2-2020

Credibility of Crime Allegations

Frances Xu Lee
Loyola University Chicago, flee3@luc.edu

Wing Suen

Recommended Citation

Xu Lee, Frances and Suen, Wing. Credibility of Crime Allegations. American Economic Journal: Microeconomics, 12, 1: 220-259, 2020. Retrieved from Loyola eCommons, School of Business: Faculty Publications and Other Works, http://dx.doi.org/10.1257/mic.20180231

American Economic Journal: Microeconomics 2020, 12(1): 220–259
https://doi.org/10.1257/mic.20180231

Credibility of Crime Allegations†

By Frances Xu Lee and Wing Suen*

The lack of hard evidence in allegations about sexual misconduct makes it difficult to separate true allegations from false ones. We provide a model in which victims and potential libelers face the same costs and benefits from making an allegation, but the tendency for perpetrators of sexual misconduct to engage in repeat offenses allows semiseparation to occur, which lends credibility to such allegations. Our model also explains why reports about sexual misconduct are often delayed, and why the public rationally assigns less credibility to these delayed reports. (*JEL* D82, J16, K14, K42)

Recent scandals of sexual crimes and misconduct have gripped the headlines and spawned a nascent movement to raise consciousness about a serious problem that used to be underreported. The stories of Bill Cosby, Larry Nassar, Harvey Weinstein, and many others share some striking similarities. First, the conduct involved mostly was not violent in nature, so that clear-cut hard evidence is lacking.[1] Second, the same person repeatedly offended multiple victims. Third, no arrest or prosecution was made upon the first allegation against the offender. Fourth, many allegations were made years after the alleged incidents.

The Bill Cosby trial stemmed from an allegation made by Andrea Constand in 2005 alleging that Bill Cosby, a comedian, drugged and raped her in 2004. This was the first public rape allegation against Cosby. No charge was brought against him at the time. Within the same year, three additional similar allegations against Cosby arose. Still, no arrest was made. A new wave of allegations surfaced in 2014 and 2015, with over 50 women alleging sexual crimes that happened from 1965 to 2008. Cosby was arrested and charged in 2015 and was convicted of three counts of aggravated indecent assault in 2018.[2]

*Lee: Loyola University Chicago, 16 E Pearson St., Chicago, IL 60611 (email: francesxu312@gmail.com); Suen: The University of Hong Kong, Pok Fu Lam, Hong Kong (email: wsuen@econ.hku.edu). Michael Ostrovsky was coeditor for this article. We are thankful for suggestions from Mariagiovanna Baccara, Navin Kartik, Harry Di Pei, Kathy Spier, Bruno Strulovic, and Abraham Wickelgren. We also have benefited from comments by workshop participants at University of Texas at Austin and Nanyang Technological University and by the audience at American Law and Economics Association Annual Meeting, Public Economic Theory Conference, Econometric Society Asian Meeting, Midwest Theory Conference, and AEA Annual Meeting.

†Go to https://doi.org/10.1257/mic.20180231 to visit the article page for additional materials and author disclosure statement(s) or to comment in the online discussion forum.

[1] According to End Violence Against Women's research, "most sexual assaults are committed by someone who is known to the victim, who does not use a weapon or severe physical violence, and who does not inflict visible injuries on the victim." See http://www.evawintl.org/Library/DocumentLibraryHandler.ashx?id=42.

[2] Details of this case were widely reported in newspapers. We obtained our sources mostly from the Wikipedia article "Bill Cosby Sexual Assault Allegations."

The Jerry Sandusky sexual abuse case is another notable example. Over a hundred incidents of abuse of children were alleged over time against the former football coach, but the first report in 2008 was met with disbelief. The state attorney general told the accuser in 2008 that the authorities needed more victims to charge Sandusky—that is, to overcome the grand jury's doubt of a possibly false accusation. Sandusky was not arrested until the second report came from a witness in 2010, reporting an incident that happened more than ten years before.[3]

An estimated 64 to 96 percent of sexual crime victims do not report the crimes committed against them (Fisher et al. 2000, Perkins and Klaus 1996). A major reason for this reluctance to report is that victims think their reports will be met with suspicion or outright disbelief (Jordan 2004). When the crimes do not produce hard evidence, there is a classic asymmetric information problem: a true victim cannot easily separate himself or herself from a libeler who makes a false accusation. A libeler can be motivated by a grudge, political motives, publicity, or potential financial gains. In 2006, three Duke athletes were accused of sexual assault, which was later found baseless. In 2014, *Rolling Stone* published an article, "A Rape on Campus," accusing several University of Virginia students of gang rape. The magazine had to retract the article in its entirety because the rape allegation was discredited. But not all false reporting is eventually rebuked. For allegations that do not present enough winning probability for the prosecutor to bring charges, there is no judgment from the jury whether or not they are true. No wonder so-called estimates of the percentage of false accusations among all reports range widely from 1.5 to 90 percent in the empirical literature (Lonsway, Archambault, and Lisak 2009).

While the percentage of false accusations is unclear, the potential of a report being false has to be the reason why sexual crime reports are not assigned a perfect credibility. Absent the possible existence of false accusers, the authorities would simply bring all cases to court, and the jury would always be able to convict beyond doubt. This is clearly not the reality. Tom Tremblay, an investigator in the sex crimes unit in Burlington, Vermont, said, "unlike any other crime I responded to in my career, there was always this thought that a rape report was a false report."[4] Understanding the circumstances that lend credibility to sexual crime allegations is important in the fight against these crimes.

This article studies the incentives to allege a crime by victims or by potential libelers in a two-period setup. There may be multiple potential accusers who can make public but unverifiable reports against the same person. These accusers can choose whether or not to report, as well as when to report. We aim to address three major questions regarding these allegations. First, allegations of sexual crimes are often made of incidents that happened a long time ago, which we call *delayed reports*. These delayed reports can come from victims who are delaying to report a true crime, as demonstrated by the Sandusky case, or from libelers who are choosing

[3] Joseph Rhee, Gerry Wagschal, and Linh Tran, "Sandusky Victim 1 Steps Out of Shadows, Says Justice Took Too Long," *ABC News*, October 19, 2012, https://abcnews.go.com/US/sandusky-victim-reveals-identity-justice-long/story?id=17511612.

[4] Rebecca Ruiz, "Why Don't Cops Believe Rape Victims? Brain Science Helps Explain the Problem—and Solve It," *Slate*, June 19, 2013, https://slate.com/news-and-politics/2013/06/why-cops-dont-believe-rape-victims-and-how-brain-science-can-solve-the-problem.html.

to make false accusations long after the time of interaction with the accused. Why do delayed reports appear so often? Second, given the possibility of false accusations, how much credence should be given to allegations that are unsubstantiated by witnesses or physical evidence? Third, a delayed report is typically met with suspicion. For example, in October 2016, supporters of Donald Trump had started the hashtag #NextFakeTrumpVictim by attacking the sexual assault allegations against Trump with tweets that read, for example, "Why didn't these 'victims' come forward 30 years ago? Could've scored a hefty sum from a billionaire." Is such skepticism justified?

A key to our analysis is that sexual crimes are often committed by recidivists, who have a tendency to engage in repeat offenses against other victims. According to the Rape, Abuse, and Incest National Network (RAINN), more than half of all alleged rapists have at least one prior conviction. Taking into account the low reporting rate and the low conviction rate,[5] this statistic suggests a strong tendency for rapists to engage in repeat offenses. In addition, the medical literature suggests that "pedophilia is a sexual orientation and unlikely to change."[6] In this paper, we assume that a true victim expects a higher chance that another victim exists who may provide corroboration than a potential libeler does.

The possibility of the existence of another victim or another potential libeler produces a freeriding problem. Because a single accusation is often insufficient evidence to cause the authorities to take action, individuals have an incentive to take a wait-and-see approach and delay making an allegation until another allegation arises. In our basic model, an individual with relatively low reporting cost always reports immediately, whereas an individual with higher reporting cost makes a delayed report if and only if there is another report against the accused.[7]

On the surface, given that there is a higher chance of having a corroborator for a victim than for a libeler, one might suspect that a victim is more inclined to wait for others to report first in order to delay the cost of making an allegation. We argue that this reasoning is not correct, because it assumes that the potential corroborator's reporting behavior is not affected by the history he or she observes. In fact, the potential corroborator (past or future victim) is more likely to report if there has been a previous report, so the higher incentive to "break the silence" and encourage the potential corroborator to report dominates the motive to delay reporting costs for individuals with low reporting costs. This dynamic *encouragement effect* works in the opposite direction of the standard freeriding effect in public goods provision. Because guilty agents have a higher tendency of recidivism than do innocent ones, the encouragement effect figures more prominently for true victims than for potential libelers. This effect causes true victims to be less inclined to make a delayed report than are potential libelers. The fact that true victims tend to make timely crime allegations with a higher probability in turn lends credence to such allegations, allowing a semiseparating equilibrium to exist even when true victims and

[5] RAINN estimates that only 310 out of 1,000 rape cases are reported, out of which 11 will get referred to prosecutors and 7 will result in a felony conviction.

[6] Harvard Medical School, "Pessimism about Pedophilia," *Harvard Mental Health Letter*, July 2010, https://www.health.harvard.edu/newsletter_article/pessimism-about-pedophilia.

[7] This potential freeriding incentive is called a "first mover disadvantage" in Ayres and Unkovic (2012).

potential libelers face the same costs and benefits from making an allegation. In other words, even though allegations are unsubstantiated by hard evidence, they do contain information that may prompt the authorities into taking action.[8]

Our model also justifies the public's skepticism toward delayed reports. If there is another allegation against a person, victims or libelers who took a wait-and-see approach will no longer shy from making an allegation because corroborated reports are more convincing than a single report. But because libelers have a greater probability of taking a wait-and-see approach than victims do, the public rationally assigns less credibility to delayed reports than to undelayed ones. The public is rightly skeptical because delayed reports are more likely to have been made "opportunistically."

The communication game described in this article is different from a cheap talk game (Crawford and Sobel 1982). Here the action of reporting carries a cost, whereas the action of not reporting does not. Reporting is directly costly for many reasons. Reporters often have to reveal facts about themselves that are not positive, such as the use of drugs and alcohol, which can lead to social stigma, suspension from school, or loss of scholarships.[9] Reporters face possible retaliation from the accused. Investigations are emotionally and physically exhausting. The easier thing to do is stay silent.

In order to highlight the difficulties in separating truthful allegations from fake ones, we purposefully avoid the traditional channel of signaling arising from payoff differences. Both a true victim and a potential libeler in our model have the same costs of reporting and the same payoffs from the authorities' decisions.[10] In this sense, our model is different from a standard signaling game (Spence 1973). In our model, different types (victim or libeler) would behave in exactly the same way if they are sure that another victim or libeler does not exist. It is the assumption that victims and libelers expect different probabilities that another accuser may exist that causes their equilibrium strategies to be different.

Farrell and Saloner (1985) studies the adoption of technology standards or political positions with network benefits, where a player benefits from waiting to see what the other player chooses as the standard or the position. Ostrovsky and Schwarz (2005) considers synchronization of timing in this framework, in which early arrival and late adoption are both costly. In that setup, players simultaneously choose an adoption time with some stochastic error; there is no encouragement effect because the move of one player is not observable by other players. Daughety and Reinganum (2011) studies a dynamic model of victims choosing when to file a lawsuit against a common defendant, where a plaintiff is more likely to win if more victims sue. In our paper, given the beliefs of the decision maker in a corroboration equilibrium, the two victims play a game that is similar to those in Farrell and Saloner (1985)

[8] This information comes from equilibrium inference, which may not constitute evidence that is admissible in court. However, it may be sufficient to induce the authorities to conduct further investigations that lead to arrest or prosecution.

[9] An accuser of rape at Brigham Young University was suspended because of the revelation that she used illegal drugs. (Jack Healy, "At Brigham Young, A Cost in Reporting a Rape," *New York Times*, April 26, 2016, https://www.nytimes.com/2016/04/27/us/rape-victims-brigham-young-university-honor-code-suspensions.html).

[10] In Chandrasekhar, Golub, and Yang (2018), different types have the same costs and benefits from taking a signaling action (asking for help), and partial separation is achieved in equilibrium because the distribution of benefits is different for different types.

and Daughety and Reinganum (2011): relative to the status quo, an action brings a benefit if coordination succeeds and a cost otherwise. In Farrell and Saloner (1985), there is no uncertainty about the existence of the other player. Closer to our paper, the plaintiffs in Daughety and Reinganum (2011) also have the trade-off between taking a costly action to encourage others and waiting to observe whether others are present. The coordination benefits for the victims as well as the libelers in our paper are endogenously determined through the reports' credibility, which in turn depends on the decision maker's equilibrium Bayesian inferences about different behaviors of the victims and the libelers. Two reports in our model are not necessarily more credible than one report: equilibriums with coordination benefit may not exist. In contrast, in Farrell and Saloner (1985) and Daughety and Reingamum (2011), the coordination benefit is exogenously assumed.

Pei and Strulovici (2019), a recent working paper, also studies the credibility of allegations with no hard evidence. It focuses on the incentive of a strategic criminal to commit crime on multiple potential victims. The victims and nonvictims all choose whether or not to report simultaneously, so an allegation cannot be delayed in their setup. A nonvictim (who may have a libeling incentive) in that setup thinks that it is likely that there are other victims, while a victim thinks that it is less likely that there are other victims because it is in the interest of the criminal to refrain from abusing widely to avoid multiple allegations. So, contrary to our setting, that libeler believes the chance of having a corroborator to be *bigger* than a true victim believes. Because of this, the crime allegation becomes arbitrarily uninformative as the punishment level for the criminal goes up.

This article is also related to Chassang and Miquel (2014), a study of unverifiable reporting by whistle-blowers. That study takes a mechanism design approach, in which the cost of reporting arises endogenously as retaliation from the accused. In that model there is a single monitor who may potentially report on inappropriate behavior of an agent. Our article focuses more on the incentive issues that arise when more than one victim (or more than one libeler) can make allegations against the same agent in a dynamic setting. We adopt a reduced-form approach by taking the distribution of reporting costs as given, but there is discounting in reporting costs if accusers make delayed reports. For sexual harassment in the workplace, the exogenous reporting costs in our model may reflect the possibility of retaliation by the accused or by the employer,[11] and these costs can be substantially lower if the accuser has left the firm by the time he or she makes a delayed report.

