainty and results in the d-type prosecutor getting a lower payoff, the prosecutor might prefer not to investigate for low values of θ. I define:

$$\underline{\theta} = \frac{dq^{\frac{1}{N}}}{h - dq}.$$

Lemma 2 *In equilibrium, for $\theta \leq \underline{\theta}$, the prosecutor investigates in the first period. If $y = h$, she discloses it, offers $x = h$, and the guilty defendant accepts the offer. If $y \in \{e, d\}$ she does not disclose it, offers $x = dq^{\frac{1}{N}}$, and both defendant types accept.*

Lemma 2 says the prosecutor and the defendant reach an agreement the first period for $\theta \leq \underline{\theta}$. The intuition is that the prosecutor prefers to make an offer that is accepted because if the probability that the defendant is guilty is low enough, the prosecutor is better off not investigating for new evidence the following period because of the risk of finding $y = e$ is higher than finding $y = h$. For $\theta > \underline{\theta}$ the equilibrium is as described in Section 3.

If the prosecutor prefers not to investigate the following periods, the way to sustain no-investigation in equilibrium is removing the incentive to deviate to investigate in the subsequent periods. To do that, the prosecutor needs to separate the guilty from the innocent by making an offer the guilty defendant strictly prefers to accept. The highest offer the guilty defendant accepts for sure is the innocent defendant's continuation loss if there is not going to be more investigation.[30]

The probability that the defendant assigns to the prosecutor being a d-type decreases as the prosecutor investigates because of the probability of finding $y = e$. Hence, after one period of investigation, the innocent defendant's continuation loss is $dq^{\frac{1}{N}}$.

A.1.2 No-investigation Equilibria for low prior belief

The prosecutor can sustain not to investigate in any period for low values of θ. The no-investigation equilibrium cannot be supported as an equilibrium for high values of θ because the incentives to investigate to get $y = h$ are increasing with θ. If θ is low, the prosecutor might prefer not to investigate if the innocent defendant accepts $x = d$ with some positive probability.

If the innocent defendant accepts $x = d$ with probability 1, the prosecutor will deviate to investigate because she benefits from finding $y = h$. She is not affected by finding $y = e$ because she can offer $y = d$, and the defendant will accept. A no-investigation equilibrium can exist because the innocent defendant accepts an offer $x \leq d$ with a probability lower than 1. It induces the prosecutor to not deviate because of the possibility of getting $y = e$ and getting a negative payoff at the trial.

I define $\mu_n^I(d)$ as the probability that the innocent defendant accepts $x = d$ at period n. For each sequence $\{\mu_1^I(d), \mu_2^I(d), \ldots, \mu_{N-1}^I(d), \mu_N^I(d)\}$ of probabilities of accepting $x = d$

[30]This is because if this offer is rejected, the prosecutor does not investigate in the following periods since only the innocent defendant rejects it. Therefore, the innocent defendant is indifferent between accepting it and rejecting it. If the offer is higher than the innocent defendant's continuation loss, the innocent defendant rejects it for sure, and the prosecutor would make a lower offer next period (to avoid trial). Hence, the guilty defendant also rejects it because there will be a lower offer next period.

at each period n, I define:

$$\underset{\sim}{\theta} = \begin{cases} \frac{d\tilde{\mu}^I_{1,..,N}(d)}{h-d\left(1-\tilde{\mu}^I_{1,..,N}(d)\right)} & \text{if } \mu^I_N(d) \in \left[0, \frac{c}{d+c}\right) \\ \frac{\left(1-\mu^I_{1,..,N}(d)\right)c}{h-d+\left(1-\mu^I_{1,..,N}(d)\right)c} & \text{if } \mu^I_N(d) \in \left[\frac{c}{d+c}, 1\right], \end{cases}$$

where $\tilde{\mu}^I_{1,..,N}(d) = \mu^I_N(d) \prod_{j=1}^{N-1} \left(1 - \mu^I_j(d)\right)$ is the probability that the innocent defendant accepts $x = d$ at $n = N$, and $\mu^I_{1,..,N}(d) = 1 - \prod_{j=1}^{N} \left(1 - \mu^I_j(d)\right)$ is the probability that the innocent defendant accepts $x = d$ between $n = 1$ and $n = N$.

Proposition 6 *For $\theta \leq \underset{\sim}{\theta}$, the prosecutor never investigates and offers $x = d$ at the end of each period. The guilty defendant accepts it in the first period, and the game ends, and the innocent defendant accepts it with probability $\mu^I_n(d)$ at each period n.*

The guilty defendant does not deviate because $x = d$ is the best offer he can receive. The innocent defendant does not deviate because he is indifferent between accepting d or getting d at the trial. The prosecutor does not make another offer because it will be rejected for sure, and she does not deviate from investigating because her expected continuation payoff for the deviation is lower than no investigation, given the possibility of finding $y = e$.

Note that $\underset{\sim}{\theta}^N = 0$ if $\mu^I_n(d) = 1$ for any n. The intuition is that if the innocent defendant accepts $x = d$ for sure at some period, the prosecutor deviates to investigate. For $\theta > \underset{\sim}{\theta}^N$, the equilibrium is the same as the immediate-agreement equilibrium described in the main part of the paper. Note that $\underset{\sim}{\theta}^N < \underline{\theta}^N$ for each N.

A.2 Public Investigation

This extension shows that if the investigation decision is public information, the prosecutor does not investigate for low values of θ. The equilibrium with public and private investigation decisions coincides when $N \to \infty$ and T are fixed.

If the prosecutor decides not to investigate, she does not induce second-order belief uncertainty in the defendant; he knows the prosecutor has evidence $y = d$. I define:

$$\underline{\theta}^{Public} = \frac{d}{h - dq}.$$

Lemma 3 *If $\theta \leq \underline{\theta}^{Public}$, the prosecutor does not investigate, and she offers $x = d$ at the end of period $n = 1$. The defendant accepts it, and the game ends in the first period.*

In the case of private investigation, the defendant's continuation loss is decreasing in the number of investigation periods; therefore, the prosecutor investigates every period as long as there is no agreement, or she does not investigate at any period. If $\theta > \bar{\theta}$ the prosecutor always investigate because $\theta\big((1-q)h + dq\big) + (1-\theta)q(d-c) > d$. If $\theta \le \bar{\theta}$, the prosecutor does not investigate for $\theta \le \underline{\theta}^{Public}$.

