Title	Pseudo-Adversarialism
Sub Title	
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Publisher	Keio Economic Society, Keio University
Publication year	2011
Jtitle	Keio Economic Society discussion paper series Vol.11, No.3 (2011.)
JaLC DOI	
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Notes	
Genre	Technical Report
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=AA10715850-00001103-0001

Pseudo-Adversarialism

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July 14, 2011

Abstract

This article offers a unified theoretical framework to address two distinctive forms of adversarial procedure: the *bona fide* adversarial system and the *pseudo*-adversarial system. In the former, a harsh contest between the prosecution and the defense is promoted, and an acquittal is rendered with sufficient likelihood. In the latter, the prosecution overpowers the defense so that defendants are almost always convicted. We explain this institutional divergence as a result of optimal incentive designs adapted to diverse environments. Policy variables of these incentive designs include a judge's standard of proof beyond reasonable doubt, a prosecutor's discretionary rule for indictment, and a defendant's right to counsel. Our theory suggests that the *bona fide* adversarial system functions best with jury trials, publicly-elected prosecutors, and competent defense counsels, while the *pseudo*-adversarial system functions best with bench trials, bureaucratic prosecutorial offices, and compromised counsels. We further investigate how these two adversarial systems can simultaneously persist.

Keywords: criminal trial; adversarial procedure; prosecutorial discretion; right to counsel.
JEL classifications: D02; D73; K41.

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1 Introduction

Among criminal justice systems which employ the so-called adversarial procedure, two distinctive patterns are frequently pointed out by scholars of comparative legal studies. One, whose representative form is found in the U.S., encourages contests between prosecutors and defense attorneys for the sake of uncovering facts, ensuring an equitable number of acquittals. The other, for which the Japanese judiciary is particularly famous, is characterized by a heavy-handed prosecution and a weak, compromised defense, so that a conviction is almost guaranteed. Following Matsuo (1979), we label the former a *bona fide* adversarial system and the latter a *pseudo*-adversarial system.[1] The question of why this institutional divergence has emerged and persists across judiciaries has long concerned scholars. We address this question with a game-theoretic model which offers novel insights.

In the adversarial system, litigation is shaped by the interplay among judges, prosecutors, and defense attorneys. In recognition of the significance of this interplay in court, numerous game-theoretic studies (e.g., Dewatripont and Tirole 1998; Parisi 2002; Nakao and Tsumagari 2011) have been conducted in order to better understand the adversarial system. However, existing studies focus mostly on the *bona fide* adversarial system as we have called it, while the *pseudo*-adversarial system has been largely dismissed by the theoretical literature. A prominent theoretical study of the Japanese judiciary is that of Ramseyer and Rasmusen (2001). They argue that the cause of the very high conviction rate lies in prosecutors' careful screening of weak cases, but we stress that the roles of judges and defense attorneys might be equally critical for the functioning of the *pseudo*-adversarial system. In other words, our analyses are based on strategic interdependency among court participants rather than merely on the individual decision-making of a single participant.

To the best of our knowledge, the Japanese judiciary is characterized by the three key players' following behavioral patterns. Judges, assuming the role of partisan arbiters, pronounce the defendant guilty in the overwhelming majority cases and produce a more than 99% rate of conviction. An outside observer might conjecture that, based on this statistic, judges heavily and perhaps unfairly favor the prosecuting party against the defense. This kind of straightforward conjecture, however, does

[1] This procedural dichotomy within the adversarial system may mirror the separation between formal and real authorities (Aghion and Tirole 1997).

not hold up against empirical criticisms (e.g., Ramseyer and Rasmusen 2001). In fact, there is broad consensus among scholars that prosecutors examine evidence very carefully and do not hesitate to drop a charge if there is even a slight possibility of acquittal (Noguchi 2006).[2] Such selective prosecution is usually explained by lack of human or financial resources (Ramseyer and Rasmusen 2001) or by career penalty on prosecutors for mistaken charges (Johnson 2002a: 228; 2007). Unlike the roles of prosecuting attorneys, those of defense attorneys are obscured and hardly visible, often limited to assisting prosecutors by convincing defendants to acknowledge guilt (Foote 2002; Goodman 2008: 418; Miyazawa 2002). Moreover, the rights of criminal suspects are less protected in Japan than in other liberal democracies (Johnson and Shinomiya 2007; Murayama 2002; Suess 1996). In short, the judiciary process in Japan fails to embrace adversarial ideals, and criminal trials remain nothing more than a formal ceremony (Ishimatsu 1989).

To delineate the contrast between the adversarial system's two distinctive forms, we develop a formal model of criminal procedure which features (i) imperfect transmission of inculpatory evidence from the prosecutor to the judge and (ii) the defense counsel's effectiveness in disproving the evidence. The model also highlights the three key players' strategic interactions by parameterizing the judge's threshold of reasonable doubt (q), the prosecutor's discretionary rule for indictment (a), and the defendant's right to effective counsel (e). In the model, a prosecutor (P) decides to indict a suspect or not, while a judge (J) convicts or acquits the indicted suspect. (In contrast, the defense attorney does not make any strategic decision except in our final extension of the model where he chooses the quality of his counsel service.)