Chamley and Gale (1994) studies a model of endogenous delay in a framework in which there is informational externality but no payoff externality. That paper shows that potential investors may delay their projects in the hope of learning about the existence of other potential investors. The model exhibits clustering in investment decisions, similar to the appearance of follow-on reports after the first allegation is made in our model. In our model of allegations about sexual crimes, the externality involved is a direct payoff externality coming from the possibility of corroboration. Delay may also occur in the investment game in Gale

[11] In a sample of 86 state workers studied in Loy and Stewart (1984), 62 percent reported retaliation by their employers following their responses to harassment.

(1995), because the benefit of investing increases in the number of investors, and investing early before the others is money losing initially. Gale (1995) finds that in some equilibrium there is an encouragement effect: investing early encourages others to invest. The literature on the dynamic provision of public goods (e.g., Fershtman and Nitzan 1991, Marx and Matthews 2000) also focuses on payoff externalities, but the existence of other players is not taken to be uncertain in that literature or in Gale (1995). Furthermore, our article analyzes how the endogenous timing of reporting behavior affects the credibility of these reports, which is not an issue in the dynamic public goods provision problem.

In Section I of the article, we lay out the setup of our signaling game. Section II analyzes the equilibrium we are most interested in—a corroboration equilibrium in which multiple reports may happen on the equilibrium path and some reports may be delayed. We provide a brief discussion of other types of equilibria in Section III. In Section IV, we extend the basic model in different ways and discuss how these modifications affect the analysis and our main conclusions. Our formal model provides a framework to study a recently developed reporting system of sexual crimes: the online *information escrow* (Ayres and Unkovic 2012). Such an analysis is developed in Section V of the article. An information escrow allows people to place allegations into an escrow on the condition that the allegations are transferred to the authorities if and only if a prespecified number of allegations are lodged against the same person. A system, using a prespecified number of two, called the "Callisto reporting system," has been developed into operation and was adopted by eight universities by 2017.[12] The basic idea is that information escrows can remove victims' incentive to wait for corroboration. We point out, however, that the credibility of two reports from a Callisto system is lower than the credibility of two reports outside a Callisto system. Depending on the standard of credibility expected by the authorities to take action, forcing all reports to go through the Callisto system may sometimes cause victims to be less forthcoming in reporting crimes than without the Callisto system.

I. The Model

An agent A is active for two periods. Agent A can be of two types: "guilty" or "innocent." The prior probability that A is a guilty type is μ_0. With probability $1 - \mu_0$, A is innocent. Guilty A hurts a person (and therefore breaks the law) with some probability in each period. We call the victim harmed in the first period V_1 and the victim harmed in the second period V_2. If A is innocent, a potential libeler holding a grudge against A appears with some probability in each period. We call the potential libeler who emerged in the first period L_1 and the one who emerged in the second period L_2. In the basic model the behavior of A is nonstrategic.[13] The focus of our analysis is the behavior of victims and

[12] Further information about this system is available at https://www.projectcallisto.org.

[13] In Section IVC, we discuss the case where the guilty agent strategically chooses whether or not to commit a crime in each period and the innocent one strategically chooses whether or not to exercise caution to avoid being libeled. The qualitative results remain the same.

potential libelers. The existence of victims and the existence of potential libelers are mutually exclusive in the basic model.[14] Table 1 shows the probability of existence of victims and potential libelers given the two states.

Table 1—Probability of Different Scenarios of Existence of Victims and Potential Libelers

	Guilty A			Innocent A	
	V_1	No V_1		L_1	No L_1
V_2	$p\lambda_v$	$(1-p)\lambda_v$	L_2	$q\lambda_l$	$(1-q)\lambda_l$
No V_2	$(1-p)\lambda_v$	$1-(2-p)\lambda_v$	No L_2	$(1-q)\lambda_l$	$1-(2-q)\lambda_l$

The entry in each cell represents the probability of the corresponding combination. All parameters—p, q, λ_v, and λ_l—are between 0 and 1. For example, if A is guilty, the probability that both V_1 and V_2 exist is $p\lambda_v$. Note that the marginal probability that V_1 exists is λ_v, and the marginal probability that V_2 exists is also λ_v. Each victim knows that she is hurt by the guilty agent A. On the basis of this knowledge, she assigns conditional probability p that another victim exists in the other period. A higher value of p indicates a higher degree of correlation across the two periods. As we mention in the introduction, many sexual crimes are perpetrated by repeat offenders.[15] On the other hand, if an innocent agent inadvertently offends another person, there is no presumption that this will happen again in the next period. We capture this difference by the following crucial assumption.

ASSUMPTION 1: $p > q$.

Suppose A is a guilty type. If V_1 and V_2 do not exist, then nothing happens. Because crimes are perpetrated in secrecy (unless there is a report of the crime), the victim does not know whether A had committed a similar crime before, nor whether A will commit a similar crime in the future. We capture this uncertainty by assuming that V_t (for $t = 1,2$) does not know whether she lives in period 1 or period 2. Ex ante, she assigns probability $1/2$ to each of these two possibilities.[16]

A victim derives utility from getting A arrested. We normalize this payoff to 1. However, reporting a crime is costly. We denote the cost of reporting by c and assume that it is an independent draw from the uniform distribution on $[0,1]$. A victim knows her own cost c, but outsiders do not observe her cost. The victim applies a discount factor $\delta \leq 1$ to benefits that are obtained or costs that are incurred a period later. All reports are public.

[14] A more natural story is to let a guilty agent face both victims and potential libelers and an innocent one face only potential libelers. In Section IVB, we show that this difference between the guilty and the innocent alone can generate credibility of a report.

[15] Groth, Longo, and McFadin (1982) finds that the majority of sexual crime offenders had been convicted more than once for a sexual assault. Moreover, on average, they admitted to having committed two to five times as many sex crimes for which they were not apprehended.

[16] Alternatively, we can allow each victim to know whether she is harmed in period 1 or period 2, which will not change the main results. We maintain the uncertain timing assumption in our basic model for its realism and its simpler notations. The case of known timing is briefly discussed in Appendix B.

Victim V_1 is harmed by A in period 1 (although she does not know that she lives in period 1). She can lodge a public allegation once, either in period 1 or in period 2. First, she can report the crime immediately in period 1. Let $\alpha(c)$ represent the probability that she chooses to immediately report the crime, and let $a \equiv E[\alpha(c)]$, where the expectation is taken over possible realizations of c. Thus, a is the ex ante probability that a victim will immediately report a crime in the absence of a prior report against agent A. Second, if V_1 does not report in period 1, she can lodge a delayed report at the end of period 2, after learning whether or not another victim has made an allegation against A. We let $\hat{\alpha}_1(c)$ represent the probability that V_1 lodges a delayed report in period 2 if she has learned that another complaint has been made, and let $\tilde{\alpha}_1(c)$ represent the probability that she lodges a delayed report in period 2 if no other victim has made a complaint.

Victim V_2 is harmed in period 2. She can lodge a complaint in period 2. If no one has accused A before, then V_2 does not know whether she is V_1 or V_2. In this case, her strategy is the same as that of V_1 in period 1, i.e., she reports the crime immediately with probability $\alpha(c)$, but she will have no chance to lodge a delayed report because she lives in the last period.[17] If someone has lodged a complaint against A, then V_2 observes this report and knows that she lives in period 2. We use $\hat{\alpha}_2(c)$ to represent the probability that V_2 complains against A, knowing that there is a prior allegation against him.

Potential libelers (if they exist) hold a grudge against an innocent agent A. They derive a payoff of 1 from getting A arrested. Their costs of lodging a complaint are independent draws from the uniform distribution on $[0, 1]$, and their discount factor is the same δ as used by the victims. In other words, the payoff structure for potential libelers is identical to that for true victims. A priori, it is not obvious whether the costs and benefits of making an allegation are higher or lower for potential libelers than for true victims. We make the assumption that their payoffs are identical to highlight the difficulty of making inferences when there are no systematic differences in payoffs.[18] For convenience, we sometimes refer to potential libelers simply as libelers, even though they may not choose to make an allegation in equilibrium.

The information structure for libelers mirrors that for victims. If no prior complaint has been filed against A, a libeler does not know whether she is L_1 or L_2, and she lodges a complaint immediately with probability $\beta(c)$. We define $b \equiv E[\beta(c)]$. All other notations parallel those for victims: L_1 files a delayed report with probability $\hat{\beta}_1(c)$ after L_2's complaint; L_1 files a delayed report with probability $\tilde{\beta}_1(c)$ if L_2 does not file a complaint; and L_2 files a complaint with probability $\hat{\beta}_2(c)$ after L_1's complaint. The only difference in the information between a libeler and a victim is that the former knows A is innocent, whereas the latter knows A is guilty.

If a report alleges that a crime happened in the same period, we call it an *undelayed report*. If a report alleges that a crime happened a period earlier, we call it a delayed report. The decision maker (the police authorities, for example) initially also does not know which period she is in, and assigns prior probability $1/2$ to either possibility. If no one makes a complaint against A (we denote this event by ϕ), the

[17] For example, we may assume that the whereabouts of agent A are no longer traceable after period 2.

[18] In Section IVD, we show that such differences, if they exist, would lead to predicable outcomes.

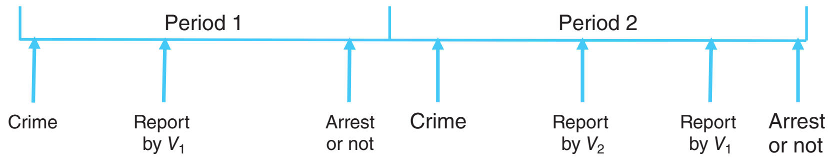

Figure 1. The Timeline When A Is Guilty

Notes: This figure shows the case in which A strikes a victim in each period. If there is no crime, there is no reporting decision. If there is no report, there is no arrest decision.

decision maker cannot arrest A. Whether a report is delayed or not is observable to the decision maker. She decides whether or not to arrest agent A after the following observable outcomes: (i) there was only one undelayed report in the current period (event r), (ii) there was only one delayed report in the current period (denoted R), (iii) there was only one undelayed report in the previous period and no report in the current period (event $r\phi$), (iv) there was one undelayed report in the previous period and another undelayed report in the current period (event rr), and (v) there was one undelayed report in the current period followed by one delayed report (event rR). For $\mathcal{E} \in \{r, R, r\phi, rr, rR\}$, let $\mu(\mathcal{E})$ represent the decision maker's posterior belief that A is a guilty type conditional on event $\mathcal{E}$. For simplicity, we just assume that the decision maker is bound to arrest A as soon as $\mu(\mathcal{E})$ is greater than or equal to some threshold standard $\hat{\mu}$, which is taken to be exogenous.[19] The game ends at the end of period 2 or whenever A is arrested. When the game moves on to the second period, if a victim or a libeler finds that she can still report after a period has passed, she basically knows that she is in period 2. Similarly, if a decision maker finds that she can still make an arrest after a period has passed, she knows that she is in period 2.

The timing of the game when A is guilty is illustrated in Figure 1. The timing of the game when A is innocent is the same, with V_t replaced by L_t for $t = 1, 2$.

II. Corroboration Equilibrium with Occasional Delay

In this section, we focus on an equilibrium in which events rr and rR both appear with positive probability on the equilibrium path; that is, it is possible to observe multiple allegations against the same agent, and sometimes these allegations are delayed. In such an equilibrium, both rr and rR lead to an arrest; otherwise, they will not appear in equilibrium. Moreover, the events r or $r\phi$ will not lead to an arrest, because if they do, then no one will follow up with a report.

In other words, we look for an equilibrium in which A is arrested if and only if there are two allegations against him. We refer to this type of equilibrium as a "corroboration equilibrium with occasional delay," or simply a *corroboration equilibrium*.

[19] The threshold standard can be determined by the decision maker's costs of making type I and type II errors.

Let $\ell(\mathcal{E})$ represent the likelihood ratio of event $\mathcal{E}$ (given the guilty type relative to the innocent type). For any fixed prior μ_0, there is a monotone relationship between $\mu(\mathcal{E})$ and $\ell(\mathcal{E})$. Thus, one can also say that the decision rule of the authorities is to arrest A if and only if $\ell(\mathcal{E}) \geq \hat{\ell}$, where $\hat{\ell} = \hat{\mu}(1-\mu_0)/(\mu_0(1-\hat{\mu}))$. We sometimes refer to $\hat{\ell}$ as the *standard of proof*. The existence of a corroboration equilibrium requires $\ell(rr)$ and $\ell(rR)$ to be greater than or equal to the standard of proof $\hat{\ell}$, and $\ell(r)$, $\ell(R)$, and $\ell(r\phi)$ to be less than $\hat{\ell}$. We proceed by assuming these conditions and then verify that they indeed hold in equilibrium.

Given the assumed conditions of the likelihood ratios described above, a silent victim V_1 who observes another person lodging a report against A in period 2 will surely lodge a delayed complaint, because doing so gives a payoff of 1 at a cost $c \leq 1$. Therefore, $\hat{\alpha}_1(c) = 1$ for any c. Similarly, a victim V_2 who knows of a prior complaint against A will also lodge a complaint upon being hurt. Therefore, $\hat{\alpha}_2(c) = 1$ for any c. On the other hand, a silent victim V_1 has no incentive to report against A at the end of period 2 if no other victim has come forward. Therefore, $\tilde{\alpha}_1(c) = 0$ for any c. The payoff structure of libelers is identical to the payoff structure of true victims. Thus, $\hat{\beta}_1(c) = \hat{\beta}_2(c) = 1$ and $\tilde{\beta}_1(c) = 0$ for any c.

Consider now a victim of A who is just harmed in the current period and has not seen a prior accusation against A. For convenience, we label her a *new victim* (even though she may be the second victim if the first one did not report). A new victim can entertain three possibilities:

(i) Another victim does not exist. The probability of this event (conditional on her knowledge of her own existence) is $(1-p)\lambda_v/\lambda_v = 1-p$.

(ii) She is V_1, and another victim V_2 exists in period 2. The probability (conditional on her knowledge of her own existence) is $(1/2)p\lambda_v/\lambda_v = (1/2)p$.

(iii) She is V_2, and another victim V_1 exists but did not report. The probability (conditional on her knowledge of her own existence) is $(1/2)p\lambda_v(1-a)/\lambda_v = (1/2)p(1-a)$.

The sum of these probabilities is $1-(1/2)pa$.