The prosecutor's expected payoff is

$$u^P = \begin{cases} d & \text{if } \theta \in (0, \underline{\theta}^{Public}] \\ \theta\Big[(1-q)h + qdq\Big] + (1-\theta)dq & \text{if } \theta \in (\underline{\theta}^{Public}, \bar{\theta}^N] \\ \theta\Big[(1-q)h + qd\Big] + (1-\theta)q(d-c) & \text{if } \theta \in (\bar{\theta}^N, 1), \end{cases}$$

and the defendant's expected loss are

$$u^I = \begin{cases} d & \text{if } \theta \in (0, \underline{\theta}^{Public}] \\ dq & \text{if } \theta \in (\underline{\theta}^{Public}, 1] \end{cases} \quad \text{and} \quad u^G = \begin{cases} d & \text{if } \theta \in (0, \underline{\theta}^{Public}] \\ (1-q)h + qdq & \text{if } \theta \in (\underline{\theta}^{Public}, \bar{\theta}^N] \\ (1-q)h + qd & \text{if } \theta \in (\bar{\theta}^N, 1) \end{cases}$$

The prosecutor's payoff is weakly better off with public investigation for $\theta \le \underline{\theta}$. The payoffs coincide at the limit as $N \to \infty$. The prosecutor is better off with public investigation because it is credible that she is not going to investigate for low values of θ. Therefore the innocent defendant is willing to accept $x = d$.

A.3 Prosecutor cares about fairness

The result regarding disclosure of exculpatory evidence holds if the prosecutor cares about the innocent defendant not getting a sentence. Intuitively, if the disutility that the prosecutor gets if the innocent defendant gets a sentence is large enough, then the prosecutor always discloses exculpatory evidence. If the desutility is low, that is, the prosecutor still prefers to induce the innocent defendant to accept a sentence, the same main results of the paper hold.

For simplicity, I consider the one-period benchmark model. Suppose the prosecutor gets a cost of $k \ge 0$ if the innocent defendant gets a sentence. If the prosecutor does not get new evidence after the investigation, she decides to offer dq to the defendant if:

$$\theta dq + (1-\theta)(dq - k) \ge \theta d + (1-\theta)(d - c - k),$$

that is, if offering dq such that both defendant types accept it, instead of offering d that only the guilty type accepts. This is the same argument that is in the main part of the text. The above condition can be written as:

$$\theta \le \tilde{\theta}.$$

An additional consideration has to be made. If $dq - k \leq 0$, the e-type prosecutor discloses exculpatory evidence for any θ, and the d-type prosecutor offers $x = 0$ for low values of θ.[31]

A.4 Inconclusive Evidence

In this Section I show that the same intuitions in the model are extended to the case in which the evidence is not conclusive regarding the type of defendant's type under a modification of the baseline model. I consider a simplified version of the model, in which the prosecutor always investigates, and there is only one period of negotiation.

Consider further that the probability of finding new evidence is $1 - q^G$ if the defendant is guilty, and $1 - q^I$, if the defendant is innocent, with $q^G, > q^I$. This assumption implies that if the prosecutor does not find new evidence, the posterior belief about the defendant's being guilty is higher than the prior belief. Lastly, consider that the new evidence is $y = h$ with probability π^G if the defendant is guilty, and π^I, if the defendant is innocent, with $\pi^G, > \pi^I$.

If the prosecutor finds evidence $y = h$, she discloses it and offers $x = h$, and both defendant types accept it. If the prosecutor does not find new evidence, there is no disclosure. The defendant's second-order belief, depending on his type, is

$$P^G(\text{d-type} \mid \text{no disclosure}) = 1 - q^G$$
$$P^I(\text{d-type} \mid \text{no disclosure}) = 1 - q^I.$$

The expected loss for each defendant type at trial is $v^G = dq^G$ and $v^I = dq^I$. In this model, if the prosecutor does not find new evidence, she updates her belief to

$$P(\alpha = G \mid y = d) = \frac{q^G\theta}{q^G\theta + q^I(1-\theta)} \equiv \theta^d.$$

The optimal offer that the d-type prosecutor makes depends on θ^d. If the prosecutor offers the guilty defendant's expected loss, only the guilty defendant accepts it. Both defendant types accept it if the offer is equal to the innocent defendant's expected loss. Therefore, the prosecutor offers $x = dq^G$ if $\theta^d > \frac{q^I}{q^G} \equiv \bar{\theta}^{NC}$.

If the prosecutor finds evidence $y = e$, her posterior belief is

$$P(\alpha = G|y = e) = \frac{(1-q^G)\pi^G\theta}{(1-q^G)\pi^G\theta + (1-q^I)\pi^I(1-\theta)} \equiv \theta^e.$$

Consider the case in which $\theta^d > \bar{\theta}^{NC}$ and $\theta^e < \bar{\theta}^{NC}$. The d-type prosecutor makes a high offer to the defendant, but the e-type prefers to make a low offer. The low offer

[31] For any high k, the d-type prosecutor offers $x = d$ if $\theta \geq \frac{c+k-d}{c+k}$. That is, if k is very large, the d-type prosecutor still offers $x = d$ when the prior belief of the defendant being guilty is very high.

is going to be rejected; the defendant will know that the prosecutor has evidence $y = e$ because she is playing a non-sequentially rational strategy for the d-type.

The two candidates for optimal strategy for the e-type prosecutor are to disclose $y = e$ and to offer $x = 0$, or make the high offer. The latter case is preferred if $\theta^e dq^G + (1 - \theta^e)(-c) \geq 0$ or $\theta^e \geq \frac{c}{dq^G+c}$.

Define:

$$\tilde{\theta}^{NC} \equiv \frac{c}{dq^G + c}.$$

The prosecutor is going to disclose evidence $y = e$ if the following conditions hold:

$$\theta^d > \bar{\theta}^{NC},\ \theta^e < \bar{\theta}^{NC},\ \text{and } \theta^e < \tilde{\theta}^{NC}$$

Figure 9 shows the conditions when the prosecutor discloses exculpatory evidence.

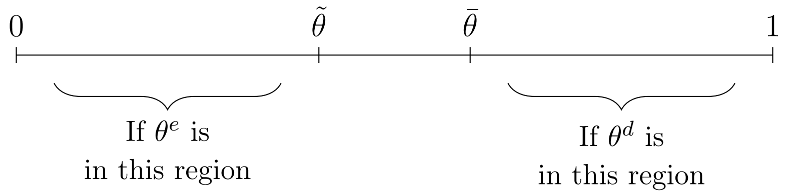

Figure 9: Conditions on posterior belief to disclose exculpatory evidence.