We first treat the effectiveness of the defense counsel as given (in Sections 2 to 6) and seek normative implications by introducing a social welfare function which measures the expected loss from erroneous judgments. Our analyses suggest that if the defense counsel can play a decisive role in assisting the judge to collect evidence, the judge may be in a position to receive more informative evidence than the prosecutor, and thus adjudication should be made by the judge. In this situation, the optimal incentive arrangement ideally promotes a harsh contest between the litigants in order to make the most use of evidence submitted from them, and it constitutes the *bona*

[2] In the U.S., on the contrary, prosecutors may indict suspects if they have *prima facie* evidence (Hirano 1989) in part because elected prosecuters are more vulnerable to political pressures from their constituency who tend to demand harsh punishments for offenders (Johnson 2002a: 15, 37, 106-107).

fide adversarial system.

In contrast, if the defense cannot effectively counteract the prosecution, little evidence can be brought from the defense to the judge. In this case, the prosecutor is superior to the judge in terms of knowledge of the case due to the noise in communication between them. In light of this informational advantage, the prosecutor is better suited than the judge to serve as the ultimate adjudicator. Thus the optimal incentive arrangement in this situation dictates that the prosecutor cautiously dismiss weak cases while the judge contents herself with merely confirming prosecutorial decisions by convicting defendants, resulting in the *pseudo*-adversarial system. In sum, the optimal incentive arrangement hinges on the relative merit between the effective defender system (which is essential for the *bona fide* adversarial system) and the informative evidence produced by the prosecution (which is favorable to the *pseudo*-adversarial system).

An important policy implication has surfaced from our theoretical investigation. A judicial reform from the *pseudo*-adversarial system to the *bona fide* adversarial system cannot be partial; it must be comprehensive. An attempt simply to lower the standard of proof or to indict more defendants would likely be insufficient and possibly even detrimental. The *bona fide* adversarial system would require not only the filing of more (and possibly weaker) cases, but also the guarantee of indigent defendants' access to effective counsel (Klein 1986; 1993).[3]

Our model has yielded a surprising finding about the *pseudo*-adversarial incentive arrangement. It suggests that if the defense counsel is not sufficiently effective, the incentive design should create a *pro-defendant bias* in the judge's mind (or a higher standard of proof required for conviction) to prevent too weak cases from being brought to court.[4] In other words, deliberate prosecution in the Japanese judiciary, according to this model, is a rational response to judges' strict interpretation of reasonable doubt (Clermont 2004: 267; Johnson 2002a: 65, 242; 2007). In this regard, it makes sense not to introduce the jury system to the Japanese judiciary because it functions to preserve an arbiter's neutrality (Feeley 1987; Shinomiya 2002). This

[3]The Japanese judiciary recently introduced a *quasi*-jury system (saiban in seido) and reformed the committee for the inquest of prosecution (kensatsu shinsa kai). It also enacted the right to court-appointed counsel at the pre-trial stage.

[4]Miceli (1990), like us, suggests the merit of creating a pro-defendant bias in the judge's mind but with a different reason. According to him, a judge's pro-defendant bias would induce prosecutors to produce evidence more effectively.

finding is in sharp contrast to the straightforward conjecture to the more than 99% conviction rate argued above.

Another approach to reducing erroneous judgments would be to furnish prosecutors with more influence over judges who tend to be less informed in the absence of an effective defender system. Our analysis suggests that a pre-committed rule for prosecution is helpful for the realization of "prosecutorial justice" (Cho 1998) which holds that prosecutors ought to serve the judiciary as *de facto* adjudicators. If prosecutors always treat similar cases in similar ways, judges do not have to hesitate to convict any indicted suspects. Our prediction that the pre-committed indictment rule will secure prosecutorial justice is consistent with the observation that the Japanese prosecutorial office employs a unified rule for indictment decisions and behaves, in essence, as a single actor. U.S. prosecutors, by contrast, are elected from different jurisdictions and work independently for their electorates (Johnson 2002a: 119-120, 153-159, 230; Noguchi 2006).

Our final analysis endogenizes defense effectiveness in each system and investigates why two separate forms of the adversarial system have been maintained for so long. We hypothesize two possible reasons for this institutional divergence. First, a better defender system enhances social welfare at increasing rates. This convex property of the social welfare function with respect to defense effectiveness suggests that the optimal effectiveness is likely to be at either a very high or a very low level, corresponding respectively to the *pseudo*- or *bona fide* adversarial system instead of to an alternative one between the two. Intuitively, if prosecutors bring only true criminals to court, even a competent defense attorney will hardly be able to vindicate his client in trial. Second, in the *pseudo*-adversarial system, lawyers lack private motives to polish their criminal defense skills. Given that an acquittal is almost impossible, their interests may incline more toward civil cases or other tasks from which a fair amount of pecuniary returns can be expected (Johnson 2002a: 241; Murayama 2002; Shinomiya 2002). Therefore, a judicial reformer may encounter much difficulty in transforming the criminal court into a place of authentic dispute.