In the first eventuality, one report is not sufficient to arrest A because $\ell(r) < \hat{\ell}$. Therefore, reporting immediately is futile (i.e., the payoff is 0). In the second eventuality, reporting immediately will encourage the future victim V_2 to report because $\hat{\alpha}_2(c) = 1$. The discounted benefit is δ. In the third eventuality, reporting immediately will cause the past victim V_1 to come forward with a delayed report because $\hat{\alpha}_1(c) = 1$. This leads to the arrest of A in the same period, with a payoff of 1. Therefore, if the new victim has reporting cost c, the expected net payoff from reporting immediately is

$$(1) \qquad \frac{1-p}{1-(1/2)pa}[-c] + \frac{(1/2)p}{1-(1/2)pa}[\delta - c] + \frac{(1/2)p(1-a)}{1-(1/2)pa}[1-c].$$

If the new victim does not report immediately, then only in the second eventuality can she follow up with a delayed report provided that V_2 makes a complaint against A. The probability that V_2 will make a complaint conditional on this eventuality is a, and the discounted net benefit is $\delta(1 - c)$. Therefore, the expected net payoff from not reporting immediately is

$$(2) \qquad \frac{1-p}{1-(1/2)pa}[0] + \frac{(1/2)p}{1-(1/2)pa}\left[a\delta(1-c)\right] + \frac{(1/2)p(1-a)}{1-(1/2)pa}[0].$$

Let $f(c,a;p)$ represent the payoff difference between reporting immediately and not reporting immediately for a new victim, given that other victims are adopting the strategies $\hat{\alpha}_1(c) = 1$, $\hat{\alpha}_2(c) = 1$, $\tilde{\alpha}_1(c) = 0$, and $E[\alpha(c)] = a$:

$$(3) \quad f(c,a;p) = \frac{1-p}{1-(1/2)pa}[-c] + \frac{(1/2)p}{1-(1/2)pa}\left[\delta - c - a\delta(1-c)\right] + \frac{(1/2)p(1-a)}{1-(1/2)pa}[1-c].$$

For any a and p, $f(\cdot\,,a;p)$ is strictly decreasing, with $f(0,a;p) > 0 > f(1,a;p)$. Therefore, there exists $\hat{c}(a,p)$ satisfying $f(\hat{c}(a,p),a;p) = 0$ such that the best response is to report immediately (i.e., choose $\alpha(c) = 1$) if and only if $c \leq \hat{c}(a,p)$. Because $a = E[\alpha(c)]$ and the distribution of c is uniform, equilibrium requires $\hat{c}(a^*,p) = a^*$.

In a similar fashion, the payoff difference between reporting immediately and not reporting immediately for a *new libeler* (i.e., a libeler who does not observe a prior report against A) is $f(c,b;q)$. Equilibrium requires that $f(b^*,b^*;q) = 0$, with the new libeler choosing $\beta(c) = 1$ if and only if $c \leq b^*$.

Before contrasting the behavior of a new victim and a new libeler, we will first point out two important incentives reflected in the net benefit function $f(c,a;p)$: strategic substitution and the encouragement effect.

LEMMA 1 (Strategic Substitution): *The net benefit $f(c,a;p)$ of reporting immediately is decreasing in a.*

If other new victims are more likely to report immediately (a increases), then a new victim is less likely to do so ($\hat{c}(a,p)$ decreases). This strategic substitution in reporting immediately among new victims (or new libelers) reflects the public good nature of crime allegations when a single report is not sufficient to lead to arrest. Each victim who has not observed an allegation against A has an incentive to take a wait-and-see approach. First, if another report later comes to surface, the new victim can reduce the cost by lodging a delayed report, which is beneficial when $\delta < 1$. Second, if the other victim does not even exist, the new victim can eliminate the cost of making a futile report. The new victim assigns a higher probability to the nonexistence of the other victim when a is higher. The downside of this wait-and-see approach for a new victim is that A may not be arrested if (i) the new victim is V_2 and V_1 did not report, or (ii) the new victim is V_1 and V_2 does not choose to be the first one to report. Both of these two events are less likely when a is higher, so the downside risk is believed to be smaller when a is higher, which explains the strategic substitution effect.

LEMMA 2 (Encouragement Effect): *The net benefit* $f(c,a;p)$ *of reporting immediately is increasing in* p.

It may appear that the freeriding problem[20] is more severe when the other victim is more likely to exist—in equation (2) the payoff from not reporting is increasing in p. However, freeriding is not the only incentive in our setting, as the model also exhibits complementarity between the possibly two victims through an encouragement effect. First, if a new victim is V_1, and if V_2 exists, then by reporting immediately the new victim raises the probability that the future victim V_2 will report the crime from $E[\alpha(c)] = a$ to $\hat{\alpha}_2(c) = 1$. Second, if a new victim is V_2, but V_1 did not report, then by reporting immediately the new victim raises the probability that V_1 will make a delayed follow-on report from $\tilde{\alpha}_1(c) = 0$ to $\hat{\alpha}_1(c) = 1$. These two effects imply that the payoff of reporting immediately in equation (1) increases in p. Lemma 2 shows that the impact of p on equation (1) dominates the impact on equation (2); so, taken together, a higher chance of the existence of another victim gives more incentive for a new victim to report immediately. The intuition can be understood by considering the extreme case when $\delta = 1$. When reporting early, one is sure to encourage the future victim if that victim exists. When reporting late, one can only freeride on the future victim if that victim exists and also reports. The chance of the latter is clearly smaller because the future victim is willing to lead only if her cost of reporting is small enough but is always willing to follow.

The proofs of Lemmas 1 and 2 are provided in Appendix A. Note that these results are generally valid for any distribution of reporting cost. Lemmas 1 and 2 also apply to the incentive of new libelers. Moreover, Lemma 2 implies that the encouragement effect is stronger for new victims than for new libelers because p is greater than q. This leads to the following result.

PROPOSITION 1: *In a corroboration equilibrium, new victims report immediately against A with a strictly higher probability than do new libelers. Moreover,* a^* *increases in* p *and* δ, *and* b^* *increases in* q *and* δ.

PROOF:

In a corroboration equilibrium, a^* satisfies $F(a^*;p) = 0$, where

$$(4) \quad F(a;p) \equiv f(a,a;p) = \frac{1/2}{1-(1/2)pa}\left[-a(2-pa) + p\delta\big(1-a(1-a)\big) + p(1-a)\right].$$

[20] When freeriding on the other accuser, one eventually still needs to file a report to corroborate if the other reports, but filing later saves expected reporting costs.

Since $f(c,a;p)$ is decreasing in a (Lemma 1) and in c, $F(a;p)$ is decreasing in a. Also, $F(0;p) > 0 > F(1;p)$. Hence, there exists a unique $a^* \in (0,1)$ such that $F(a^*;p) = 0$. Lemma 2 implies that $F(a;p)$ increases in p. By the implicit function theorem, an increase in p raises a^*. Because the equilibrium b^* satisfies $F(b^*;q) = 0, p > q$ implies $a^* > b^*$. Finally, because $F(a;p)$ increases in δ, a^* is increasing in δ. Likewise, b^* is increasing in δ. ∎

The fact that $a^* > b^*$ in a corroboration equilibrium lends credibility to allegations about sexual crimes. If victims and libelers report with equal probability, the likelihood ratio of an undelayed report (event r) would be simply λ_v/λ_l. We can take λ_v/λ_l to be the "face value" of a crime allegation. However, Proposition 1 implies that the likelihood ratio in the event of an undelayed report is $\lambda_v a^*/(\lambda_l b^*) > \lambda_v/\lambda_l$. The additional credibility is the result of equilibrium inference, coming from the reasoning that true victims are more likely to make an undelayed report than libelers are. Furthermore, we also have the following result.

PROPOSITION 2: *In a corroboration equilibrium, two undelayed reports against A are assigned a greater credibility than one undelayed report corroborated by a delayed report.*

PROOF:

Suppose agent A is guilty. The event $\mathcal{E} = rR$ is observed only when both V_1 and V_2 exist, V_1 has cost above a^*, and V_2 has cost below a^*. The probability of this event is $p\lambda_v a^*(1-a^*)$, and the likelihood ratio is $\ell(rR) = p\lambda_v a^*(1-a^*)/(q\lambda_l b^*(1-b^*))$. The event $\mathcal{E} = rr$ is observed only when both V_1 and V_2 exist, and V_1 has cost below a^* (V_2 will always report when V_1 has reported in the earlier period). The likelihood ratio is $\ell(rr) = p\lambda_v a^*/(q\lambda_l b^*)$. By Proposition 1, $a^* > b^*$, which implies $\ell(rr) > \ell(rR)$. ∎

Proposition 2 is consistent with common attacks on the credibility of accusations that surface long after the alleged crimes. In a corroboration equilibrium, true victims are more likely than libelers to lodge an undelayed complaint against A if there is no prior complaint against him, but everyone (true victim or not) can secure an arrest of A if there is already a prior complaint. Because libelers are more likely to take a wait-and-see approach, the public rationally believes that delayed reports are more likely to be "opportunistic" and assigns less credibility to them.

PROPOSITION 3: *A corroboration equilibrium exists if and only if*

$$\hat{\ell} \in (\underline{\ell}^*, \overline{\ell}^*] \equiv \left(\frac{\lambda_v(2-p)a^*}{\lambda_l(2-q)b^*}, \frac{p\lambda_v a^*(1-a^*)}{q\lambda_l b^*(1-b^*)}\right].$$

Moreover, there exists $\bar{p}(\delta)$, *which is decreasing in* δ *and greater than* $2/3$, *such that the range* $(\underline{\ell}^*, \overline{\ell}^*]$ *is nonempty for all* $p \leq \bar{p}(\delta)$.

PROOF:

Suppose A is a guilty type. Given the strategy profile in a corroboration equilibrium, there are two possibilities that lead to the event r: (i) the current period is period 1 and V_1 reported (this happens with probability $(1/2)\lambda_v a^*$); and (ii) the current period is period 2, V_1 didn't exist, and V_2 reported (this happens with probability $(1/2)(1-p)\lambda_v a^*$). Therefore, the probability of observing r given A is guilty is $(1/2)\lambda_v a^*(2-p)$. Similarly, the probability of observing r given A is innocent is $(1/2)\lambda_l b^*(2-q)$. This gives $\ell(r) = \underline{\ell}^*$. The event $r\phi$ happens if V_1 exists and makes an immediate report but V_2 does not exist, which occurs with probability $(1-p)\lambda_v a^*$. The corresponding likelihood ratio is $\ell(r\phi) = (1-p)\lambda_v a^*/((1-q)\lambda_l b^*) < \underline{\ell}^*$. In the proof of Proposition 2, we show that $\ell(rR) = \bar{\ell}^* < \ell(rr)$. The event R is off equilibrium. We can assign an off-equilibrium belief such that $\ell(R) < \hat{\ell}$. This establishes that a corroboration equilibrium exists if and only if $\hat{\ell} \in (\ell(r), \ell(rR)]$.

The range $(\underline{\ell}^*, \bar{\ell}^*]$ is nonempty if and only if

$$\frac{p(1-a^*)}{2-p} > \frac{q(1-b^*)}{2-q}.$$

The left-hand side of the inequality above is equal to the right-hand side when $p = q$. Because $p > q$, it suffices to show that the left-hand side is increasing in p, which is equivalent to

$$2(1-a^*) - p(2-p)\frac{\partial a^*}{\partial p} > 0. \tag{5}$$

By implicit differentiation of (4),

$$\frac{\partial a^*}{\partial p} = \frac{(1+\delta)\big(1-a^*(1-a^*)\big)}{2+(1+\delta)p(1-2a^*)} = \frac{2a^*}{p\big(2+(1+\delta)p(1-2a^*)\big)},$$

where the second equality holds because $F(a^*;p) = 0$ implies $(1+\delta)(1-a^*(1-a^*)) = 2a^*/p$. Suppose p and δ are such that $a^* < 1/2$. Then, we have $\partial a^*/\partial p < a^*/p$, and therefore the left-hand side of (5) is positive when $a^* < 1/2$. From the equation $F(a^*;p) = 0$, we can verify that $a^* = 1/2$ when $p = 2/3$ and $\delta = 1$. Because a^* increases in p and δ (Proposition 1), $q < p \leq 2/3$ implies $b^* < a^* < 1/2$ for any $\delta \leq 1$.

This argument also shows that we must have $a^* > 1/2$ whenever

$$h(a^*,p,\delta) \equiv 2(1-a^*) - p(2-p)\frac{(1+\delta)\big(1-a^*(1-a^*)\big)}{2+(1+\delta)p(1-2a^*)} = 0.$$

For $a^* > 1/2$, $h(a^*,p,\delta)$ is decreasing in a^*, p, and δ. By Proposition 1, this implies $H(p,\delta) \equiv h(a^*(p,\delta),p,\delta)$ is decreasing in p and δ. Thus, the locus $\bar{p}(\delta)$ that satisfies $H(\bar{p}(\delta),\delta) = 0$ is decreasing in δ, with $H(p,\delta) > 0$ for all $p < \bar{p}(\delta)$. ∎

Proposition 3 states that a corroboration equilibrium exists whenever the standard of proof $\hat{\ell}$ falls in the range $(\ell(r), \ell(rR)]$. Because rr is more credible than rR, and r

is more credible than $r\phi$, the accused agent A will be arrested if and only if there are two reports lodged against him.

The range $(\ell(r), \ell(rR)]$ may be empty, in which case a corroboration equilibrium does not exist. This may occur because, for very high values of p and δ, the event rR is even less credible than r.[21] The reason is that rR reveals that the first accuser chose not to report right away. Because libelers are more likely to take this wait-and-see approach, this brings down the belief, reflected in the ratio $(1-a^*)/(1-b^*)$. If both p and δ are close to 1, then $1-a^*$ would be close to 0, causing an undelayed report followed by a delayed report to be less credible than just one undelayed report.

Proposition 3 also establishes that the existence of a corroboration equilibrium is guaranteed whenever p or δ is not too large. Specifically, for any δ, a corroboration equilibrium always exists if $p \leq 2/3$. Suppose, for example, that $\lambda_v = \lambda_l = 0.2$, $p = 0.6$, $q = 0.2$, and $\delta = 1$. Then, in a corroboration equilibrium, $a^* = 0.41$ and $b^* = 0.17$. In other words, about 59 percent of the new victims do not report the crimes against them immediately, and about 83 percent of the potential libelers do not libel immediately. In such an equilibrium, $\ell(rr) = 7.24$ and $\ell(rR) = 5.14$. A corroboration equilibrium exists if and only if $\hat{\ell} \in (1.88, 5.14]$. If victims and libelers were to always lodge a complaint immediately (e.g., if they are nonstrategic), the credibility of two undelayed reports would be $\ell(rr) = p\lambda_v/(q\lambda_l) = 3$. Thus, for $\hat{\ell} \in (3, 5.14]$, agent A would never get arrested if victims and libelers behaved nonstrategically by always reporting immediately, but A will be arrested with some probability in the corroborated equilibrium of our model. More generally, $p \leq 2/3$ implies $a^* < 1/2$, and hence $a^*(1-a^*) \geq b^*(1-b^*)$. This ensures that $\ell(rR) \geq p\lambda_v/(q\lambda_l)$. The fact that, in a corroboration equilibrium, true victims are more likely to make allegations against A than libelers are lends credence to such allegations.