Now, in terms of the prior belief θ, the prosecutor discloses exculpatory evidence if the prior belief is either not too high or too low.[32]

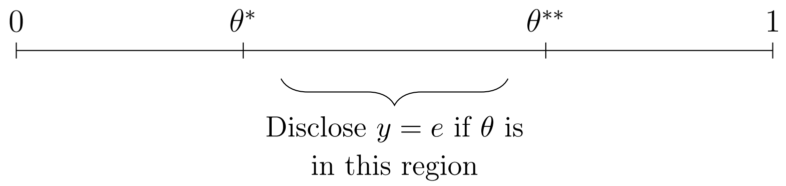

Figure 10: Conditions on prior belief to disclose exculpatory evidence.

Figure 10 shows that, for the inconclusive case, the prior belief cannot be too high to disclose exculpatory evidence, because, in that case, the prosecutor will still make a high offer if she gets exculpatory evidence.

If the prosecutor does not get new evidence, and $\theta^d > \bar{\theta}^{NC}$, the prosecutor makes an offer that only the guilty defendant accepts. Therefore, if the defendant is innocent, they do not reach an agreement, and they go to trial. If the disclosure of evidence is mandatory, they always reach an agreement.

[32] $\theta^* = \frac{q^I \bar{\theta}}{q^G - \bar{\theta}(q^G - q^I)}$ and $\theta^{**} = \frac{(1-q^I)\pi^I \tilde{\theta}}{(1-q^G)\pi^G - \tilde{\theta}((1-q^G)\pi^G - (1-q^I)\pi^I)}$

A.5 Bayesian Trial

In this Section, I consider an alternative way to model the trial. Suppose that evidence d does not exist, and the trial assigns a sentence depending on the public posterior belief after exculpatory or incriminating evidence is revealed. The public posterior belief is denoted by θ^T. The defendant gets a sentence h if the evidence is incriminating, 0 if it is exculpatory, and $\theta^T h$ if there is no evidence.

To get a simple intuition, consider the one-period model of Section 3. In this case, the investigation is not a decision, and the prosecutor always investigates. Following the same arguments as in Section 3, the no-evidence-type prosecutor makes an offer θ^T if

$$\theta h \theta^T + (1-\theta)(\theta^T h - c) \geq q\theta^T h$$

In equilibrium, $\theta^T = \theta$ given that not having evidence does not change the prior belief. Therefore, the prosecutor discloses exculpatory evidence to avoid the trial if $\theta \geq \frac{c}{h(1-q)+c}$. This result is qualitatively equivalent to the key insight of the paper.

Nevertheless, considering the prosecutor's decision regarding the investigation, the result differs from the model in the main part of the paper.

Lemma 4 *If the investigation is the prosecutor's private information, the prosecutor investigates for any value of the prior belief. If the investigation decision is public, the prosecutor does not investigate for any prior belief.*

Proof. The proof of the Lemma 4 is a comparison of expected payoffs. For the first result, suppose the defendant accepts θd with probability μ. Also, suppose that $\theta h\mu - c(1-\mu) < 0$; that is, if the prosecutor investigates and gets exculpatory evidence, she discloses it. Prosecutor's payoff of no investigation is $V = \theta h\mu(\theta h - c)(1-\mu)$, therefore she deviates to investigate if:

$$V < \theta[(1-q)h + qV] + (1-\theta)qV \quad \Leftrightarrow \quad V < \theta h,$$

which is always true. Consider now $\theta h\mu - c(1-\mu) \geq 0$, in this case the prosecutor deviates to investigate if:

$$V < \theta[(1-q)h + qV] + (1-\theta)[(1-q)(\theta h\mu - c(1-\mu)) + qV] \quad \Leftrightarrow \quad \theta < 1 + \frac{c(1-\mu)}{h\mu}$$

which is always true.

For the second result, the prosecutor investigates if the expected payoff of the investigation is higher than θh. The prosecutor's payoffs are $\theta h(1-\theta q(1-q))$ and $\theta h - (1-\theta)qc$ for the cases of no disclosure and disclosure of exculpatory evidence, and both are lower than θh. ■

The intuitive reason for the difference between public and private investigation is that the prosecutor perfectly signals that he has no evidence if he decides not to investigate in the former case. The highest payoff that the prosecutor can get is θh. If the defendant is guilty, he can get at most h with probability θ, and if the defendant is innocent, he does not get more than $q\theta h$ with probability $(1-\theta)$. Therefore if the prosecutor can signal no evidence, she will do it.

However, when the investigation is private information, the incentive to investigate is very high. If the prosecutor gets new evidence, it will be h with probability θ and e with probability $(1-\theta)$. Therefore, at worst, the prosecutor gets $qV + (1-q)\theta h$ if she deviates, which is higher than V because the value of V is increasing in θ. So it is always better to try to get h even if θ is very low. In the model of the main part of the paper, this is not true because V is not a function of θ; therefore, for low values of θ, it is better not to investigate.

A.6 Parametric Assumptions

If $c > d(1-q)$ is not satisfied then $\tilde{\theta} \leq 0$. That is, the prosecutor always discloses exculpatory evidence. The intuition is that given the low cost of going to trial with respect to d, the d-type prosecutor always prefers to offer $x = d$ at the last period. That implies the e-type prosecutor never imitates the d-type prosecutor's offer; otherwise, she will have a negative payoff to trial.

The condition $h > d\big(q + \frac{c}{c-d(1-q)}\big)$ allows $\underline{\theta} < \tilde{\theta}$ for $N \to \infty$ that is the most restrictive case. For the analysis, I consider a less restrictive condition (for a general N):

$$h > d\left(\frac{c(q^{\frac{1}{N}} + q) - dq(1-q)}{c - d(1-q)}\right)$$

Note that $q + \frac{c}{c-d(1-q)} > \frac{c(q^{\frac{1}{N}}+q)-dq(1-q)}{c-d(1-q)}$ for any N.

If the above condition is not satisfied, then $\underline{\theta} > \tilde{\theta}$. There are two cases.