The rest of the article proceeds as follows. Section 2 presents a game-theoretic model of criminal procedure whose equilibria are derived in Section 3. Section 4 considers incentive arrangements to induce the first-best decision profile of indictment and judgment. Sections 5 to 7 address the model's implications toward criminal justice systems. Section 5 introduces two adversarial forms which may emerge as responses to their respective environments. Section 6 hypothesizes that the hierarchical structure of prosecutors' offices may hold implications for how a criminal system operates. Section 7 offers possible explanations for why judiciaries have maintained the two adversarial systems for so long. Section 8 offers a conclusion. All proofs appear in the Appendix.

2 The Model of Criminal Procedure

This section presents a game-theoretic model of criminal procedure. The model aims to assist us in analyzing how various procedural constituents in court such as prosecutorial discretion, the right to counsel, and the reasonable-doubt standard function interdependently.

2.1 Outline of the Game

The game starts when a suspect is apprehended. Neither prosecutor P nor judge J know whether the suspect is guilty or innocent $s \in \{G, I\}$, but they share the prior probability that the suspect is guilty. Based on inculpatory evidence summarized as a signal $s_P \in [0,1]$, the prosecutor P decides whether or not to indict the suspect. His decision is denoted as a mixed strategy $\sigma_P(s_P) \in [0,1]$, which represents the probability of indictment given s_P.

If the prosecutor P drops a charge against the suspect, he receives normalized payoff of zero, and the game ends. If he files a charge, he submits evidence to court. The judge J then receives a signal $s_J \in [0,1]$, which can differ from s_P due to noisy communication between them. This communication is imperfect because: (i) evidence the prosecutor possesses contains unverifiable information; (ii) it may be censored or even falsified by the prosecutor in his favor; (iii) it can be partially invalidated by the defense.

Based on the signal s_J, the judge J decides to convict or acquit the defendant (i.e., the indicted suspect). Her decision is expressed as a mixed strategy $\sigma_J(s_J) \in [0,1]$, which is the probability of conviction given s_J. The game terminates with conviction, acquittal, or dismissal: $t \in \{C, A, D\}$.

The players P and J are treated as rational actors who seek to maximize their payoffs. An indictment generates the cost of litigation c to the prosecutor P, who further gains a reward $w \geq 0$ from winning a conviction and incurs a loss $l \geq 0$ from an acquittal. A negative c encourages indictment. On the other hand, the judge J's sole concern is the just enforcement of criminal law. She thus prefers the defendant to be convicted if and only if her belief of guilt is beyond the threshold of "reasonable doubt" $q \in (0,1)$ (Feddersen and Pesendorfer 1998). Namely, J's *ex-post* payoff is $-q$ when an innocent defendant is convicted, $q-1$ when a guilty one is discharged or acquitted, and zero otherwise.

For convenience, we use the following notations for the pure strategies:

Definition 1 *(i) $\overline{\sigma}_P(\bar{s}_P)$ denotes P's pure strategy that dictates indictment ($\sigma_P(s_P) = 1$) if $s_P > \bar{s}_P$ and dismissal ($\sigma_P(s_P) = 0$) if $s_P < \bar{s}_P$; (ii) J's pure strategy is defined as $\overline{\sigma}_J(\bar{s}_J)$ in a similar manner.*[5]

By these pure strategies $\overline{\sigma}_P(\bar{s}_P)$ and $\overline{\sigma}_J(\bar{s}_J)$, the prosecutor P indicts the suspect if and only if his signal s_P is larger than a critical value $\bar{s}_P$, and the judge J convicts the defendant if and only if her signal s_J exceeds $\bar{s}_J$.

2.2 Informational Structure

We next define the distributions of the two signals s_P and s_J. The prosecutor P's signal s_P follows a conditional density $f_P(s_P|s)$, which is both continuous and positive on $s_P \in (0,1)$ for $s \in \{G, I\}$. The conditional density $f_J(s_J|s_P, s, e)$ of the judge J's signal s_J is also continuous and positive on $s_J \in (0,1)$ for any $s_P \in [0,1]$, $s \in \{I, G\}$, and $e \in [0,1]$, where e denotes the overall quality of defense lawyers in a jurisdiction or the "effectiveness" of criminal defense. This effectiveness e would be determined by the constitutional protection of defendants' right to counsel or by the burden of case loads to defense lawyers. It is so far treated exogenously, and the defense counsel does not make any strategic choice in the game.[6] The counsel's quality e can influence the judge's impression of the case (more precisely, the distribution of s_J) when the defendant is truly innocent but is uninfluential otherwise. Formally, the conditional

[5] As shown later, the probabilities that $s_P = \bar{s}_P$ and that $s_J = \bar{s}_J$ are zero and therefore are safely ignored.