If the existences of V_1 and V_2 are very positively correlated (e.g., when $p > 2/3$), a corroboration equilibrium still exists when future costs and benefits are sufficiently discounted. This is because a lower δ gives a new victim more incentive to wait and see and thus reduces a^* to ensure that $\ell(rR) > \ell(r)$. Specifically, when $\delta \leq 1/3$, we have $a^* \leq 1/2$ for any value of p. This will guarantee that a corroboration equilibrium exists.

The criminal justice system is imperfect and has to strike a balance between the possibilities of punishing the innocent (type I error) and letting go the guilty (type II error). In our model, type I error occurs because libelers wrongly accuse A even though he has not broken the law. Given that there is at least one libeler, the probability that an innocent agent A will be arrested in a corroboration equilibrium is:

$$\Pr[\text{type I}] = \frac{q}{2-q}\left(1-\left(1-b^*\right)^2\right), \tag{6}$$

where the fraction is the probability that there are two potential libelers given that there is at least one, and the second term is the probability that at least one of L_1

[21] For example, when $\lambda_v = \lambda_l$, $p = 0.9$, $q = 0.8$, and $\delta = 0.95$, we have $a^* = 0.69$ and $b^* = 0.59$. Then $\ell(r) \approx 1.07 > 0.99 = \ell(rR)$.

and L_2 has a reporting cost less than b^* (which will lead to two reports because the other one will follow up). Similarly, given that there is at least one victim, the probability that the evidence against a guilty agent A does not reach the standard of proof in a corroboration equilibrium is:

$$\Pr[\text{type II}] = \frac{p}{2-p}(1-a^*)^2 + \frac{2(1-p)}{2-p}. \tag{7}$$

The first term is the conditional probability that neither V_1 nor V_2 lodges a complaint. The second term is the conditional probability that A has hurt only one victim, so the evidence is not sufficient to reach the threshold regardless of whether the victim lodges a complaint or not.

PROPOSITION 4: *In a corroboration equilibrium, the probability of type I error increases in q and δ, and the probability of type II error decreases in p and δ.*

PROOF:

From equation (6), the probability of type I error increases in q and in b^*. Proposition 1 establishes that b^* increases in q and δ. Therefore, $\Pr[\text{type I}]$ increases in $q\delta$. From equation (7), $\Pr[\text{type II}]$ decreases in p and in a^*. Because a^* increases in p and δ, $\Pr[\text{type II}]$ decreases in p and δ. ■

An increase in the correlation of repeated offense p by a guilty agent A has two effects on the probability of his getting away without punishment. The first effect is mechanical: a higher p raises the chance that there are two victims to report his crime. The second effect works through the response of the victims: a victim who expects the existence of another victim is more likely to report the crime through the encouragement effect. Both effects tend to reduce the probability of not having A arrested.

In a corroboration equilibrium, new victims face a trade-off between encouraging others to report the crime and delaying to pay the cost of reporting. Greater patience δ makes the latter option less attractive and hence increases the probability that they report immediately. When people are more forthcoming in making an allegation against A, the probability of type I error increases and the probability of type II error decreases.

III. Other Types of Equilibria

A. *Other Equilibria with a Corroboration Flavor*

In the previous section, we focus on corroboration equilibrium, in which agent A is arrested if and only if there are two reports against him. The corroboration equilibrium, provided that it exists, is not the only equilibrium in our model. Multiple equilibria exist because beliefs are self-confirming. For example, if rR does not lead to arrest, then no one has an incentive to make a delayed report. Because rR does not occur in equilibrium in this case, we can assign off-equilibrium beliefs such that rR is not credible enough to cause an arrest, hence confirming the equilibrium construction. In this subsection, we consider two other types of equilibria in which corroboration is a necessary (but not sufficient) condition for making an arrest. In the first type, agent A is arrested only when both reports against him are undelayed. We call this an rr-equilibrium. In the second type, agent A is arrested only when one report is undelayed and the other is delayed. We call this an rR-equilibrium.

In an rr-equilibrium, the event rR does not lead to an arrest. Therefore, a silent V_1 who has not reported in period 1 has no incentive to file a delayed report against A upon learning that V_2 has reported. Unlike in a corroboration equilibrium, we therefore have $\hat{\alpha}_1(c) = 0$ for all c. Nevertheless, as in a corroboration equilibrium, we still have $\tilde{\alpha}_1(c) = 0$ (V_1 will not report in period 2 if no one reports against A) and $\hat{\alpha}_2(c) = 1$ (V_2 will report if she learns that V_1 has already made a report) in an rr-equilibrium.

We continue to use a to denote the probability of reporting right away by a new victim, and we will use a_{rr} to denote its equilibrium value. Likewise, b_{rr} is the equilibrium probability of reporting immediately by a new libeler. In an rr-equilibrium, reporting immediately gives a new victim a payoff of

$$-c + \frac{(1/2)p}{1-(1/2)pa}[\delta].$$

Not reporting gives her a payoff of 0, as delaying the report will certainly lead to no arrest. The equilibrium probability of a new victim reporting right away when there is no prior report is the unique solution for a to:

$$F_{rr}(a;p) \equiv \frac{(1/2)p}{1-(1/2)pa}\delta - a = 0. \tag{8}$$

Comparing (8) to (4) in the previous section, we see that both the benefit from reporting immediately and the benefit from delaying to report are smaller in an rr-equilibrium than in a corroboration equilibrium. Moreover, substituting the equilibrium value of a_{rr} obtained from equation (8) and evaluating $F(a;p)$ from equation (4) at this value, we obtain

$$F(a_{rr};p) = \frac{1/2}{1-(1/2)pa_{rr}}\left[p(1-a_{rr})(1-\delta a_{rr})\right] > 0.$$

This implies $a_{rr} < a^*$, because $F(\cdot\,;p)$ is single crossing from above. Therefore, the overall effect of not allowing corroboration with delay as sufficient grounds for arrest is to discourage new victims from making a report immediately, as it removes the chance that an immediate report will encourage past victims who did not report to come forward by filing delayed reports.

Consider next an rR-equilibrium. In such an equilibrium, because a second undelayed report will not lead to arrest, we have $\hat{\alpha}_2(c) = 0$ (whereas we still have

$\hat{\alpha}_1(c) = 1$ and $\tilde{\alpha}_1(c) = 0$, as in a corroboration equilibrium). The payoff to a new victim from reporting immediately is

$$-c + \frac{(1/2)p(1-a)}{1-(1/2)pa}[1],$$

which comes from the possibility that V_1 exists but has not reported. On the other hand, not reporting gives a new victim a payoff of

$$\frac{(1/2)p}{1-(1/2)pa}\left[a\delta(1-c)\right],$$

which comes from the possibility of reporting later if V_2 exists and makes a report. Let a_{rR} be the equilibrium probability that a new victim reports immediately, and let b_{rR} be the equilibrium probability that a new libeler reports immediately. Then, a_{rR} is given by the unique solution for a to the following equality:

$$(9) \qquad F_{rR}(a;p) \equiv \frac{(1/2)p(1-a)}{1-(1/2)pa} - a - \frac{(1/2)p}{1-(1/2)pa}a\delta(1-a) = 0.$$

Comparing (9) to the corresponding equation (4), which characterizes a^* in a corroboration equilibrium, because the payoff from reporting immediately is reduced but the payoff from not reporting remains unchanged, we have $a_{rR} < a^*$.

PROPOSITION 5:

(*i*) *There exists a nonempty interval* $(\underline{\ell}_{rr}, \overline{\ell}_{rr}]$ *such that an rr-equilibrium exists if and only if* $\hat{\ell}$ *is in that interval. In this equilibrium,* $b_{rr} < a_{rr} < a^*$. *Moreover,* $\overline{\ell}_{rr} > \overline{\ell}^*$, *and if* $p \leq 2/3$, *then* $\underline{\ell}_{rr} > \underline{\ell}^*$.

(*ii*) *There exists a nonempty interval* $(\underline{\ell}_{rR}, \overline{\ell}_{rR}]$ *such that an rR-equilibrium exists if and only if* $\hat{\ell}$ *is in that interval. In this equilibrium,* $b_{rR} < a_{rR} < a^*$. *Moreover,* $\overline{\ell}_{rR} > \overline{\ell}^*$, *and if* $p \leq 2/3$, *then* $\underline{\ell}_{rR} > \underline{\ell}^*$.

The proof of Proposition 5 is in Appendix A. In both the *rr*-equilibrium and the *rR*-equilibrium, new victims are less likely to report immediately compared with the case in a corroboration equilibrium. Furthermore, because $\hat{\alpha}_1(c) = 0$ in an *rr*-equilibrium and $\hat{\alpha}_2(c) = 0$ in an *rR*-equilibrium (these two quantities are both equal to 1 in a corroboration equilibrium), the overall probability that a victim or a libeler will make an allegation is lower compared with that in a corroboration equilibrium.

Compared with a corroboration equilibrium, an *rr*-equilibrium and an *rR*-equilibrium both reduce type I error but increase type II error, for two reasons: (i) each reduces the set of events under which A is arrested, and (ii) the probability that a new victim or new libeler will report immediately is lower. On the other hand, Proposition 5 also shows that arrests in an *rr*-equilibrium or an *rR*-equilibrium are more credible than the event *rR* in a corroboration equilibrium (assuming p is not too large). Thus, even if the standard of proof $\hat{\ell}$ is so high that a corroboration equilibrium does not exist, it is still possible that the model will admit an *rr*-equilibrium or an *rR*-equilibrium.

The event *rR* is off the equilibrium path in an *rr*-equilibrium, and likewise for the event *rr* in an *rR*-equilibrium. Standard refinements are not sufficient to rule out these two types of equilibria. Nevertheless, because both event *rr* and event *rR* are observed in reality, we believe that the corroboration equilibrium is the most relevant equilibrium to focus on, not *rr*-equilibrium or *rR*-equilibrium.

B. *Lower Standard of Proof and No-Corroboration Equilibrium*

The probabilities of type I and type II errors can be affected by the standard of proof $\hat{\ell}$. Consider the case where one report against agent A is sufficient to lead to arrest. In such a case, no one will have an incentive to file a second report against the same person, so *rr* and *rR* are off-equilibrium events. We call this type of equilibrium a *no-corroboration equilibrium*. The existence of a no-corroboration equilibrium requires $\ell(r) \geq \hat{\ell}$ and $\ell(R) \geq \hat{\ell}$. Because the event r is sufficient for arrest, the event $r\phi$ is irrelevant. We first assume that these conditions hold, and we subsequently verify that this is true for some values of $\hat{\ell}$.

Suppose agent A is guilty. If a victim of A has seen a prior accusation against him, there is no point for her to report because one report is sufficient to punish A. Therefore, $\hat{\alpha}_1(c) = \hat{\alpha}_2(c) = 0$ for all c. On the other hand, if a silent victim V_1 observes no one coming forward to complain against A in period 2, she will make a delayed report because the event R is sufficient to lead to arrest. This means that we have $\tilde{\alpha}_1(c) = 1$ in a no-corroboration equilibrium.

For a new victim (who does not see a prior accusation against A), the payoff from reporting immediately is $1 - c$. The payoff from not reporting immediately is

$$(10) \qquad \frac{1-p}{1-(1/2)pa}\left[\frac{1}{2}\delta(1-c)\right] + \frac{(1/2)p}{1-(1/2)pa} \times \left[a\delta + (1-a)\delta(1-c)\right] + \frac{(1/2)p(1-a)}{1-(1/2)pa}[1].$$

The first fraction is the probability that another victim does not exist. Given this, there is probability $1/2$ that she is V_1, in which case she lodges a delayed report at the end of period 2 and gets $\delta(1-c)$. The second fraction is the conditional probability that this victim is V_1 and V_2 exists. With probability a, V_2 reports the crime and V_1 gets δ, and with probability $1-a$, V_2 does not report the crime and V_1 lodges a delayed report and gets $\delta(1-c)$. The final term is the conditional probability that she is V_2 and V_1 exists but did not report. If she does not report, V_1 will lodge a delayed report and V_2 gets 1.

Let $f_{nc}(c,a;p)$ represent the difference between $1-c$ and (10), and define $F_{nc}(a;p) \equiv f_{nc}(a,a;p)$. We have:

$$F_{nc}(a;p) = \frac{1/2}{1-(1/2)pa}\Big[(1-a)(2-pa) - (1-p)\delta(1-a) - p\delta\big(1-a(1-a)\big) - p(1-a)\Big].$$

Because $F_{nc}(0;p) > 0 > F_{nc}(1;p)$ and $F_{nc}(\cdot\,;p)$ is single crossing from above, there exists a unique a_{nc} such that $F_{nc}(a_{nc};p) = 0$. In a no-corroboration equilibrium, the strategy of a new victim is $\alpha(c) = 1$ (i.e., report immediately) if and only if $c \le a_{nc}$. Similarly, the strategy of a libeler who sees no prior report against A is $\beta(c) = 1$ if and only if $c \le b_{nc}$, where $F_{nc}(b_{nc};q) = 0$.

PROPOSITION 6: *A no-corroboration equilibrium exists only if $\hat{\ell} < \lambda_v/\lambda_l$. Comparing the outcome in a no-corroboration equilibrium to that in a corroboration equilibrium, the probability of convicting an innocent A is higher, and the probability of acquitting a guilty A is lower.*

PROOF:

A no-corroboration equilibrium exists if and only if the standard of proof is lower than the likelihood ratio corresponding to event r or R, i.e.,

$$\hat{\ell} \le \ell(r) = \min\left\{\frac{\lambda_v a_{nc}(2-pa_{nc})}{\lambda_l b_{nc}(2-qb_{nc})}, \frac{\lambda_v(1-a_{nc})(1-pa_{nc})}{\lambda_l(1-b_{nc})(1-qb_{nc})}\right\}.$$

Because rr and rR are off-equilibrium events, we can assign off-equilibrium beliefs such that $\ell(rr) \ge \hat{\ell}$ and $\ell(rR) \ge \hat{\ell}$. Given these beliefs, there is no profitable deviation from the strategy profile of a no-corroboration equilibrium. Note that $F_{nc}(a;p)$ is single crossing from above and is decreasing in p. Hence, $p > q$ implies $a_{nc} < b_{nc}$. This implies that $a_{nc}(2-pa_{nc})/(b_{nc}(2-qb_{nc})) < 1$. Hence, a no-corroboration equilibrium exists only if $\hat{\ell} \le \ell(r) < \lambda_v/\lambda_l$.