Case 1: $\underline{\theta} > \bar{\theta}$. The new cutoff θ such that the prosecutor investigates is

$$\underline{\theta}^{*N} = \frac{cq^{\frac{N-1}{N}} + d(1 - q^{\frac{N-1}{N}})}{cq^{\frac{N-1}{N}} + d(1-q) + h(1 - q^{\frac{N-1}{N}})}$$

Note $\underline{\theta}^{*N}$ is decreasing in N, with limit:

$$\underline{\theta}^{**} = \frac{cq + d(1-q)}{cq + d(1-q) + h(1-q)}$$

Here the prosecutor either always discloses $y = e$ if $\theta > \underline{\theta}$, or reaches an immediate agreement with the defendant if $\theta \leq \underline{\theta}$.

Case 2: $\underline{\theta} \in (\tilde{\theta}, \bar{\theta}]$. In this case, the results described in the main part of the paper hold.

B Proofs

Proposition 1. The prosecutor's payoff if she discloses $x = h$ is h. If the prosecutor does not disclose $y = h$, the guilty defendant's belief about the prosecutor's type is $P_G(\text{d}-\textit{type} \mid \textit{no-disclosure}\ ) = 1$, it implies the guilty defendant does not accept anything higher than $x = d$ that gives the prosecutor a payoff of at most d.

If $\theta \leq \tilde{\theta}$, the prosecutor offers $x = dq$ if $y = d$ after the investigation. If the prosecutor offers $x > d$, the offer is rejected, and she gets a payoff of $d - c < dq$. If she deviates to $x \in (dq, d]$, the offer is only accepted by the guilty defendant and rejected by the innocent. Therefore her expected payoff is $\theta x + (1 - \theta)(d - c)$ which is lower than dq because $\theta x + (1 - \theta)(d - c) \leq \theta d + (1 - \theta)(d - c) = d - c(1 - \theta) < dq$ for $\theta < \tilde{\theta}$. If the prosecutor deviates to offer $x < dq$, both defendant types accept the offer, and the prosecutor gets a payoff lower than dq. Therefore there is no profitable deviation.

If $\theta \leq \tilde{\theta}$ and $y = e$, the best response for the e-type prosecutor is to mimic the d-type prosecutor. Note that the e-type prosecutor knows the defendant is innocent. Therefore, if she offers $x > dq$, the defendant will reject the offer, and she gets a payoff of $-c$. If she offers $x < dq$, the offer is rejected, and she gets $-c$. The offer is rejected because the innocent defendant that gets an offer $x < dq$ updates his belief about the prosecutor's type to the persecutor being a e-type prosecutor with probability 1.

For $\theta \leq \tilde{\theta}$, the guilty defendant always accepts dq because her expected loss of going to the trial is at least d. The innocent defendant accepts $x = dq$ because her second-order belief about the prosecutor's evidence is e with probability $1-q$ and d with probability q. Therefore his expected loss at trial is dq. The innocent defendant rejects $x < dq$ because the d-type prosecutor never sends that offer. Accordingly, he updates his belief to the prosecutor being e-type, and therefore, her expected loss at trial is 0.

Consider $\theta > \tilde{\theta}$. The prosecutor offers $x = d$ if $y = d$. If she instead offers $x > d$, the offer is rejected for sure, and she gets a payoff of $d - c < \theta d + (1 - \theta)(d - c)$. If the prosecutor deviates to $x < d$, only the guilty defendant accepts it, and the prosecutor gets an expected payoff of $\theta x + (1 - \theta)(d - c) < \theta d + (1 - \theta)(d - c)$.

The prosecutor discloses e and offers $x = 0$ if $y = e$. If the prosecutor offers $x > 0$, the offer is rejected, and the prosecutor gets $-c$. If the prosecutor does not disclose $y = e$, and she offers $x \geq d$, the offer is rejected for sure, and she gets $-c$ at trial. Suppose she offers $x < d$, the innocent defendant updates his belief about the prosecutor type to be e-type and therefore rejects the offer, and the prosecutor gets $-c$. If the prosecutor does not disclose $y = e$ and offers $x = 0$, the payoff is the same as disclosing it and offering $x = 0$.

For $\theta > \tilde{\theta}$, the guilty defendant always accepts d because his expected loss of going to the trial is at least d. The innocent defendant does not accept $x > 0$. If there is no disclosure, a deviation to accept $x = d$ generates the same expected loss at the trial, so it is not a profitable deviation. Note that accepting $x = d$ cannot be an equilibrium because, in that case, the prosecutor with $y = e$ deviates to no-disclosing. Any offer $x \in (0, d)$ reveals the prosecutor has $y = e$.

Proposition 2. For every period n, the prosectuor does not have $y = h$ at the beginning of the period on the equilibrium path. This is because the prosecutor discloses it and offers $x = y$ at the end of the period that she gets it. Also, for $n \leq 2$, it is not possible that the prosecutor's belief about the defendant's type belongs to the interval $(\bar{\theta}, \tilde{\theta}]$. This is because on the equilibrium path, the prosecutor updates her belief to $\theta' = \tilde{\theta}$ if $(\tilde{\theta}, \bar{\theta}]$.

For this Section, consider the following notation: y_f^n represents the evidence that the prosecutor has after the investigation at period n.

I. Last period before trial ($n = N$): Following on-path strategies, the prosecutor can only have $y^N \in \{e, d\}$ at the beginning of the period. If $y_f^N = h$; to disclose the evidence and offer $x^N = h$, and $\mu^G(h) = 1$ is an equilibrium. The guilty defendant's continuation loss if he rejects $x = h$ is $v^G = h$, so he is indifferent.

Disclosing $x = h$ is the best response. The prosecutor's continuation value if she discloses $x = h$ is $v^P = h$. If the prosecutor does not disclose $y = h$, the guilty defendant's belief about the prosecutor's type is $P_G(\text{d}-\textit{type} \mid \textit{no-disclosure}\ ) = 1$, it implies the guilty defendant does not accept anything higher than $x = d$ that gives the prosecutor a continuation value $v^P = d$.

Case $\theta \in [0, \tilde{\theta}]$. If $y_f^N = d$, the continuation loss are $v^G = d$ and $v^I = dq$. The prosecutor's optimal offer is either $x = v^I$ such that both defendant types accept it $\mu^I(dq) = \mu^G(dq) = 1$, or $x = v^G$ such that only the guilty defendant accepts it $\mu^I(d) = 0, \mu^G(d) = 1$. The prosecutor is better off offering the innocent defendant's continuation loss because it brings her an expected payoff of qd, which is larger than θd if $\theta \leq \tilde{\theta}$.