[6] Section 7 analyzes the extension that the parameter e is a policy variable controlled by a social planner.

density of s_J can be shown as:

$$\begin{aligned} f_J(s_J|s_P,G) &= \widetilde{f}_J(s_J|s_P) \\ f_J(s_J|s_P,I,e) &= \widetilde{f}_J(s_J|s_P) + e\phi(s_J), \end{aligned}$$

where $\widetilde{f}_J(s_J|s_P)$ is the density $f_J(s_J|s_P,s,e)$ when $e=0$ for any $s \in \{I,G\}$, and $\phi(s_J)$ determines how the counsel quality affects the signal s_J in I. $\widetilde{f}_J(s_J|s_P)$ must be continuous and positive on s_J, and $\int_0^1 \phi(s_J)ds_J = 0$. For notational convenience, we define the joint density of s_J and s_P conditional on s to be

$$g(s_J, s_P|s,e) \equiv f_J(s_J|s_P,s,e)f_P(s_P|s).$$

All the density functions, the parameter e, and players' payoffs are common knowledge. The density functions satisfy the following monotone likelihood ratio properties (MLRP):

Assumption 1 *(i)* $\frac{\widetilde{f}_J(s_J|s_P)}{\widetilde{f}_J(s_J|s_P^{'})}$ *decreases in* s_J *for any* $s_P < s_P^{'}$. *(ii)* $\frac{g(s_J,s_P|I,e)}{g(s_J,s_P|G)}$ *decreases in* s_P *for any* $e \in [0,1]$ *and in* s_J *for any* $e \in (0,1]$.

Assumption 1 guarantees: (i) a larger s_P tends to yield a larger s_J in state G; (ii) a larger s_P or s_J implies that the suspect is more likely to be guilty.

Lemma 1 *(i) The prosecutor P's belief of guilt* $\Pr(G|s_P)$ *increases in* s_P*, where*

$$\begin{aligned} \Pr(G|s_P) &= \frac{\Pr(G)\, f_P(s_P|G)}{\Pr(G)\, f_P(s_P|G) + \Pr(I)\, f_P(s_P|I)} \\ &= \frac{1}{1+\frac{\Pr(I)}{\Pr(G)}\frac{f_P(s_P|I)}{f_P(s_P|G)}}. \end{aligned}$$

(ii) There exists a unique $\hat{s}_J \in (0,1)$ *such that* $\phi(\hat{s}_J) > 0$ *for* $s_J < \hat{s}_J$ *and* $\phi(\hat{s}_J) < 0$ *for* $s_J > \hat{s}_J$.

It can be deduced from Lemma 1-(ii) that an effective defense ($e > 0$) can weaken inculpatory evidence s_J when the defendant is truly innocent.

3 Equilibrium Analyses

This section delivers best responses and equilibria. We employ the perfect Bayesian equilibrium as the game's solution.

3.1 Best Responses

The best response of the prosecutor P can be determined as follows. Given the signal s_P and the judge J's strategy $\sigma_J(\cdot)$, P's *interim* payoff from indictment is

$$\Pr(A|s_P)(-l) + \Pr(C|s_P)w - c = (\Pr(C|s_P) - a)(w + l),$$

where

$$a \equiv \frac{c + l}{w + l}$$

and $\Pr(t|s_P)$ ($t \in \{C, A\}$) is P's belief that J pronounces a decision t given s_P. For instance,

$$\begin{aligned}\Pr(C|s_P) &= \Pr(C|s_P, \sigma_J(\cdot), e) \\ &= \sum_{s\in\{G,I\}} \Pr(s|s_P) \int_0^1 \sigma_J(s_J) f_J(s_J|s_P, s, e) ds_J.\end{aligned}$$

The prosecutor P prefers to indict a suspect if and only if he expects a conviction to be likely enough that $\Pr(C|s_P) > a$.

Lemma 2 *With J's pure strategy $\bar{s}_J \in (0, 1)$ of $\overline{\sigma}_J(\bar{s}_J)$, (i) $\Pr(C|s_P, \overline{\sigma}_J(\bar{s}_J), e)$ increases in s_P, (ii) decreases in $\bar{s}_J$, and (iii) decreases in e.*

By Lemma 2, (i) P responds to J's pure strategy $\overline{\sigma}_J(\bar{s}_J)$ with a pure strategy $\overline{\sigma}_P(\bar{s}_P)$; (ii) as J raises the standard of proof $\bar{s}_J$, P also raises the bar for indictment $\bar{s}_P$; (iii) a more effective defender system makes a conviction less likely (for a given standard of proof $\bar{s}_J$) and thus discourages P from indicting a suspect.