If there are two libelers, L_1 either makes an undelayed report or a delayed report in a no-corroboration equilibrium. If there is only one libeler and this libeler is L_2, she makes an undelayed report with probability b_{nc}. Therefore, the overall probability of type I error in a no-corroboration equilibrium is

$$\frac{q}{2-q} + \frac{2(1-q)}{2-q}\left(\frac{1}{2} + \frac{1}{2}b_{nc}\right),$$

which is greater than (6). Similarly, the probability of type II error is

$$\frac{2(1-p)}{2-p}\left(\frac{1}{2}(1-a_{nc})\right),$$

which is less than (7). ∎

In a no-corroboration equilibrium, there is no "encouragement effect" to motivate a new victim to report immediately in order to induce a future or past victim to report. As a result, only the freerider effect is present, and the freerider effect is stronger the more likely that another victim exists. Hence a new victim has a higher incentive to freeride than a new libeler does and, as a result, reports with a lower probability. This implies that a no-corroboration equilibrium exists only if the standard of proof $\hat{\ell}$ is so low that one will be arrested on the basis of a single report even if the victim and the libeler have the same pooling behavior (i.e., as if they were nonstrategic). The advantage of having a lower standard of proof is that a guilty agent is more likely to be punished; the disadvantage is that it comes with a much higher chance of type I error.

There are other types of equilibria with a no-corroboration flavor. In all such equilibria, agent A is sometimes arrested when there is only one report (delayed or not) against him. In the first type, which we call an r-equilibrium, agent A is arrested in event r but not in event R. In the second type, which we call an R-equilibrium, agent A is arrested in event R but not in event r. The key features of these equilibria are quite similar to those for the no-corroboration equilibrium described in Proposition 6. We summarize these features in the following proposition.

PROPOSITION 7: *In an r-equilibrium, new victims report immediately with a lower probability than do new libelers. In an R-equilibrium, neither new victims nor new libelers ever report immediately. Each of these two types of equilibria exists only if the standard of proof* $\hat{\ell}$ *is below* λ_v/λ_l.

Allowing only one report to lead to arrest eliminates the encouragement effect for new victims to report immediately. Proposition 7 shows that an r-equilibrium and an R-equilibrium share the same feature that a victim reports right away with a lower probability than a libeler when there is no prior report. This adverse selection of accusers in turn implies that the standard of proof has to be so low (i.e., lower than λ_v/λ_l) that the public is willing to arrest someone knowing that a libeler is more active in reporting than a victim. Because such a standard of proof seems to us to be an implausibly low standard, and because we do observe multiple allegations (rr or rR) in reality, we choose to focus on the corroboration equilibrium in the remainder of this article.

IV. Model Extensions

We have made a number of modeling choices in the basic model to make it simple and transparent: V_1 cannot make a delayed report in period 2 before V_2 makes her decision, a guilty agent does not face potential libelers, agent A is not strategic, and the victims and libelers have the same payoff structure. These restrictions can be relaxed without altering our main conclusions. We present the analysis in this section.

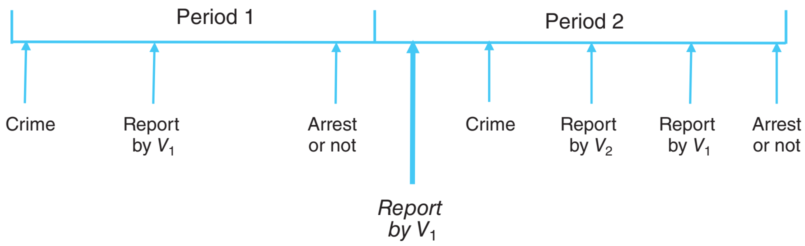

FIGURE 2: THE MODIFIED TIMELINE WHEN A IS GUILTY

Notes: Victim V_1 can make a delayed report in period 2 before knowing whether V_2 reports or not. If V_2 reports, V_1 will have another chance to make a delayed report before the end of period 2 provided that she has not already done so.

A. *Delay of the Initial Report*

In our basic model, a delayed report is always preceded by an undelayed report in a corroboration equilibrium. In reality, sometimes even the first report against an accused is significantly delayed. For example, the first two allegations of sexual assault (almost simultaneously in 2016) against Larry Nassar, a former physician for the USA Gymnastics team, were delayed for 16 years and 17 years. The alleged crimes happened when the accusers were teenagers, so a large part of the periods of silence were spent when the accusers were adults. This means the delay had to do with something more than just the immaturity of the accusers. In this section, we show that the delay of the first report can be an equilibrium outcome if we also allow V_1 to report in the second period before V_2 can and if there is some discounting (i.e., $\delta < 1$).

In Figure 2, we modify the timeline of the basic model by allowing V_1 to have a chance to make a delayed report in period 2 before she learns about the existence of another report against A. If V_1 does not use this chance, she still has another chance to make a delayed report after V_2 has her chance to report. The timeline for potential libelers is modified in a similar manner.

In this modified setting, if V_1 reports in period 2 followed by V_2's report, we denote the event by Rr. If V_1 reports in period 2 and there is no report by V_2, we denote the event by $R\phi$. We will focus on a corroboration equilibrium in which agent A is arrested if and only if there are two reports against him (i.e., in the events rr, rR, or Rr).

By the time of the second period, V_1 already knows that she is V_1. If she has not yet reported, by reporting in period 2, she will get payoff $p - c$ because with probability p, V_2 exists and will follow up with a report. By not reporting in period 2, V_1 will get $pa(1 - c)$ because V_2 will report with probability a, after which V_1 can follow up with a report. Therefore, the cutoff type (denoted $\hat{c}_2$) of V_1, who is indifferent between reporting and not reporting in period 2 before V_2's turn to report, is determined by $p - \hat{c}_2 = pa(1 - \hat{c}_2)$, which gives

$$\hat{c}_2(a,p) = \frac{p(1-a)}{1-pa}.$$

Any V_1 whose cost is below $\hat{c}_2(a,p)$ will report in period 2 if she has not reported before. For the case where A is innocent, L_1 whose cost is below $\hat{c}_2(b,q) = q(1-b)/(1-qb)$ will report in period 2 if she has not reported before.

There are two cases to consider: (i) $\hat{c}_2(a,p) \geq a$, and (ii) $\hat{c}_2(a,p) < a$. However, only case (i) is relevant;[22] we therefore focus on case (i). In this case, some types of victim with $c \in (a, \hat{c}_2(a,p)]$ will choose not to report immediately but rather wait until period 2 to lead with a delayed report.

Consider a new victim who has not seen a prior report. The expected net payoff from reporting immediately is:

$$\frac{1-p}{1-(1/2)p\hat{c}_2(a,p)}[-c] + \frac{(1/2)p}{1-(1/2)p\hat{c}_2(a,p)}[\delta - c] + \frac{(1/2)p\big(1-\hat{c}_2(a,p)\big)}{1-(1/2)p\hat{c}_2(a,p)}[1-c].$$

Her expected net payoff from not reporting immediately is:

$$\frac{1-p}{1-(1/2)p\hat{c}_2(a,p)}\left[-\frac{1}{2}\delta c\right] + \frac{(1/2)p}{1-(1/2)p\hat{c}_2(a,p)}\big[\delta(1-c)\big].$$

The first term above refers to the situation where another victim does not exist. Given this, there is probability $1/2$ that the new victim is V_1, in which case she will make a delayed report in period 2 if her cost is $c < \hat{c}_2(a,p)$.

By the same logic as in the basic model, the equilibrium probability that a new victim will report immediately, denoted a_{del}, is the solution in a to the following equation:

$$F_{del}(a;p) \equiv \frac{1/2}{1-(1/2)p\hat{c}_2(a,p)}\Big[-a\big(2-\delta-p\hat{c}_2(a,p)\big)+p\big(1-\hat{c}_2(a,p)\big)\Big] = 0.$$

It is straightforward to show that a unique $a_{del} \in (0,1)$ exists, and that a_{del} increases in p and δ.

PROPOSITION 8: *Suppose V_1 can make a delayed report in period 2 before V_2 has her chance to report. Then, in a corroboration equilibrium, (i) if $c \leq a_{del}$, then V_1 reports immediately in period 1; (ii) if $c \in (a_{del}, \hat{c}_2(a_{del},p)]$, then V_1 makes a delayed report in period 2 before V_2 has her chance to report; and (iii) if $c > \hat{c}_2(a_{del},p)$, then V_1 makes a delayed report in period 2 if and only if she observed that V_2 has reported. Compared with the corroboration equilibrium in the basic model, $a_{del} < a^* < \hat{c}_2(a_{del},p)$ when $\delta < 1$.*

[22] In case (i), $c > a$ implies $c > \hat{c}_2(a,p)$. Any type who does not report immediately when she is a new victim will choose to wait in period 2 rather than leading with a delayed report. Then the condition that determines the equilibrium value of a is the same as in the basic model, i.e., a satisfies $F(a;p) = 0$. But because $\delta < 1$, $F(a;p) = 0$ implies $p(1-a+a^2) > a$, which contradicts $\hat{c}_2(a,p) \leq a$.

PROOF:

Suppose $\delta = 1$. Then the option for V_1 to make a delayed report before knowing whether V_2 has reported or not has no value to V_1 because there is no discounting. This implies $a_{del} = \hat{c}_2(a_{del}, p) = a^*$ for $\delta = 1$. Now, $a_{del} - \hat{c}_2(a_{del}, p)$ is increasing in δ because a_{del} increases in δ. Thus, $a_{del} - \hat{c}_2(a_{del}, p) < 0$ for all $\delta < 1$. Furthermore, because $\hat{c}_2(a_{del}, p)$ decreases in δ whereas a^* increases in δ, we have $\hat{c}_2(a_{del}, p) > a^*$ for all $\delta < 1$.

For any $\delta < 1$, the condition $F_{del}(a_{del}; p) = 0$ can be written as:

$$-a\big(2 - p\hat{c}_2\big(a_{del}, p\big)\big) + \delta a_{del} + p\big(1 - \hat{c}_2\big(a_{del}, p\big)\big) = 0.$$

The fact that $\hat{c}_2(a_{del}, p) > a_{del}$ implies

$$-a\big(2 - pa_{del}\big) + \delta a_{del} + p\big(1 - a_{del}\big) > 0.$$

Moreover, $\hat{c}_2(a, p) > a$ if and only if $a < p(1 - a + a^2)$. This implies that

$$-a\big(2 - pa_{del}\big) + p\delta\big(1 - a_{del} + a_{del}^2\big) + p\big(1 - a_{del}\big) > 0,$$

which is equivalent to $F(a_{del}; p) > 0$. As $F(\cdot\,; p)$ is single crossing from above, we obtain $a_{del} < a^*$. ∎

This corroboration equilibrium exists if and only if

$$\max\big\{\ell(r), \ell(R\phi), \ell(r\phi)\big\} < \min\big\{\ell(rr), \ell(Rr), \ell(rR)\big\}.$$

For example, when $\lambda_v = \lambda_l, p = 0.3, q = 0.1$, and $\delta = 0.8$, we have $a_{del} = 0.20$, $\hat{c}_2(a_{del}, p) = 0.26$, $b_{del} = 0.076$, and $\hat{c}_2(b_{del}, q) = 0.09$. In this case, $\max\{\ell(r), \ell(R\phi), \ell(r\phi)\} = \ell(r) = 2.89$ and $\min\{\ell(rr), \ell(Rr), \ell(rR)\} = \ell(Rr) = 30.18$. Therefore, $\ell(r) < \ell(Rr)$, and the corroboration equilibrium exists for $\hat{\ell} \in (\ell(r), \ell(Rr)]$. Compared with the basic model in which $a^* = 0.22$ and $b^* = 0.08$, V_1 (or L_1) in the basic model is less likely to report in period 1 but is more likely to have reported in period 2 before V_2 (or L_2) chooses to report.

B. *Guilty One Faces Both Victims and Libelers*

It is natural that libelers may exist not just for an innocent agent but also for a guilty one. In this subsection, we assume that both the guilty and the innocent agent face the same chance of having potential libelers, but the guilty one also faces an additional chance of accusation by victims. We show that this difference *alone* can generate differences in reporting behavior between victims and libelers to produce semiseparation between guilty and innocent types, so here we remove recidivism as a force for semiseparation by assuming independent probabilities of existence of potential reporters across two periods.

Suppose that, in each period independently, a guilty agent A has probability x of facing a victim, probability y of facing a libeler, and probability $1 - x - y$ of facing neither a victim nor a libeler. On the other hand, an innocent agent has probability y of facing a libeler and probability $1 - y$ of not facing a libeler (an innocent agent never faces a victim). We assume that these events are *independent* across periods.[23] Let a denote the probability that a new victim reports immediately and b denote the probability that a new libeler reports immediately. The common prior that the state is guilty is μ_0.

We study a corroboration equilibrium again. For the purpose of comparing with the basic model, we let $p = x + y$ in this section. Also let a_E be the expected probability of reporting of the other potential accuser (given her existence) from the perspective of a victim, i.e.,

$$a_E = \frac{x}{x+y} a + \frac{y}{x+y} b. \tag{11}$$

Then, a new victim can entertain three possibilities: (i) another accuser does not exist (with probability $1 - p$), (ii) she is V_1 and another accuser exists (with probability $(1/2)p$), or (iii) she is V_2 and another accuser existed but did not report (with probability $(1/2)p\,a_E$). Her payoff from reporting immediately is:

$$-c + \frac{(1/2)p}{1-(1/2)pa_E}\big[\delta\big] + \frac{(1/2)p(1-a_E)}{1-(1/2)p\,a_E}\big[1\big].$$

Her payoff from not reporting immediately is:

$$\frac{(1/2)p}{1-(1/2)pa_E}\big[a_E\delta(1-c)\big].$$

This implies that the equilibrium probability of reporting by a new victim must satisfy:

$$f_{both}(a, a_E, p) \equiv -a + \frac{(1/2)p}{1-(1/2)pa_E}\delta\big(1 - a_E(1-a)\big) + \frac{(1/2)p(1-a_E)}{1-(1/2)pa_E} = 0. \tag{12}$$

A new libeler does not know the state. Since both states give rise to the same probability of a libeler, a new libeler uses prior μ_0. Again, for comparison with the basic model, we let $q = \mu_0 x + y$ in this section. Also let b_E be the expected probability of reporting of the other accuser (given that she exists) from the perspective of a libeler, i.e.,

$$b_E = \frac{\mu_0 x}{\mu_0 x + y} a + \frac{y}{\mu_0 x + y} b. \tag{13}$$

[23] We purposefully use independent probabilities here to show that correlation is not needed for this model extension. The mere fact that $x > 0$ can generate different behavior between the victims and libelers.