If the outcome of the investigation is $y_f^N = e$, disclosing it gives the prosecutor a continuation payoff of $v^P = 0$ because the innocent defendant's continuation loss is zero. If she does not disclose it, she can offer $x = dq$ that the innocent defendant accepts.

Case $\theta \in (\bar{\theta}, 1)$. Suppose $y_f^N = d$. Continuation loss are $v^G = d$ and $v^I = dq$. The prosecutor's optimal offer is either $x = v^I$ such that both defendant types accept it with $\mu^I(dq) = \mu^G(dq) = 1$, or $x = v^G$ such that only guilty defendant accepts it $\mu^I(d) = 0, \mu^G(d) = 1$. The prosecutor is better off offering the guilty defendant's continuation loss because it brings her an expected payoff of θd instead of dq when $\theta > \bar{\theta}$. This implies the prosecutor offers $x = d$, and the guilty defendant accepts it.

If $y_f^N = e$, disclosing it is an equilibrium. It cannot be an equilibrium where a e-type prosecutor can successfully hide evidence and get a payoff higher than zero. If the prosecutor has evidence $y = d$, she will offer $x = d$ because any other offer is strictly dominated. Therefore, if there is no disclosure and the innocent defendant gets an offer $x \in (0, d)$, he will update his belief about the prosecutor type to $P_I(y = d \mid x \in (0, d)) = 0$, because otherwise she would have offered $x = d$, and then the innocent defendant will reject the offer.

Finally, if $y^N = d$ at the beginning of period N, the prosecutor does not deviates from investigate, otherwise $v^P = dq$ instead if $v^P = \theta[(1 - q^{\frac{1}{N}})h + q^{\frac{1}{N}}dq] + (1-\theta)dq$ if $\theta \leq \tilde{\theta}$, and $v^P = \theta d + (1-\theta)(d-c)$ instead of $v^P = \theta[(1 - q^{\frac{1}{N}})h + q^{\frac{1}{N}}d] + (1-\theta)q^{\frac{1}{N}}(d-c)$ if $\theta > \bar{\theta}^N$. Note that $\theta d + (1-\theta)(d-c)$ is larger than $\theta[(1 - q^{\frac{1}{N}})h + q^{\frac{1}{N}}d] + (1-\theta)q^{\frac{1}{N}}d$ for $\theta > \frac{d-c}{h-c}$, and note further that $\frac{d-c}{h-c}$ is always lower than $\tilde{\theta}$ given the parametric assumptions, therefore $\frac{d-c}{h-c} < \bar{\theta}$.

II. Intermediate periods $(1 < n < N)$**:** Following on-path strategies the prosecutor can only have $y^n \in \{e, d\}$. Suppose the prosecutor investigates and gets evidence $y = h$; to disclose the evidence and offer $x^n = h$, and $\mu^G(x = h) = 1$ is an equilibrium. The guilty defendant's continuation loss if he rejects $x = h$ is $v^G = h$, so he is indifferent.

To disclose $x = h$ is the best response. The prosecutor's continuation value if she discloses $x = h$ is $v^P = h$. If the prosecutor does not disclose $x = h$, $P_G(y = d \mid \textit{no-disclosure}\ ) = 1$, it implies the guilty-defendant does not accept anything higher than $x = (1 - q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}dq$.

<u>Case $\theta \in [0, \tilde{\theta}]$.</u> Suppose $y_f^n = d$. The continuation loss are $v^G = (1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}dq$ and $v^I = dq$. The prosecutor's continuation payoff is $v^P = \theta\big((1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}dq\big) + (1-\theta)dq$.

Any offer x that is not rejected by both defendant types is not a profitable deviation for the prosecutor. Consider an offer that both types accept. The highest offer—, the one that maximizes the prosecutor's payoff—that both defendant types accept is $qd^{\frac{n}{N}}$. This is not a profitable deviation from offering x such that both defendant types reject, because $\theta\big((1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}dq\big) + (1-\theta)dq$ is higher than $qd^{\frac{n}{N}}$. The innocent defendant rejects any higher offer because $dq^{\frac{n}{N}}$ is the highest continuation loss that the innocent defendant can get, and it is reached when the prosecutor does not investigate any further period.

The highest offer that only the guilty defendant might accept is his continuation loss minus $\epsilon \to 0$, $x' = (1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}dq - \epsilon$. This offer is not a profitable deviation because the prosecutor's payoff under the deviation is at most $\theta\big((1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}dq\big) + (1-\theta)dq$.

If $y_f^n = e$, the prosecutor equilibrium strategy is to mimic a d-type prosecutor. The relevant deviation to check this is an equilibrium is not to mimic the d-type prosecutor. If the prosecutor discloses $x = e$ or offers $x < v^G$, the innocent defendant updates $P_I(y = d \mid x < v^G) = 0$, that gives a lower expected continuation payoff for the prosecutor. Therefore, to mimic a d-type prosecutor is an equilibrium.

The prosecutor investigates at the beginning of n is an equilibrium, because it gives him an expected payoff of $v^P = \theta[(1 - q^{\frac{N+1-n}{N}})h + q^{\frac{N+1-n}{N}}dq] + (1-\theta)dq$ that is higher than the one shot no-investigation payoff $v^P = \theta[(1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}dq] + (1-\theta)dq$.

Case $\theta \in (\bar{\theta}, 1)$: Consider $\theta \in (\tilde{\theta}, 1)$. Suppose $y_f^n = d$. The continuation loss are $v^G = (1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}d$ and $v^I = dq$. The prosecutor's continuation value is $v^P = \theta\Big((1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}))d\Big)$.

The equilibrium strategy for the prosecutor is to offer $x > (1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}d$ such that is rejected by both defendant types. If she deviates to offer x such that both types accept, she has to offer $qd^{\frac{n}{N}}$ as analyzed above. This is not a profitable deviation because $qd^{\frac{n}{N}}$ is lower than $\theta\Big((1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}))d\Big) + (1-\theta)q(d-c)$ when $\theta > \bar{\theta}^N$.

As before, the highest offer that only the guilty defendant accepts is his continuation loss minus $\epsilon \to 0$, $x' = (1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}d - \epsilon$. The induced continuation equilibrium gives an expected payoff to the prosecutor of at most the same payoff as following the equilibrium strategy.