We next derive the judge J's rational behavior. Given her signal s_J and the prosecutor P's strategy $\sigma_P(\cdot)$, J's *interim* expected payoff when choosing her strategy

$\sigma_J(s_J)$ is:

$$\begin{aligned} & \sigma_J(s_J)\Pr(I|s_J)(-q) + (1-\sigma_J(s_J))\Pr(G|s_J)(q-1) \\ = \; & \sigma_J(s_J)[\Pr(G|s_J) - q] + \Pr(G|s_J)(q-1), \end{aligned}$$

where $\Pr(s|s_J)$ is J's belief of $s \in \{G, I\}$ given s_J. Namely,

$$\begin{aligned} \Pr(G|s_J) &= \Pr(G|s_J, \sigma_P(\cdot), e) \\ &= \frac{1}{1 + \frac{\Pr(I)}{\Pr(G)} \frac{\int_0^1 \sigma_P(s_P) g(s_J, s_P|I, e) ds_P}{\int_0^1 \sigma_P(s_P) g(s_J, s_P|G) ds_P}}. \end{aligned}$$

The judge J's rational decision is to convict a suspect ($\sigma_J(s_J) = 1$) if and only if $\Pr(G|s_J) > q$.

Lemma 3 *(i) Regardless of the prosecutor P's strategy $\sigma_P(\cdot)$, $\Pr(G|s_J)$ increases in s_J. With P's pure strategy $\overline{\sigma}_P(\bar{s}_P)$, (ii) $\Pr(G|s_J, \overline{\sigma}_P(\bar{s}_P), e)$ decreases in $\bar{s}_P$, (iii) decreases in e for $s_J < \hat{s}_J$ and increases in e for $s_J > \hat{s}_J$, where $\hat{s}_J$ is defined in Lemma 1.*

By Lemma 3-(i), a higher s_J indicates to J that the defendant is more likely to be guilty, so that J's best response against P's strategy $\sigma_P(\cdot)$ is always pure $\overline{\sigma}_J(\bar{s}_J)$;[7] therefore, J, having the higher threshold of reasonable doubt (q), sets the higher standard of proof ($\bar{s}_J$). By (ii), if P is more deliberate for indictment, J can be more confident in rendering a conviction (for a given s_J). By (iii), if the defense is more effective, the signal s_J becomes more informative to J, helping her to draw the conclusion that the defendant is guilty.

3.2 Equilibrium

Lemmas 2 and 3 hold that both players must adopt pure strategies in any equilibrium.

Definition 2 *$(\bar{s}_P^{EQ}, \bar{s}_J^{EQ})$ denotes the thresholds of a pure-strategy equilibrium.*

There always exists a trivial equilibrium in which no suspect is indicted with the belief (off the equilibrium path) that any defendant will be acquitted. We rule out

[7] This is the reason that Lemma 2 focuses on pure strategy $\overline{\sigma}_J(\bar{s}_J)$ of J.

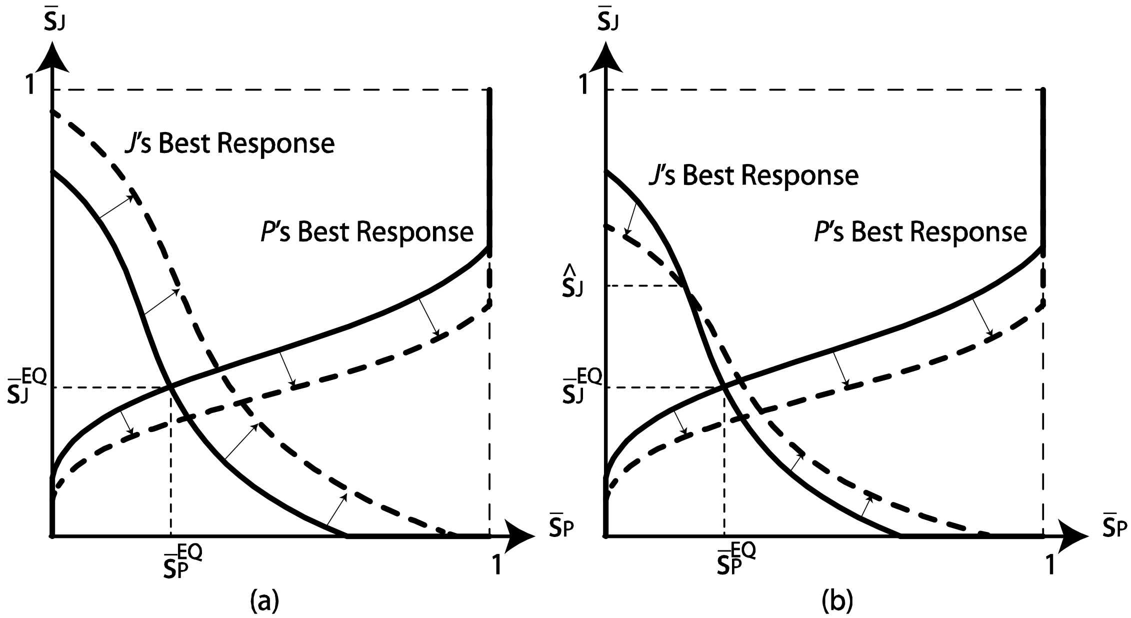

Figure 1: Equilibrium $(\bar{s}_P^{EQ}, \bar{s}_J^{EQ})$ moves (a) when a or q increases and (b) when e increases. [Both figures (a, b) are subject to change.]