A similar argument shows that the equilibrium probability of reporting by a new libeler must satisfy:

$$(14)\quad f_{both}(b, b_E, q) \;=\; -b + \frac{(1/2)\,q}{1-(1/2)\,qb_E}\delta\big(1-b_E(1-b)\big) + \frac{(1/2)\,q(1-b_E)}{1-(1/2)\,qb_E}$$
$$=\; 0.$$

The equilibrium a_{both} and b_{both} are solutions in a and b to the system of four equations: (11), (12), (13), and (14).

PROPOSITION 9: *In a corroboration equilibrium in which a guilty agent may face both victims and libelers, $a_{both} > b_{both}$. Moreover, $\ell(rr) > \ell(rR)$ in this equilibrium.*

PROOF:

Suppose to the contrary that $a_{both} \le b_{both}$. Note from equations (11) and (13) that the equilibrium a_E^* and b_E^* are weighted averages of a_{both} and b_{both} and that a_E puts more weight on a_{both} than does b_E. This implies $a_{both} \le a_E^* \le b_E^* \le b_{both}$. The function $f_{both}(a, a_E, p)$ is decreasing in a, decreasing in a_E, and increasing in p. Note also that $p = x + y > \mu_0 x + y = q$. Therefore,

$$0 \;=\; F_{both}\big(a_{both}, a_E^*, p\big) \;>\; F_{both}\big(b_{both}, b_E^*, q\big) \;=\; 0.$$

This forms a contradiction.

We have established that $a_{both} > b_{both}$, which in turn implies that $a_{both} > a_E^* > b_E^* > b_{both}$. The likelihood ratios of the events rr and rR are, respectively:

$$\ell(rr) \;=\; \frac{p^2 a_E^*}{y^2 b_{both}}; \quad \ell(rR) \;=\; \frac{p^2 a_E^*(1-a_E^*)}{y^2 b_{both}(1-b_{both})}.$$

Therefore, $a_E^* > b_{both}$ and $p > y$ imply $\ell(rr) > \ell(rR)$. ∎

Here, a victim and a libeler both expect there to be the same chance of another potential libeler in another period. But a victim's private information tells her that the chance of a true victim being out there is higher than what an uninformed libeler thinks. Therefore, the encouragement effect is stronger for a victim than for a libeler, and the main results carry through: a new victim leads with a higher probability than a new libeler, and a delayed report is met with suspicion in a corroboration equilibrium.

C. *Strategic Agent*

In the basic model, the guilty agent is nonstrategic and commits crimes according to exogenous probabilities. We can endogenize the existence of victims by letting the guilty agent strategically choose whether and when to commit a crime to gain some benefit. Likewise, an innocent agent can strategically choose whether and when to avoid offending at a cost and thus prevent having to face potential libelers.

We will capture the difference between the criminal and the innocent agent in the following way: the criminal has a benefit of crime that is persistent over the two periods—a criminal who gains a high benefit from a crime will still gain a high benefit in the next period from another crime. This captures another aspect of the tendency for perpetrators of sexual crimes to engage in repeat offenses. In contrast, we assume that the cost for an innocent agent to avoid being libeled is independent across the two periods. We show that this simple difference can drive the same main result of semiseparation in the reporters' behavior.

Consider first the behavior of a criminal agent. In each period, the criminal agent A chooses whether or not to commit a crime. Suppose his benefit from committing each crime is π, which is distributed uniformly on the interval $[0,1]$ but is persistent over the two periods, and his cost of being arrested is 1. For this extension, we will focus on characterizing the corroboration equilibrium. We continue to denote a new victim's expected probability of reporting immediately by a.

If a crime was not committed in period 1, then A will surely commit a crime in period 2 because one report cannot get him arrested. If a crime was committed in period 1 and V_1 has reported, A has no incentive to commit another crime in period 2, because V_2 upon seeing a previous report will surely report, and two reports will cause A to be arrested.

Now consider the subgame where a crime was committed in period 1 but V_1 did not report in period 1. If A decides to commit the crime again in period 2, he gets payoff $\pi - a$. This is because V_2, as a new victim, will report with probability a, after which V_1 will follow with a report that will get A arrested. If A does not commit the crime, his payoff is 0. Therefore, he commits the crime in period 2 if and only if $\pi > a$.

Going backward to period 1, the payoff from committing a crime in period 1 is

$$\pi + (1-a)\delta \max\{\pi - a, 0\}.$$

Here, $1-a$ is the probability that V_1 does not report, which gives him a chance to commit a crime again in period 2. His payoff from not committing a crime in period 1 is $\delta\pi$, reflecting that he can commit a crime in the future with impunity because a single report from V_2 is not enough to get him arrested. Thus A will surely commit a crime in period 1.

Consider the incentive of a new victim. She entertains two possibilities:

(i) She is V_1. If she reports, there will be no more crime. The cost of reporting is c . If she does not report, then with probability $1-a$, the crime will be repeated and V_2 will report with probability a, which she can then follow with a report.

(ii) She is V_2. A previous victim must exist but was silent. If she reports, V_1 will follow with her report. The payoff is $1-c$. If she does not report, the payoff is 0.

Conditional on her own existence and the silence so far, the probability of her being V_1 is $1/(1+(1-a)^2)$, and the probability of her being V_2 is $(1-a)^2/(1+(1-a)^2)$. The payoff difference between reporting immediately and not doing so is:

$$f_g(c,a) \;=\; \frac{1}{1+(1-a)^2}\big[-c-(1-a)a\delta(1-c)\big]+\frac{(1-a)^2}{1+(1-a)^2}[1-c].$$

For any a, $f_g(\cdot\,,a)$ is strictly decreasing, with $f_g(0,a) > 0 > f_g(1,a)$. Therefore, there exists $\hat{c}_g(a)$ satisfying $f_g(\hat{c}_g(a),a) = 0$ such that the best response is to report immediately if and only if $c \le \hat{c}_g(a)$. The equilibrium of reporting by a new victim, denoted a_g, is the solution to:

$$(15) \qquad F_g(a) \equiv f_g(a,a) = \frac{1}{1+(1-a)^2}\big[-a+(1-a)^2(1-a-a\delta)\big] = 0.$$

Next, we consider the behavior of an innocent agent. In each period, there is a person with the intention to libel (a libeler). For example, a professor can see that a student is failing his class because of poor performance, or a boss is firing a worker because of tardiness. When a libeler exists, the innocent agent A can exercise caution to avoid being libeled. For example, the professor can avoid meeting the student alone in the office, or even bend the rules to let that student pass despite poor performance. To exercise caution (or to bend the rules), there is a cost γ_1 in period 1 and γ_2 in period 2. We assume that γ_1 and γ_2 are distributed uniformly over $[0,1]$ and *independently* across two periods. We will just call the action "exercising caution" (which includes bending the rules) for simplicity. Exercising caution removes any grounds for the libeler to make a complaint against A.

If caution was exercised in period 1, then A will not exercise caution in period 2. If caution was not exercised in period 1 and L_1 has reported, then A will exercise caution in period 2. If caution was not exercised in period 1 but L_1 has not reported, then A exercises caution in period 2 if and only if $\gamma_2 < b$.

Going back to period 1, if A exercises caution, he does not have to do so in the future, so the payoff is $-\gamma_1$. On the other hand, if A does not exercise caution in period 1, there are two possibilities. (i) If L_1 libels in period 1, A will definitely exercise caution, paying a cost $E[\gamma_2]$. (ii) If L_1 does not libel in period 1, A will make a decision in period 2 based on his period 2 cost of exercising caution, paying a cost $E[\min\{\gamma_2,b\}]$. Therefore, the expected payoff from not exercising caution in period 1 is:

$$-\delta\big(bE[\gamma_2]+(1-b)E\big[\min\{\gamma_2,b\}\big]\big) = -\frac{\delta b(3-b)}{2} \equiv -q_1(b).$$

In period 1, A will exercise caution if and only if $-\gamma_1 > -q_1(b)$. Since γ_1 is uniformly distributed on $[0,1]$, L_1 exists with probability $q_1(b)$.

A new potential libeler knows that there are three possibilities when she sees no prior report:

(i) She is L_1. This happens with probability $(1/2)\,q_1(b)$. If she reports, there will be no more potential libeler (thus no more report) in the future. Her payoff would be $-c$. If she does not report, with probability $1-b$ (the probability that $\gamma_2 > b$), there is L_2 in the future who will report with probability b. Her payoff would be $(1-b)b\delta(1-c)$.

(ii) She is L_2 and L_1 exists but did not report. This happens with probability $(1/2)\,q_1(b)(1-b)^2$, since it requires $\gamma_1 < q_1(b)$, $\gamma_2 > b$, and L_1 not to report. In this case, if L_2 reports, L_1 will follow and A will be arrested. The payoff for L_2 would be $1-c$. If she does not report, A will not be arrested. The payoff would be 0.

(iii) She is L_2 and L_1 does not exist. This event happens with probability $(1/2)(1-q_1(b))$. The payoff to L_2 would be $-c$ if she reports, and 0 if she does not.

Let $f_i(c,b)$ represent the payoff difference between reporting immediately and not doing so, which is given by:

$$\frac{q_1(b)}{1+q_1(b)(1-b)^2}\big[-c-(1-b)b\delta(1-c)\big]$$
$$+\frac{q_1(b)(1-b)^2}{1+q_1(b)(1-b)^2}[1-c]+\frac{1-q_1(b)}{1+q_1(b)(1-b)^2}[-c].$$

For any b, $f_i(\cdot\,,b)$ is strictly decreasing, so there exists a critical level of reporting cost below which a new libeler will make an accusation. The equilibrium probability of reporting by a new libeler, denoted b_i, is the solution to:

$$\text{(16)}\quad F_i(b) \equiv f_i(b,b) = \frac{1}{1+q_1(b)(1-b)^2}\big[-b+q_1(b)(1-b)^2(1-b-b\delta)\big]$$
$$= 0.$$

We are now in the position to show that $a_g > b_i$. Note that $F_i(b)$ is single crossing from above in b. Therefore, it is sufficient to show that $F_i(a_g) < 0$. From equations (15) and (16), we have

$$F_i(a_g) = \frac{1}{1+q_1(a_g)(1-a_g)^2}\big[-(1-q_i(a_g))\,a_g\big] < 0.$$

This establishes that $a_g > b_i$. The intuition is that V_2 knows for sure that V_1 exists, but L_2 does not know for sure that L_1 exists. As in the basic model, the higher belief that one's report will be corroborated raises the encouragement effect to cause a new victim to break the silence with a greater probability.

D. *Possible Payoff Differences*

Different payoff assumptions about victims and libelers would have predicable implications for the results. To this end, we derive comparative statics results with respect to the cost and benefit of reporting. This exercise also serves to demonstrate that the assumption that reporting costs are uniformly distributed is not essential for our model.

Suppose the distribution of reporting cost is given by $G(c;\kappa)$ on the support $[0,1]$. Here, an increase in κ represents a first-order stochastic increase in reporting cost. Suppose the benefit of getting the accused arrested is $\rho > 0$. In a corroboration equilibrium, if the strategy is for a new victim to lodge a complaint against A if and only if her reporting cost is lower than some critical value $\hat{c}$, then $a = E[\alpha(c)] = G(\hat{c};\kappa)$. Whenever it is interior, the critical type $\hat{c}$ is indifferent between reporting immediately and not doing so. Therefore, the equilibrium value of a for victims satisfies the indifference condition:

$$f(\hat{c},a;p) = \frac{1/2}{1-(1/2)pa}\left[-\hat{c}(2-pa) + p\delta\big(\rho - a(\rho-\hat{c})\big) + p(\rho - a)\right] = 0,$$

where $\hat{c} = G^{-1}(a;\kappa)$. This payoff difference is single crossing from above in a. Moreover, a higher κ raises $G^{-1}(a;\kappa)$ for any a. Because the payoff difference decreases in $G^{-1}(a;\kappa)$, the equilibrium value a^* must fall as κ increases. Not surprisingly, a stochastic increase in reporting cost causes people to be less forthcoming in making an allegation. Similarly, it is straightforward to show that a^* increases in ρ, i.e., a higher benefit from having the accused arrested causes people to be more forthcoming in making an allegation.

We can apply this comparative statics result to study differences in costs or benefits between victims and libelers. For example, in practice libelers may face the possibility of being discovered as libelers and may suffer negative consequences as a result. This can be incorporated as a higher cost of reporting than for the true victims. Assume that the distributions of reporting cost for victims and libelers are $G(c;\kappa_v)$ and $G(c;\kappa_l)$, respectively, with $\kappa_l > \kappa_v$. Our analysis would predict that $a^* > b^*$ even if $p = q$. In this case, the model would be similar to that in Chandrasekhar, Golub, and Yang (2018), in which semiseparation of victims from libelers is driven by differences in the distribution of reporting costs.

Alternatively, one can imagine that libelers may be partly motivated by private compensation, so that they can get a benefit even if the accused is not arrested. If we model the possibility of private compensation as a stochastic reduction in reporting cost for libelers (but not for victims), then this will suggest that $\kappa_l < \kappa_v$, which has the effect of raising b^* relative to a^*, which in turn has the effect of reducing the credibility of crime allegations.

E. *Other Extensions*

Our model can be modified in other directions. We show that the correlation structure in the basic model can be replaced by the assumption that the existence of victims (or libelers) in the two periods is independent across time, provided that the probability of having a potential accuser in each period is greater for the guilty type than for the innocent type. Several extensions would not alter the main results of the paper, such as (i) allowing the reporters to know which period they are in and (ii) allowing more victims than just two. We describe these extensions more fully in Appendix B.