It is not an equilibrium that the prosecutor offers x', the guilty defendant accepts it with probability $\mu^G \in (0,1]$, and the innocent defendant rejects such that $\theta' < \bar{\theta}$ if a rejection is observed. In that case, the guilty defendant anticipates the updating and deviates to reject x' because his continuation loss is lower if $\theta' < \bar{\theta}$. This deviation gives the prosecutor an expected payoff of $dq^{\frac{n}{N}}$ if $\theta' \leq \underline{\theta}^N$ and $\theta\big((1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}dq\big) + (1-\theta)dq$ if $\theta' \in [0, \bar{\theta}]$.

Any other strategy by the guilty defendant provides the prosecutor a continuation payoff bounded by $\theta\Big((1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}))d\Big) + (1-\theta)q(d-c)$. If $\mu^G \in [0,1)$, such that $\theta' \in (\bar{\theta}^N, \theta]$ if prosecutor observes a rejection, the prosecutor gets an expected payoff of $\theta\big((1-q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}d - \mu^G\epsilon\big) + (1-\theta)q(d-c)$ under the deviation offer.

If $y_f^n = e$, the equilibrium strategy for the prosecutor is to disclose the evidence and offer $x = 0$. If the prosecutor deviates to no-disclosure and offers $x = 0$, it brings the same payoffs as to disclose the evidence and offer $x = 0$. Therefore is not a profitable deviation. If the prosecutor does not disclose and offer $x \in (0, d]$, the innocent defendant will reject it because he will update his belief to $P_I(y = d \mid \text{no-disclosure and } x \in (0, d]) = 0$ given that a d-type prosecutor never offers less than d.

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III. First period ($n = 1$): Suppose the prosecutor gets evidence $y = h$. To disclose the evidence and offer $x = h$, and $\mu^G(h) = 1$ is the equilibrium. There is no profitable deviation: the guilty defendant's continuation loss if he rejects $x = h$ is $v^G = h$, so he is indifferent.

To disclose $x = h$ is the best response. The prosecutor's continuation value if she discloses $x = h$ is $v^P = h$. If the prosecutor does not disclose $x = h$, $P_G(y = d \mid \textit{no-disclosure}\ ) = 1$, it implies the guilty defendant does not accept anything higher than $x = d$. In that case, the prosecutor makes an offer that is rejected for sure. At $n+1$, the prosecutor discloses $y = h$. If the prosecutor never discloses, her continuation value is $v^P = d$, which is lower than h. As before, the prosecutor is indifferent between disclosing $x = h$ at n or at $n+1$; I assume the prosecutor discloses it as soon as she gets it.

The cases $\theta \in [0, \tilde{\theta}]$ and $\theta \in (\bar{\theta}^N, 1)$ are the same that if $n \in (1, N)$ discussed above.

Case $\theta \in (\tilde{\theta}, \bar{\theta}]$: The equilibrium is to offer $x = (1 - q^{\frac{N-1}{N}})h + q^{\frac{N-1}{N}}dq$ if $y \in \{e, d\}$ in the first period. The guilty defendant accepts it with probability $\mu^G(x) = \frac{\theta - \bar{\theta}}{\theta(1-\bar{\theta})}$. The innocent defendant rejects it. The prosecutor updates her belief to $\theta' = \bar{\theta}$.

The guilty defendant does not deviate because he gets the same expected payoff as accepting it if he rejects the offer. If the innocent defendant accepts the offer, he is worse off.

The prosecutor does not deviate; if $x < (1 - q^{\frac{N-1}{N}})h + q^{\frac{N-1}{N}}dq$ the guilty defendant accepts the offer for sure, but the payoff is lower. Also, it cannot be an equilibrium, because if the guilty defendant accepts it for sure, then the prosecutor does not investigate anymore because $\theta' = 0$; therefore, the guilty defendant deviates to rejection. If $x \in [(1 - q^{\frac{N-1}{N}})h + q^{\frac{N-1}{N}}dq, (1 - q^{\frac{N-1}{N}})h + q^{\frac{N-1}{N}}d)$ the guilty defendant rejects it given that the continuation loss when $\theta = \bar{\theta}$ is lower. If $\theta' > \bar{\theta}$, then the prosecutor accepts it; however, it is not profitable for the prosecutor when $\theta \leq \bar{\theta}$. Also, it cannot be an equilibrium because if the guilty defendant accepts for sure, then the prosecutor does not investigate anymore because $\theta' = 0$; therefore, the guilty defendant deviates to rejection. If $x \geq (1 - q^{\frac{N-1}{N}})h + q^{\frac{N-1}{N}}d)$ and $\theta = \tilde{\theta}$ if there is a rejection; the guilty defendant always rejects the offer and the prosecutor is worse off.

If the prosecutor delays the offer x such that $\theta' = \tilde{\theta}$, for some values of θ, she will be indifferent, but for others, she will be worse. Suppose the prosecutor delays the offer x to period $n > 1$, at n there were n investigations, so the offer that makes the guilty defendant indifferent is $x = (1 - q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}dq$. The prosecutor is willing to make this offer if:

$$\theta\Big((1 - q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}dq\Big) + (1-\theta)dq \geq \Big((1 - q^{\frac{N-n}{N}})h + q^{\frac{N-n}{N}}d\Big)$$

$$\iff \quad \theta \leq \frac{q^{\frac{N-n}{N}}}{q^{\frac{N-n}{N}} + q(1 - q^{\frac{N-n}{N}})} \equiv \tilde{\theta}'$$

Note that $\tilde{\theta}' < \bar{\theta}$ for $n > 1$. This implies that if the prosecutor waits until period n, she is not going to separate the guilty defendant from the innocent if $\theta \in (\tilde{\theta}', \bar{\theta}]$. For values $\theta \in (\tilde{\theta}, \tilde{\theta}']$ the prosecutor gets the same payoff making the offer x at the first period or waiting until n. For values $\theta \in (\tilde{\theta}', \bar{\theta}]$ the prosecutor is worse off waiting until n, because her payoff of making the offer at the first period is: $\theta\Big((1 - q^{\frac{N-1}{N}})h + q^{\frac{N-1}{N}}dq\Big) + (1-\theta)dq$ that is larger than waiting until n, where the payoff is $\Big((1 - q^{\frac{N-}{N}})h + q^{\frac{N-1}{N}}d\Big)$.

In conclusion, the prosecutor does not deviates and offers $x = (1 - q^{\frac{N-1}{N}})h + q^{\frac{N-1}{N}}dq$ at period 1.