this trivial equilibrium. There can also exist uninteresting equilibria when $a = 0$ or $a = 1$ with which P's indictment decision is independent of s_P. We rule out these uninteresting equilibria as well by restricting $a \in (0, 1)$, or equivalently $-l < c < w$, and focus on interesting ones where at least some but not all suspects are indicted.

Proposition 1 *(i) If there exists a non-trivial equilibrium with $\bar{s}_P^{EQ} < 1$, it is unique. In the non-trivial equilibrium where at least some but not all suspects are indicted ($\bar{s}_P^{EQ} \in (0, 1)$), (ii) $(\bar{s}_P^{EQ}, \bar{s}_J^{EQ})$ satisfies that $\Pr(G|s_J = \bar{s}_J^{EQ}, \overline{\sigma}_P(\bar{s}_P^{EQ}), e) = q$ and $\Pr(C|s_P = \bar{s}_P^{EQ}, \overline{\sigma}_J(\bar{s}_J^{EQ}), e) = a$, (iii) an increase in a raises $\bar{s}_P^{EQ}$ (fewer indictments) and lowers $\bar{s}_J^{EQ}$ (more convictions), (iv) an increase in q raises both $\bar{s}_P^{EQ}$ and $\bar{s}_J^{EQ}$, and (v) if $\bar{s}_J^{EQ} < \hat{s}_J$, an increase in e raises $\bar{s}_P^{EQ}$.*

Proposition 1-(i, ii) can be interpreted as such: The equilibrium is determined at the intersection of the best response curves of J and P (Figure 1). By (iii), P sends fewer cases to trial as a increases. This occurs when the reward from conviction (w) is reduced, the penalty from acquittal (l) becomes heavier, or the cost of litigation (c) increases. (This movement corresponds to the downward shift of P's best response curve in Figure 1-(a).) Simultaneously, J lowers the standard of proof $\bar{s}_J^{EQ}$ and renders more convictions. By (iv), a higher threshold of reasonable doubt (q) provokes P to abandon more cases (pushing J's best response curve to the right in Figure 1-(a)). By (v), as e increases, J's best response curve in Figure 1-(b) rotates anti-clockwise, raising the standard of proof ($\bar{s}_J$) where $\bar{s}_J < \hat{s}_J$ but lowering it in the remaining area (Lemma 3-(iii)). An increase in e also causes a downward shift of P's best response curve. In sum, P becomes more reluctant to press a charge when $\bar{s}_J^{EQ} < \hat{s}_J$.

4 Incentive Arrangements

Exploiting the equilibrium outcome above, we consider various incentive arrangements by introducing a benevolent social planner. This section delineates the optimal incentive design given the defense's effectiveness.

4.1 The Social Planner

Assume a social planner who controls two policy instruments (a, b) for a given defense quality e. The former variable a is defined as above, while the latter b, the judge J's pro-defendant bias, is added to the threshold of reasonable doubt q, so that J incurs $-q - b$ from a false conviction and $q + b - 1$ from a false acquittal. The social planner and the judge J have the identical threshold when $b = 0$. The social planner maximizes the social welfare

$$
\begin{aligned}
& V(\bar{s}_P, \bar{s}_J | e) \equiv \Pr(I) \int_{\bar{s}_J}^{1} \int_{\bar{s}_P}^{1} g(s_J, s_P | I) ds_J ds_P (-q) \\
+ \quad & \Pr(G) \left[\int_{0}^{\bar{s}_J} \int_{\bar{s}_P}^{1} g(s_J, s_P | G) ds_P ds_J + \int_{0}^{1} \int_{0}^{\bar{s}_P} g(s_J, s_P | G) ds_P ds_J \right] (q - 1)
\end{aligned}
$$

subject to the equilibrium condition in Proposition 1-(ii) that $(\bar{s}_P, \bar{s}_J) = (\bar{s}_P^{EQ}, \bar{s}_J^{EQ})$. (Note that $\bar{s}_P^{EQ}$ and $\bar{s}_J^{EQ}$ are functions of a, b, and e.)

To make the analysis tractable, we restrict the signal distributions by adding an assumption that holds for the rest of the article:

Assumption 2 *(i) There exists* $\hat{s}_P \in (0, 1)$ *such that* $\Pr(G | \hat{s}_P) = q$. *(ii)* $\Pr(G | s_J = \hat{s}_J, \overline{\sigma}_P(\bar{s}_P = 0), e = 0) > q$.[8]

[8] There exists $q \in (0, 1)$ that satisfies both (i) and (ii) simultaneously. See Claim 2 and its proof in the Appendix.