V. Callisto Reporting System

An online sexual assault reporting system called Callisto had been adopted by eight universities by late 2017. This reporting system allows a student to log a report into the system under the precondition that it will be released to the school only if another student names the same perpetrator, an option called "match." The system also allows reporting to the school authority directly, but the system does not allow any potential reporter to see other reports in the system. The nonprofit organization that founded this system believes that sexual assault is prevalent on campus, that the reporting rate is low, and that repeat offenders are not stopped.[24] The Callisto reporting system falls under the definition of an "information escrow" in Ayres and Unkovic (2012), because Callisto allows people to transmit information to it under seal and have the information forwarded only under prespecified conditions.[25]

In this section, we examine the outcome assuming that a school uses Callisto as the reporting channel. Other assumptions maintained in the basic model are kept the same. The action choice for the school is to investigate and discipline the accused or not. We assume that an infinitesimally small cost is incurred when one enters a report into the system, and cost c is incurred when the report is submitted to the school authority because only then is the potentially unflattering conduct of the accuser known, and only then does the emotionally exhausting investigation begin.

The Callisto system can potentially create three distinguishable events at the school in our two-period setup: (i) no report (denoted ϕ), (ii) two reports and both are not delayed (rr), and (iii) two reports and one is delayed (rR). Any time only one report is in the system, the system shows no report to the school. To give reporters strict incentive to report, either rr or rR should lead to an investigation and possibly to disciplinary action. For there to be an interesting issue, no report from the Callisto system should lead to no action by the school. We focus on the corroboration equilibrium, in which both rr and rR cause the school to take investigative or disciplinary action. This requires $\hat{\ell} \leq \ell(rr)$ and $\hat{\ell} \leq \ell(rR)$.

First, observe that for a victim or a libeler, using the "match" option is better than reporting directly to the school through the Callisto system. If there is already another corroborating report, then it makes no difference. If there has not been one, then using the "match" option can avoid wasting the reporting cost or can

[24] See the Callisto website, https://www.projectcallisto.org/what-we-do.

[25] Sometimes, journalists perform a role that is similar to an information escrow. They do not publish a story until they have gathered a few allegations from different sources. For example, the *New York Times* broke the story on Harvey Weinstein in October 2017 after gathering allegations from multiple women. The accusers were not paying the cost of publicly accusing Weinstein until several pieces of corroboration were available and the news article was published.

delay the reporting cost if the corroborating report comes in the future. Second, logging the complaint into the system right away is better than waiting to log it later, as long as the chance of having a corroborator is not infinitesimally small. Therefore, in any corroboration equilibrium, a victim or a libeler logs the complaint into Callisto with no delay. This means that the event *rr* occurs with probability $p\lambda_v$ if the accused is guilty, or with probability $q\lambda_l$ if the accused is innocent.

On the equilibrium path, the reports are submitted to the school only when the event is *rr*. The likelihood ratio corresponding to this event is $\ell(rr) = p\lambda_v/q\lambda_l$. For this event to be sufficient for the school to take action, we must have $\hat{\ell} \leq p\lambda_v/q\lambda_l$. As long as there are not two reporters, there is no alert to the school authority: ϕ. The likelihood ratio corresponding to this event is $\ell(\phi) = (1 - p\lambda_v)/(1 - q\lambda_l)$, which has to be less than $\hat{\ell}$ in a corroboration equilibrium. Because *rR* is off equilibrium, we can assign an off-equilibrium belief such that $\hat{\ell} \leq \ell(rR)$. This establishes the following result.

PROPOSITION 10: *Under a Callisto reporting system, a corroboration equilibrium exists if and only if*

$$\hat{\ell} \in \left(\underline{\ell}_{Cal}, \overline{\ell}_{Cal}\right] \equiv \left(\frac{1 - p\lambda_v}{1 - q\lambda_l}, \frac{p\lambda_v}{q\lambda_l}\right].$$

This interval is nonempty as long as $p\lambda_v > q\lambda_l$. Because of the stronger incentive to report for both victims and libelers, the equilibrium probability of reporting immediately satisfies $a_{Cal} = 1 > a^*$ and $b_{Cal} = 1 > b^*$. However, because $a_{Cal} = b_{Cal}$ whereas $a^* > b^*$, two reports (rr) from the Callisto system do not carry the same level of credibility as two reports (rr) without the Callisto system. In fact, two reports (rr) in the Callisto system may even carry less credibility than the event *rR* without the Callisto system if p is not very large. If $p \leq 2/3$, then $\ell(rR)$ in the basic model is greater than $\overline{\ell}_{Cal}$. Therefore, if $p \leq 2/3$ and $\hat{\ell} \in (\overline{\ell}_{Cal}, \overline{\ell}^*]$, the standard of proof is so high that victims have no incentive to pay the infinitesimally small cost of lodging a complaint, knowing that even two reports are not sufficient to cause the school to take action under the Callisto system. In contrast, the same standard of proof will induce a positive equilibrium probability of reporting a^* without the Callisto system. In other words, adopting the Callisto system can potentially backfire if maintaining credibility of allegations is a serious concern.

VI. Conclusion

Allegations about sexual crimes and misconduct can be difficult to handle because they often leave behind no physical evidence. Victims usually do not have hard evidence to prove the existence of the crime, which gives libelers ample opportunities to fake as victims. This article shows that, despite this difficulty, allegations without hard evidence have a certain level of credibility. First, an allegation proves the existence of an individual who has the intention of either a victim or a libeler. This fact alone may carry some credibility if the probability of existence of such potential allegation makers is larger for a true criminal than for an innocent person. Second, the tendency of sexual criminals to repeatedly offend gives a victim more confidence about the existence of another potential corroborator than it gives a libeler. As a result, in a corroboration equilibrium, a victim is more motivated to encourage other potential corroborators by leading with a first report against the accused than a libeler is against an innocent person. This difference in equilibrium behavior boosts the credibility of an undelayed report while reducing the credibility of a follow-up report that alleges a crime that occurred a long time ago.

The decision maker who handles crime allegations in our model is the police and the prosecution team, who can take into account the entire history of reports to reach a decision of whether to search, arrest, or prosecute. For cases of less severe sexual harassment, the decision maker may be the human resources department of the employer, which may also use Bayesian inference to reach a decision on whether the accused should be punished or not. It also applies to the decision of the trial judge or jury whenever "prior bad acts" are admissible under the Federal Rules of Evidence, whether as an exception to Rule 404, under Rule 406 to establish a habit, or under Rules 413 through 415, all of which are adopted by most states (Reed 1993).

Absent in our model are the settlement between the accused and the accuser and the confidentiality clauses typical in settlement agreements. These clearly played a role in the suppression of some public allegations of crimes and misconduct. Neither do we consider fully the possible behavioral responses by the agent being accused. In the main model, we simply assume that the agent's behavior is nonstrategic. In Section IVC, we present an extension in which an agent strategically decides whether to engage in a crime. Nevertheless, he always chooses to commit the first crime because one allegation is not sufficient to lead to an arrest. More realistically, there are significant costs to an agent when he is publicly accused, such as loss of reputation, even if the accusation does not constitute sufficient evidence to cause an arrest. A public allegation may also cause other potential victims to take more caution against the agent. Our extended model does not fully capture these deterrence effects arising from crime allegations. Incorporating these more realistic features into our model is an agenda for further research.

Appendix

A. *Omitted Proofs*

PROOF OF LEMMA 1:

Take the derivative of $f(c, a; p)$ in equation (3) with respect to a to get

$$\frac{\partial f}{\partial a} = \frac{(1/2)p}{1 - (1/2)pa}\left[f(c, a; p) - \delta(1 - c) - (1 - c)\right],$$

which is negative because $f(c, a; p) < 1 - c$. ∎

PROOF OF LEMMA 2:

Take the derivative of equation (3) with respect to p to get

$$\frac{\partial f}{\partial p} = \frac{1}{1-(1/2)pa}\Big[\frac{1}{2}af(c,a;p) + c + \frac{1}{2}\big(\delta - c - a\delta(1-c)\big) + \frac{1}{2}(1-a)(1-c)\Big]$$

$$> \frac{(1/2)a}{1-(1/2)pa}\Big[f(c,a;p) + c + \delta\big(1 - a(1-c)\big) + (1-a)(1-c)\Big],$$

which is positive because $f(c,a;p) > -c$. ■

PROOF OF PROPOSITION 5:

(i) We have shown in the text that $a_{rr} < a^*$. Note also that b_{rr} satisfies $F_{rr}(b_{rr};q) = 0$. Because $F_{rr}(a;p)$ is single crossing from above in a and increasing in p, $q < p$ implies $b_{rr} < a_{rr}$.

In an rr-equilibrium, event rr occurs with probability $p\lambda_v a_{rr}$. The corresponding likelihood ratio is $\ell(rr) = p\lambda_v a_{rr}/(q\lambda_l b_{rr})$. Two events lead to the event r. Either the current period is period 1 and V_1 reports (this happens with probability $(1/2)\lambda_v a_{rr}$), or the current period is period 2 and V_1 either did not exist or did not report while V_2 reports (this happens with probability $(1/2)(1-pa_{rr})\lambda_v a_{rr}$). Therefore, $\ell(r) = \lambda_v(2-pa_{rr})a_{rr}/(\lambda_l(2-qb_{rr})b_{rr})$. Substituting $a_{rr} = p\delta/(2-pa_{rr})$ and $b_{rr} = q\delta/(2-qb_{rr})$, we obtain $\ell(r) = p\lambda_v/q\lambda_l$. Therefore, an rr-equilibrium exists if

$$\hat{\ell} \in (\underline{\ell}_{rr}, \overline{\ell}_{rr}] \equiv \left(\frac{p\lambda_v}{q\lambda_l}, \frac{p\lambda_v a_{rr}}{q\lambda_l b_{rr}}\right].$$

The event $r\phi$ occurs when V_1 exists and makes a report but V_2 does not exist. The corresponding likelihood ratio is $\ell(r\phi) = \lambda_v(1-p)a_{rr}/(\lambda_l(1-q)b_{rr}) < \underline{\ell}_{rr}$. The events R and rR are off equilibrium, and we can assign off-equilibrium beliefs such that their corresponding likelihood ratios are below the standard of proof.

Because $a_{rr} > b_{rr}$, it is obvious that the interval $(\underline{\ell}_{rr}, \overline{\ell}_{rr}]$ is nonempty. To establish that $\overline{\ell}_{rr} > \overline{\ell}^*$, we show

$$\frac{a_{rr}}{b_{rr}} > \frac{a^*(1-a^*)}{b^*(1-b^*)}.$$

Because these two sides are equal when $p = q$, it suffices to show that $a^*(1-a^*)/a_{rr}$ decreases in p, which requires

$$\frac{1-2a^*}{a^*(1-a^*)}\frac{\partial a^*}{\partial p} < \frac{1}{a_{rr}}\frac{\partial a_{rr}}{\partial p}.$$

If $a^* \geq 1/2$, then the condition above is satisfied. So, assume $a^* < 1/2$. In this case, the condition above is equivalent to

$$\frac{1-2a^*}{(1-a^*)\big(2+(1+\delta)p(1-2a^*)\big)} < \frac{1}{2-2pa_{rr}},$$

which holds for all $a^* < 1/2$.

Finally, we establish that $p \leq 2/3$ implies $\underline{\ell}_{rr} > \underline{\ell}^*$. Because the latter is equivalent to

$$\frac{(2-p)\,a^*}{(2-q)\,b^*} < \frac{p}{q},$$

it is sufficient to establish that $(2-p)\,a^*/p$ decreases in p, i.e.,

$$-2a^* + (2-p)p\frac{\partial a^*}{\partial p} = -2a^* + (2-p)\frac{2a^*}{2+(1+\delta)p(1-2a^*)} < 0.$$

This inequality holds because $p \leq 2/3$ implies $a^* < 1/2$.

(ii) We have shown in the text that $a_{rR} < a^*$. As in part (i) of the proof, $q < p$ implies $b_{rR} < a_{rR}$.

In an rR-equilibrium, the likelihood ratio corresponding to event rR is $\ell(rR) = p\lambda_v a_{rR}(1-a_{rR})/(q\lambda_l b_{rR}(1-b_{rR}))$, and the likelihood ratio corresponding to event r is $\ell(r) = \lambda_v(2-p)\,a_{rR}/(\lambda_l(2-q)b_{rR})$. The event $r\phi$ occurs whenever V_1 exists and makes a report (because V_2 does not report as rr does not lead to arrest). The corresponding likelihood ratio is $\ell(r\phi) = \lambda_v a_{rR}/(\lambda_l b_{rR}) > \ell(r)$. An rR-equilibrium exists if

$$\hat{\ell} \in (\underline{\ell}_{rR}, \overline{\ell}_{rR}] \equiv \left(\frac{\lambda_v a_{rR}}{\lambda_l b_{rR}}, \frac{p\lambda_v a_{rR}(1-a_{rR})}{q\lambda_l b_{rR}(1-b_{rR})}\right].$$

The events R and rr are off equilibrium, and we can assign off-equilibrium beliefs such that their corresponding likelihood ratios are below the standard of proof.

To show that the interval $(\underline{\ell}_{rR}, \overline{\ell}_{rR}]$ is nonempty, we need to show that $p(1-a_{rR}) > q(1-b_{rR})$. It suffices to show that the left-hand side of this inequality is increasing in p, which requires

$$1 - a_{rR} - p\frac{\partial a_{rR}}{\partial p} = 1 - a_{rR} - \frac{2\,a_{rR}}{2+(1+\delta)p(1-2\,a_{rR})} > 0.$$

It is straightforward to verify that $F_{rR}(1/2;p) < 0$. As $F_{rR}(\cdot\,;p)$ is single crossing from above, we have $a_{rR} < 1/2$, which implies that the inequality condition displayed above holds.

Next we show that

$$\frac{a^*(1-a^*)}{b^*(1-b^*)} < \frac{a_{rR}(1-a_{rR})}{b_{rR}(1-b_{rR})}.$$

It is sufficient to show that $(a^*(1-a^*))/(a_{rR}(1-a_{rR}))$ decreases in p, i.e.,

$$\frac{1-2a^*}{a^*(1-a^*)}\frac{\partial a^*}{\partial p} - \frac{1-2\,a_{rR}}{a_{rR}(1-a_{rR})}\frac{\partial a_{rR}}{\partial p} < 0.$$

Plugging in the partial derivatives, this is equivalent to

$$\frac{1-2\,a^*}{(1-a^*)\big(2+(1+\delta)p(1-2\,a^*)\big)} - \frac{1-2\,a_{rR}}{(1-a_{rR})\big(2+(1+\delta)p(1-2\,a_{rR})\big)} < 0,$$

which reduces to

$$(1+\delta)p(1-2a^*)(1-2a_{rR})(a^*-a_{rR}) \ < \ 2(a^*-a_{rR}).$$

Because $a^* \ > \ a_{rR}$, the inequality above is true. This establishes that $\bar{\ell}^* \ < \ \bar{\ell}_{rR}$.