Lemma 1. At the end of period n the prosecutor's expected payoff is:

$$\theta\Big((1-q^{\frac{N-n+1}{N}})h+q^{\frac{N-n+1}{N}}d\Big)+(1-\theta)q^{\frac{N-n+1}{N}}d$$

If the prosecutor decides to make an offer that is accepted by the defendant, it was to be equal to the defendant's continuation loss. The guilty defendant's continuation loss is:

$$v_n^G=(1-q^{\frac{N-n+1}{N}})h+q^{\frac{N-n+1}{N}}d,$$

and the innocent defendant's continuatio'n loss is :

$$v_n^I=q^{\frac{N-n+1}{N}}.$$

Therefore, is the proposer makes an offer that is accepted by the defendant, as most get the same expetedd payoff.

Proposition 3. The innocent defendant's expected loss in voluntary disclosure case is dq for any N, and the same value for the mandatory disclosure case.

The guilty defendant's expected loss in the voluntary disclosure case is:

$$u^G=\begin{cases}(1-q)h+qdq & \text{if } \theta\in[0,\bar{\theta}]\\(1-q)h+qd & \text{if } \theta\in(\bar{\theta},1)\end{cases}$$

and in the mandatory case is $(1-q)h+qd$ for any N. For $\theta\leq\bar{\theta}$ under mandatory disclosure the expected loss is $(1-q)h+qd$ that is larger than the voluntary disclosure expected payoff d.

For $\theta>\bar{\theta}]$, the guilty defendant's expected loss under mandatory disclosure is the same than under voluntary disclosure.

Proposition 4. The prosecutor's payoff with voluntary disclosure of evidence is:

$$u^P=\begin{cases}\theta\Big[(1-q)h+qdq\Big]+(1-\theta)dq & \text{if } \theta\in[0,\bar{\theta}]\\\theta\Big[(1-q)h+qd\Big] & \text{if } \theta\in(\bar{\theta},1)\end{cases}$$

while in the mandatory disclosure of evidence is $\theta\Big((1-q)h+dq\Big)+(1-\theta)dq$ for any θ.

For $\theta\leq\bar{\theta}]$, the prosecutor payoff with mandatory disclosure is: $\theta\Big((1-q)h+dq\Big)+(1-\theta)dq$ that is larger than $\theta\Big[(1-q)h+qdq\Big]+(1-\theta)dq$. For $\theta>\bar{\theta}$, the mandatory disclosure payoff for the prosecutor is $\theta\Big((1-q)h+dq\Big)+(1-\theta)dq$ that is larger than

$\theta\Big((1-q)h + dq\Big) + (1-\theta)dq.$

Proposition 5. For $\theta \in [0, \bar{\theta}]$, the prosecutor makes an offer that is accepted by both defendant types at $t = T$, therefore the game ends for sure at T. Note that at $t < T$ the game ends only if the prosecutor gets $y = h$. That happens with probability $1 - e^{-\lambda \frac{T-\epsilon}{T}}$ if $\theta \in (\underline{\theta}, \tilde{\theta}]$, and $1 - e^{-\lambda \frac{T-\epsilon}{T}}(1-\mu^G)$ if $\theta \in (\tilde{\theta}, \bar{\theta}]$.

For $\theta \in (\bar{\theta}, 1]$, at $t = T$ the d-type prosecutor makes an offer that is rejected by the innocent defendant, therefore there is no mass point. If the defendant is guilty, he accepts the offer that the d-type prosecutor makes at $t = T$. Note that at $T - \epsilon$ the game ends if the defendant is guilty only if the prosecutor gets $y = h$, it happens with probability $1 - e^{-\lambda \frac{T-\epsilon}{T}}$ if $\theta \in (\bar{\theta}, 1]$.

Lemma 2. The prosecutor's strategy is as follows. On the equilibrium path, she only investigates at $n = 1$. If she gets $y = h$, she discloses it and offers $x = h$. If she gets $y = e$ or does not get any new evidence, she does not disclose it and offers $x = dq^{\frac{1}{N}}$ for all n.

The guilty defendant's strategy, if there is disclosure of $y = h$, is $\mu^G(x) = 1$ if $x \leq h$, and $\mu^G(x) = 0$ otherwise. If there is no-disclosure of $y = h$; $\mu^G(x) = 1$ if $x \leq d$, and $\mu^G(x) = 0$ otherwise for all n. The innocent defendant's strategy, if there is disclosure of $y = e$, is $\mu^I(x) = 1$ if $x \leq 0$, and $\mu^I(x) = 0$ otherwise. If there is no disclosure of $y = e$; $\mu^I(x) = 1$ if $x \leq dq^{\frac{1}{N}}$ and $\mu^I(x) = 0$ otherwise for all n.

Disclosing $x = h$ is the best response. The prosecutor's continuation value if she discloses $x = h$ is $v^P = h$. If the prosecutor does not disclose $y = h$ the guilty defendant's belief about the prosecutor's type is $P_G(\text{d}-\textit{type} \mid \textit{no-disclosure}\,) = 1$, it implies the guilty defendant does not accept anything higher than $x = d$, that gives the prosecutor a continuation value $v^P = dq^{\frac{1}{N}}$.

The prosecutor's expected continuation payoff at the end of $n = 1$, if $y \in \{e, d\}$ is $dq^{\frac{1}{N}}$. The innocent defendant and the guilty defendant's expected loss are: $v^I = dq^{\frac{1}{N}}$ and $v^G = dq^{\frac{1}{N}}$.

The guilty defendant does not deviate to rejection because if the prosecutor observes a rejection, she will update her belief to $\theta' = 0$; she does not investigate the following periods and offers $x = dq^{\frac{1}{N}}$ every subsequent period. Therefore, the guilty defendant is not better off. The same applies to the innocent defendant; if there is a rejection, the prosecutor is not going to investigate, and she will offer $x = dq^{\frac{1}{N}}$ next period.

Note that it is not possible to have a different belief than $\theta' = 0$ when there is a rejection, because if $\theta' > 0$ the prosecutor will investigates at least one more period, that bring an expected payoff of at least $(1 - q^{\frac{1}{N}})h + q^{\frac{1}{N}} dq^{\frac{2}{N}}$ to her. It is larger than $dq^{\frac{1}{N}}$. Therefore the guilty defendant will reject with probability one. Thus, it is not possible to have $\theta' > 0$.