Assumption 2-(i) means that if the social planner did not know s_J, she would prefer a suspect with small s_P to be freed and one with large s_P to be penalized: $\Pr(G|s_P = 0) < q < \Pr(G|s_P = 1)$. In other words, s_P is informative enough that she can and should condition her decision on s_P. Assumption 2-(ii) guarantees that an improvement of the counsel quality e raises the best-response standard of proof $\bar{s}_J$ for a given $\bar{s}_P$ and therefore favors the defendant. (Graphically, Assumption 2-(ii) means that $\hat{s}_J$ is larger than the $\bar{s}_J$-intercept of J's best response when $e = 0$ in Figure 1-(b).)

4.2 Optimal Policy Bundle

We derive the policy bundle (a, b) that maximizes $V(\bar{s}_P, \bar{s}_J|e)$ in two steps. In Step 1, we find the first-best decision profile $(\bar{s}_P^{FB}, \bar{s}_J^{FB})$ which maximizes the social welfare $V(\bar{s}_P, \bar{s}_J|e)$ without being constrained to equilibrium.

Definition 3 $(\bar{s}_P^{FB}, \bar{s}_J^{FB})$ *denotes the thresholds of the first-best decision profile.*

In Step 2, we show the existence of policy bundle $(a^{FB}(e), b^{FB}(e))$ that achieves the first-best solution even in equilibrium: given that $a = a^{FB}(e)$ and $b = b^{FB}(e)$, $(\bar{s}_P^{EQ}, \bar{s}_J^{EQ}) = (\bar{s}_P^{FB}, \bar{s}_J^{FB})$. Moreover, we show how the optimal policy $(a^{FB}(e), b^{FB}(e))$ can vary across judiciaries with different defense qualities e.

Step 1: First-Best Solution. The first-best solution hinges critically on the defense quality e.

Lemma 4 *There exists $\hat{e} \in (0, 1]$ such that (i) for $e \leq \hat{e}$, $(\bar{s}_P^{FB}, \bar{s}_J^{FB}) = (\hat{s}_P, 0)$ and that (ii) for $e > \hat{e}$, $\bar{s}_P^{FB}$ decreases in e unless $\bar{s}_P^{FB} = 0$, and $\bar{s}_J^{FB}$ increases in e.*

To paraphrase Lemma 4, if the defender system is "ineffective," the first-best solution utilizes only the prosecutor's information s_P and neglects the judge's s_J, convicting all the indictees. When the defense counsel is completely incompetent ($e = 0$), s_J adds no information to s_P, and therefore the optimal decision bundle relies solely on s_P. In other words, s_P is a sufficient statistic for s_J, which should be fully ignored. In this scenario, the prosecutor P ultimately determines the fate of a suspect, while the judge J casts no objection to him—the prosecutor is a *de facto* adjudicator and the judge a mere rubber stamper.[9] Lemma 4-(i) suggests that even a slight improvement in the defense quality e does not change the scenario. Due to noise in information transmission from P to J, s_J remains useless ($\bar{s}_J^{FB} = 0$) unless e is sufficiently large.

On the contrary, Lemma 4-(ii) implies that if the counsel quality is sufficiently high ($e > \hat{e}$), the evidence will prove so informative to J that she will utilize s_J. This scenario suggests that more suspects should be indicted (a lower $\bar{s}_P$).[10]

Step 2: Implementation of the First-Best. We demonstrate that with an appropriate policy bundle $(a^{FB}(e), b^{FB}(e))$, the optimal decision profile $(\bar{s}_J^{FB}, \bar{s}_P^{FB})$ can emerge as an equilibrium of the game.

Proposition 2 *(i) If the defense quality is low ($e \leq \hat{e}$), the first-best decision profile $(\bar{s}_P^{FB}, \bar{s}_J^{FB}) = (\hat{s}_P, 0)$ can be approximately attained by the equilibrium with $(a^{FB}(e)$, $b^{FB}(e))$ such that $a^{FB}(e)$ is almost one and* $\Pr(G|\bar{s}_J = 0, \overline{\sigma}_P(\bar{s}_P = \hat{s}_P), e) = q + b^{FB}(e)$ *where $b^{FB}(e)$ is non-negative and decreases in $e \in [0, \hat{e}]$.*[11] *(ii) If the defense quality is high ($e > \hat{e}$), the first-best profile $(\bar{s}_P^{FB}, \bar{s}_J^{FB})$ can be attained with $(a^{FB}(e), b^{FB}(e))$ such that $a^{FB}(e) =$* $\Pr(C|s_P = \bar{s}_P^{FB}, \overline{\sigma}_J(\bar{s}_P = \bar{s}_J^{FB}), e)$ *and $b^{FB}(e) = 0$, where $a^{FB}(e)$ decreases in e.*