Finally, we show that $p \ \leq \ 2/3$ implies

$$\frac{(2-p)\,a^*}{(2-b)\,b^*} \ < \ \frac{a_{rR}}{b_{rR}}.$$

It suffices to show that $(2-p)\,a^*/a_{rR}$ decreases in p, which is equivalent to

$$-1+\frac{4(2-p)(1+\delta)(a^*-a_{rR})}{\big(2+(1+\delta)p(1-2a^*)\big)\big(2+(1+\delta)p(1-2a_{rR})\big)} \ < \ 0.$$

The left-hand side is increasing in δ. Therefore, it is sufficient to establish that

$$-1+\frac{2(2-p)(a^*-a_{rR})}{\big(1+p(1-2a^*)\big)\big(1+p(1-2a_{rR})\big)} \ < \ 0.$$

From equations (4) and (9), we obtain

$$2(a^*-a_{rR}) \ = \ p\delta - p(1+\delta)\big(a^*(1-a^*) - a_{rR}(1-a_{rR})\big) \ < \ p\delta,$$

because $p \ \leq \ 2/3$ implies $a^* \ < \ 1/2$. Hence, $2(2-p)(a^*-a_{rR}) \ < \ 1$, which establishes that $\underline{\ell}^* \ < \ \underline{\ell}_{rR}$. ∎

PROOF OF PROPOSITION 7:

(a) Let E denote the set of events $\mathcal{E}$ such that $\ell(\mathcal{E}) \ \geq \ \hat{\ell}$ (i.e., the set of events that lead to an arrest). In an r-equilibrium, $r \ \in \ E$ and $R \ \notin \ E$. If $r \ \in \ E$, then it does not matter whether any of $r\phi$, rr, and rR is in E. The events $r\phi$ and rr will not appear because the game ends right after r. The event rR is off equilibrium because within a period after r, no one has incentive to make a delayed report.

In an r-equilibrium, reporting immediately gives a new victim $1-c$. Not reporting gives her $(1/2)pa\delta/(1-(1/2)pa)$ (when the victim is V_1 and V_2 exists and reports with probability a). The equilibrium probability of reporting right away, denoted a_r, is defined by the solution to the following equation:

$$F_r(a;p) \ \equiv \ 1-a-\frac{(1/2)\,pa}{1-(1/2)\,pa}\delta \ = \ 0.$$

A new libeler reports right away with probability b_r, which satisfies $F_r(b_r;q) \ = \ 0$. As $F_r(a;p)$ is single crossing from above in a and is decreasing in p, a_r is decreasing in p. From this we obtain $a_r \ < \ b_r$.

The event r occurs either when V_1 reports immediately (which happens with probability $(1/2)\lambda_v a_r$) or when V_2 reports immediately if V_1 does not report (which happens with probability $(1/2)(1 - pa_r)\lambda_v a_r)$. The corresponding likelihood ratio is $\ell(r) = \lambda_v(2 - pa_r)a_r/(\lambda_l(2 - qb_r)b_r)$. Thus, an r-equilibrium exists if and only if

$$\hat{\ell} \leq \bar{\ell}_r \equiv \frac{\lambda_v(2 - pa_r)a_r}{\lambda_l(2 - qb_r)b_r}.$$

The event R is off equilibrium, and we can assign off-equilibrium beliefs such that $\ell(R) < \hat{\ell}$. Note that $\bar{\ell}_r < \lambda_v/\lambda_l$ if and only if $(2 - pa_r)a_r/((2 - qb_r)b_r) < 1$. This condition is true because $p > q$ and $(2 - pa_r)a_r$ is decreasing in p.

(b) We next consider an R-equilibrium, in which $R \in E$ but $r \notin E$. If $r \notin E$, then $r\phi$ is not in E. Otherwise, after r, no one (victim or libeler) will report. So the belief after $r\phi$ should be the same as the belief after r, which forms a contradiction. It follows that there are only four possible types of R-equilibrium:

(i) $r \notin E, \quad R \in E, \quad rr \in E, \quad rR \in E;$

(ii) $r \notin E, \quad R \in E, \quad rr \notin E, \quad rR \in E;$

(iii) $r \notin E, \quad R \in E, \quad rr \in E, \quad rR \notin E;$

(iv) $r \notin E, \quad R \in E, \quad rr \notin E, \quad rR \notin E.$

Consider case (i). For a new victim, reporting immediately gives a payoff of

$$\frac{(1/2)pa}{1 - (1/2)pa}\delta + \frac{(1/2)p(1 - a)}{1 - (1/2)pa} - c.$$

Not reporting gives payoff of

$$\frac{(1/2)pa}{1 - (1/2)pa}\delta(1 - c) + \frac{(1/2)p(1 - a)}{1 - (1/2)pa} + \frac{(1/2)(1 - pa)}{1 - (1/2)pa}\delta(1 - c),$$

because any V_1 can delay reporting to achieve an arrest even if V_2 does not exist. Thus, not reporting immediately dominates reporting immediately even when $c = 0$. It follows that the equilibrium probabilities of reporting immediately by new victims and new libelers are $a_R = b_R = 0$. Only event R occurs in equilibrium; rr and rR are off-equilibrium events. The likelihood ratio associated with event R is λ_v/λ_l. Thus, an R-equilibrium exists if and only if

$$\hat{\ell} \leq \bar{\ell}_R \equiv \frac{\lambda_v}{\lambda_l}.$$

In case (ii), the payoff from reporting immediately is smaller than that in case (i) (because the first term of that payoff becomes 0 when rr does not lead to arrest), but the payoff from not reporting immediately remains the same as that in case (i). It follows that not reporting immediately still dominates reporting immediately. The equilibrium probabilities of reporting immediately are $a_R = b_R = 0$, and this equilibrium exists if and only if $\hat{\ell} \leq \lambda_v/\lambda_l$.

In case (iii), the payoff difference between reporting immediately and not reporting immediately for a new victim is

$$f_R(c,a;p) \equiv \left(\frac{(1/2)pa}{1-(1/2)pa}\delta - c\right) - \left(\frac{(1/2)p(1-a)}{1-(1/2)pa} + \frac{(1/2)(1-pa)}{1-(1/2)pa}\delta(1-c)\right).$$

Thus, $f_R(a,a;p) = 0$ if and only if

$$pa\delta - a(2-pa) - p(1-a) - (1-pa)\delta(1-a) = 0.$$

The left-hand side of the equation above is convex in a and is negative at $a = 0$ and at $a = 1$. Therefore, $f_R(a,a;p) < 0$ for all $a \in [0,1]$. The only equilibrium probabilities of reporting consistent with this case are $a_R = b_R = 0$, and this equilibrium exists if and only if $\hat{\ell} \leq \lambda_v/\lambda_l$.

In case (iv), the payoff from reporting immediately is smaller than that in case (iii), but the payoff from not reporting immediately remains the same as that in case (iii). It follows that not reporting immediately still dominates reporting immediately. The equilibrium probabilities of reporting immediately are $a_R = b_R = 0$, and this equilibrium exists if and only if $\hat{\ell} \leq \lambda_v/\lambda_l$. ∎

B. *Other Model Extensions*

Replacing Correlation with Independence.—The correlation between the existence for the victims across two periods fits the story of recidivism for the sexual crime offenders. The key of the analysis is that a victim expects another victim to exist with a higher probability than a libeler expects of another libeler. Therefore, the difference in the behaviors of victims and libelers can also be generated by assuming independence across the two periods, if we let the guilty agent hurt a victim each period with a higher probability than an innocent agent offends a potential libeler. That is, one can alternatively assume that a victim exists with independent probability $p \in (0,1)$ in each period for a true criminal, and a libeler exists with independent probability $q \in (0,1)$ in each period for an innocent agent. Then the assumption $p > q$ plays the same role as in the basic model and generates $a^* > b^*$. All qualitative results in the basic model will remain the same.

Accusers Know Which Period They Are In.—In the main setup, a victim is not sure whether she is the early one who gets hurt or the later one who gets hurt. Alternatively, we can let victims know the timing (although such an assumption is less realistic in our view). For $t = 1,2$, let V_t denote the victim hurt by A in period t, who knows that she is hurt in period t. Just as in the main setup, the crucial strategic variables are the probability of leading with an undelayed report. Here, since new victims V_1 and V_2 are distinctive individuals with knowledge of the calendar time, we denote their probability of reporting immediately by a_1 and a_2, respectively. Similarly, we have b_1 for a new first-period libeler and b_2 for a new second-period libeler.

One can show that, just as in the main setup, the net benefits of reporting immediately for a new V_1 and for a new V_2 are both decreasing in the probabilities of leading

$(a_1$ and $a_2)$ by the other victim and increasing in the probability (p) of the existence of the other victim. That is, we have the same strategic substitution and encouragement effect. It is straightforward to show that the equilibrium values of a_1 and a_2 cannot both decrease in p. Indeed, when p is not too large, both a_1 and a_2 increase in p. In this case, we have $a_t > b_t$ for $t = 1, 2$ in a corroboration equilibrium of this alternative model.

More Victims.—Increasing the number of victims or libelers affects the incentive to make a crime allegation through both the encouragement effect and the strategic substitution effect. We illustrate this point by showing that having more potential victims does not necessarily reduce the probability that a new victim will lodge an immediate report, because the encouragement effect may sometimes outweigh the freeriding effect to cause these victims to be more forthcoming in making an allegation.

Consider the following simple modification of the basic model. In period 1, guilty agent A hurts one victim with probability p. In period 2, he hurts *two* victims with probability p. Similarly, an innocent agent A offends one person with probability q in period 1, and another two persons with probability q in period 2. We study a corroboration equilibrium in which at least two accusations against A $(rr$ or $rR)$ are needed before the authorities will arrest him.

The key difference from the basic model is that a victim who learns that there is a prior report against A does not necessarily report against him (i.e., $\hat{\alpha}_2(c) \neq 1)$ because she may count on the other victim in period 2 to file a report. One can show that $\hat{\alpha}_2(c) = 1$ if and only if $c \leq 1/2$.

Given such a strategy by V_2, there are two opposing effects on the incentive of a new victim to report immediately. First, if a victim is V_1, she is worried that the two victims in period 2 may not corroborate her allegation because these two victims freeride on each other (the probability that at least one of these two victims will corroborate V_1's report is only $3/4$), which reduces her incentive to report immediately. On the other hand, if a victim is V_2, lodging a complaint immediately may lead to an arrest if it is corroborated by a contemporary victim, even if V_1 does not exist. This second effect raises the payoff from reporting immediately. Which of these two effects dominates will depend on parameter values. It is not the case that having more potential victims always causes each new victim to be less forthcoming in lodging a complaint.

REFERENCES

Ayres, Ian, and Cait Unkovic. 2012. "Information Escrows." *Michigan Law Review* 111 (2): 145–96.

Chamley, Christophe, and Douglas Gale. 1994. "Information Revelation and Strategic Delay in a Model of Investment." *Econometrica* 62 (5): 1065–85.

Chandrasekhar, Arun G., Benjamin Golub, and He Yang. 2017. "Signaling, Stigma, and Silence in Social Learning." Unpublished. https://pdfs.semanticscholar.org/d48b/1acc8d69c8016808ddc16ee8076a631781e3.pdf?_ga=2.169474088.889643191.1574347628-583193638.1573220884.

Chassang, Sylvain, and Gerard Padró i Miquel. 2014. "Corruption, Intimidation, and Whistle-Blowing: A Theory of Inference from Unverifiable Reports." NBER Working Paper W20315.

Daughety, Andrew F., and Jennifer F. Reinganum. 2011. "A Dynamic Model of Lawsuit Joinder and Settlement." *RAND Journal of Economics* 42 (3): 471–94.

Farrell, Joseph, and Garth Saloner. 1985. "Standardization, Compatibility, and Innovation." *RAND Journal of Economics* 16 (1): 70–83.

Fershtman, Chaim, and Shmuel Nitzan. 1991. "Dynamic Voluntary Provision of Public Goods." *European Economic Review* 35 (5): 1057–67.

Fisher, Bonnie S., Francis T. Cullen, and Michael G. Turner. 2000. *The Sexual Victimization of College Women*. Washington, DC: United States Department of Justice.

Gale, Douglas. 1995. "Dynamic Coordination Games." *Economic Theory* 5 (1): 1–18.

Groth, A. Nicholas, Robert E. Longo, and J. Bradley McFadin. 1982. "Undetected Recidivism among Rapists and Child Molesters." *Crime and Delinquency* 28 (3): 450–58.

Jordan, Jan. 2004. "Beyond Belief? Police, Rape and Women's Credibility." *Criminology and Criminal Justice* 4 (1): 29–59.

Lonsway, Kimberly A., Joanne Archambault, and David Lisak. 2009. "False Reports: Moving beyond the Issue to Successfully Investigate and Prosecute Non-stranger Sexual Assault." https://www.nsvrc.org/sites/default/files/publications/2018-10/Lisak-False-Reports-Moving-beyond.pdf.

Loy, Pamela Hewitt, and Lea P. Stewart. 1984. "The Extent and Effects of the Sexual Harassment of Working Women." *Sociological Focus* 17 (1): 31–43.

Marx, Leslie M., and Steven A. Matthews. 2000. "Dynamic Voluntary Contribution to a Public Project." *Review of Economic Studies* 67 (2): 327–58.

Ostrovsky, Michael, and Michael Schwarz. 2005. "Adoption of Standards under Uncertainty." *RAND Journal of Economics* 36 (4): 816–32.

Pei, Harry, and Bruno Strulovici. 2018. "Strategic Abuse and Accuser Credibility." Northwestern University Center for the Study of Industrial Organization Working Paper 0145.

Perkins, Craig, and Patsy Klaus. 1996. *Criminal Victimization 1994*. Washington, DC: United States Bureau of Justice Statistics.

Polinsky, A. Mitchell, and Steven Shavell. 1989. "Legal Error, Litigation, and the Incentive to Obey the Law." *Journal of Law, Economics, and Organization* 5 (1): 99–108.

Reed, Thomas J. 1993. "Reading Gaol Revisited: Admission of Uncharged Misconduct Evidence in Sex Offender Cases." *American Journal of Criminal Law* 21: 127–221.

Sable, Marjorie R., Fran Danis, Denise L. Mauzy, and Sarah K. Gallagher. 2006. "Barriers to Reporting Sexual Assault for Women and Men: Perspectives of College Students." *Journal of American College Health* 55 (3): 157–62.

Spence, Michael. 1973. "Job Market Signaling." *Quarterly Journal of Economics* 87 (3): 355–74.