The prosecutor does not deviate to offer less than $x = dq^{\frac{1}{N}}$ because it brings her a lower payoff. If $x > dq^{\frac{1}{N}}$ the innocent defendant will reject it because $dq^{\frac{1}{N}}$ is his highest expected loss when there is no further investigation, so he will never accept a larger offer. It cannot be that the guilty defendant accepts it with probability one because, in that case, $\theta' = 0$ and the prosecutor will decrease the offer in later periods. Therefore the guilty defendant is better of rejecting it. If the guilty defendant accepts it with probability $\mu^G < 1$ such that there is investigation in future periods, the prosecutor is worse off because if there is at least one more investigation her payoff will be at most $v^P = \theta\Big((1-q^{\frac{1}{N}})h + q^{\frac{1}{N}} dq^{\frac{2}{N}}\Big) + (1-\theta)dq^{\frac{2}{N}}$ that is lower than $dq^{\frac{1}{N}}$ when $\theta \leq \tilde{\theta}^N$. Therefore, there is no profitable deviation.

The prosecutor investigates the first period is an equilibrium, otherwise she gets $dq^{\frac{1}{N}}$ instead of $\theta\Big((1-q^{\frac{1}{N}})h + q^{\frac{1}{N}} dq^{\frac{1}{N}}\Big)(1-\theta)dq^{\frac{1}{N}}$ that is larger than $dq^{\frac{1}{N}}$ when $\theta \leq \bar{\theta}^N$. Note that off the equilibrium path $\theta' = 0$ for $n > 1$, that implies the prosecutor never deviates to investigate the following periods.

Proposition 6. Call $\mu_n^I(x)$ the probability that the innocent defendant accepts the offer x at period n. The prosecutor's expected payoff of the equilibrium strategies is $\theta d + (1-\theta)d\mu^I_{1,..,N}$, where $\mu^I_{1,..,N}$ is the probability of accepting $x = d$ at any period between 1 and N.

<u>For $\mu_N^I \in [0, \frac{c}{d+c})$:</u> If the prosecutor one-shot deviates at period $n = 1$, her payoff is

$$\theta\Big((1-q^{\frac{1}{N}})h + q^{\frac{1}{N}}d\Big) + (1-\theta)\Big((1-q^{\frac{1}{N}})d\mu^I_{1,..,N-1} + q^{\frac{1}{N}}d\mu^I_{1,..,N}\Big)$$

where $\mu^I_{1,..,N-1}$ is the probability the prosecutor accepts d in any of the periods from 1 to $N-1$. This probability reflects the fact that the prosecutor best strategy if she gets $y = e$ at period $n = 1$ is offer $x = d$ every period until $n = N-1$. If the innocent defendant rejects $x = d$ at $n = N-1$, the prosecutor discloses $y = e$ at N.

The prosecutor is not going to deviate after period $n = 1$, because if the game has not ended it is because the defendant is innocent. Therefore, investigating is a strictly dominated strategy. The prosecutor is better off deviating if:

$$\theta > \frac{d(\mu^I_{1,..,N} - \mu^I_{1,..,N-1})}{h - d(1-\mu^I_{1,..,N} + \mu^I_{1,..,N-1})} \quad \Longleftrightarrow \quad \theta > \frac{d\tilde{\mu}^I_1}{h - d(1-\tilde{\mu}^I_1)}$$

where $\tilde{\mu}^I_n = \mu^I_{n,..,N} - \mu^I_{n,..,N-1} = (1-\mu^I_n)(1-\mu^I_{n+1})\cdots(1-\mu^I_{N-1})\mu^I_N$ is the probability of the innocent defendant accepts $x = d$ at period $n = N$. Then $\frac{d\tilde{\mu}^I_n}{h-d(1-\tilde{\mu}^I_n)} = \underset{\sim}{\theta}^N$, therefore, if $\theta \leq \underset{\sim}{\theta}^N$ the prosecutor is better off no deviating.

Note that deviations after first period are also not profitable, because the prosecutor deviates at n if $\theta^{(n)} > \frac{d\tilde{\mu}^I_n}{h-d(1-\tilde{\mu}^I_n)}$, and note that $\underset{\sim}{\theta}^N < \frac{d\tilde{\mu}^I_n}{h-d(1-\tilde{\mu}^I_n)}$ because $\tilde{\mu}^I_1 < \tilde{\mu}^I_n$, therefore the prosecutor does not deviates for $\theta \leq \underset{\sim}{\theta}^N$.

For $\mu_N^I \in [\frac{c}{d+c}, 1]$: If the prosecutor one-shot deviates at period n, her payoff will be:

$$\theta\Big((1 - q^{\frac{1}{N}})h + q^{\frac{1}{N}}d\Big) + (1-\theta)\Big((1 - q^{\frac{1}{N}})\Big(d\mu_{1,..,N}^I - c(1 - \mu_{1,..,N}^I)\Big) + q^{\frac{1}{N}}d\mu_{1,..,N}^I\Big)$$

In this case the prosecutor offers $x = d$ in every period, including period $n = N$, even if she gets $y = e$.

The prosecutor is not going to deviate after period $n = 1$ because if the game has not ended, it is because the defendant is innocent. Therefore, investigating is a strictly dominated strategy.

The prosecutor is better off deviating if:

$$\theta > \frac{(1 - \mu_{1,..,N}^I)c}{h - d + (1 - \mu_{1,..,N}^I)c}$$

Note $\frac{(1-\mu_{1,..,N}^I)c}{h-d+(1-\mu_{1,..,N}^I)c} = \underset{\sim}{\theta}^N$, therefore, if $\theta \leq \underset{\sim}{\theta}^N$ the prosecutor is better off no deviating.

Lemma 3. For values of $\theta > \underline{\theta}^{\text{Public}}$, the proof of Lemma 3 is the same than the proof of Proposition 2 and 3. For $\theta < \underline{\theta}^{\text{Public}}$, the prosecutor payoff is $v^P = d$. If the prosecutor deviates at any period $n \in [1, N]$, the defendant is going to observe it and therefore her payoff is going to be:

$$\theta\Big((1 - q^{\frac{1}{N}})h + q^{\frac{1}{N}}dq^{\frac{1}{N}}\Big) + (1-\theta)dq^{\frac{1}{N}}$$

The best strategy for the prosecutor is to disclose $y = h$ and to hide $y = e$. On the other hand, the innocent defendant's continuation loss if there is only one investigation is $q^{\frac{1}{N}}d$.

The prosecutor is better off deviating if: $\theta > \frac{d}{h-dq^{\frac{1}{N}}}$. However $\frac{d}{h-dq^{\frac{1}{N}}} > \frac{d}{h-dq}$, therefore the prosecutor does not deviate.