Proposition 2 yields policy implications for incentive design in the adversarial procedure. By (i), given an ineffective defender system ($e \leq \hat{e}$), because decisive evidence cannot be expected from the defense, the policy arrangement should not rely on the evidence the judge J possesses ($\bar{s}_J^{FB} = 0$) while weak cases should be screened out of prosecution ($a^{FB}(e) \approx 1$). Since the prosecutor P has an informational advantage over the judge J, a decision to release a suspect should be made at the prosecutorial stage rather than at trial. That is, once indicted, any suspect is almost surely convicted. This policy—consistent with the high cost of indictment (c), little reward from winning a conviction (w), and heavy penalty on acquittal (l)—might be

[9] In addition, by Assumption 2-(i), the optimal threshold for prosecution $\bar{s}_P^{FB}$ when $e = 0$ is $\hat{s}_P$.

[10] A sufficient condition for $\hat{e} < 1$ is $\Pr(G|s_J = 0, \overline{\sigma}_P(\bar{s}_P = \hat{s}_P), e = 1) < q$. This condition means that when s_P is used most effectively ($\bar{s}_P = \hat{s}_P$), a fraction of suspects with $s_P > \hat{s}_P$ should be indicted but acquitted if the judge J receives the weakest inculpatory evidence ($s_J = 0$) in light of a defense counsel with the highest quality ($e = 1$).

[11] If $a = 1$, P becomes indifferent between indictment and dismissal against $\overline{\sigma}_J(\bar{s}_J = 0)$, resulting in multiple equilibria. If $a < 1$, on the other hand, the equilibrium is uniquely determined. To avoid multiplicity of equilibria, we make the following approximation: $a \approx 1$ when $e \leq \hat{e}$.

arranged through budget cuts or office downsizing (Ramseyer and Rasmusen 2001) as well as through a career program which imposes penalties on mistaken charges (Johnson 2002a: 228; 2007).

Concurrently, a pro-defendant bias $b > 0$ in judgment is also desirable to reduce prosecution because knowing conclusively that a conviction is rendered without the bias, the prosecutor would respond by filing too many cases in equilibrium. This bias might be created merely by the judge's strict interpretation of reasonable doubt (Johnson 2002a: 242; 2007).

By (ii), with an "effective" defender system ($e > \hat{e}$), the policy design should promote indictments from the prosecutor P and allow a certain number of acquittals from the judge J because she may receive informative evidence from the defense. Thus, no bias in adjudication needs to be created ($b = 0$), although the standard of proof ($\bar{s}_J^{FB}$) is subject to change with e. Theoretically, in the former scenario (i), the criminal system's ultimate decision is based solely on the continuous signal s_P, while in the latter (ii), it is based on s_J, which is possibly both more noisy and more informative than s_P, with P's binary decision ($s_P > \bar{s}_P^{FB}$).

5 Two Forms of the Adversarial System

The previous section shows that with an appropriate incentive arrangement, a unique non-trivial equilibrium can coincide with the first-best solution. We next characterize the equilibrium in relation to the judicial performance measured by the rates of indictment and conviction.

In our model, the rates of indictment and conviction are defined as follows:

Definition 4 *Given pure strategies $(\overline{\sigma}_P(\bar{s}_P), \overline{\sigma}_J(\bar{s}_J))$, the rate of indictment is*

$$IR(\bar{s}_P) \equiv \sum_{s \in \{G,I\}} \Pr(s) \int_{\bar{s}_P}^{1} f_P(s_P|s) ds_P,$$

while the rate of conviction is

$$CR(\bar{s}_P, \bar{s}_J, e) \equiv \frac{\sum_{s \in \{G,I\}} \Pr(s) \int_{\bar{s}_P}^{1} \int_{\bar{s}_J}^{1} g(s_J, s_P|s, e) ds_J ds_P}{IR(\bar{s}_P)}.$$

The model can assist in predicting how these statistics vary across judiciaries with diverse defense qualities e.

Proposition 3 *(i) If the counsel quality remains low ($e < \hat{e}$), the rate of indictment $IR(\bar{s}_P^{FB})$ does not change in e, and the rate of conviction is 100%: $CR(\bar{s}_P^{FB}, \bar{s}_J^{FB}, e) = 1$. (ii) If the quality is sufficiently high ($e > \hat{e}$), $IR(\bar{s}_P^{FB})$ increases in e, and $CR(\bar{s}_P^{FB}, \bar{s}_J^{FB}, e)$ decreases in e.*

Proposition 3-(i) confirms our previous predictions (Lemma 4 and Proposition 2) that if a defendant's access to effective counsel is limited ($e < \hat{e}$), the optimal procedure looks *pseudo*-adversarial. Although the adversarial procedure is adopted *de jure*, the defense party is overwhelmed by the prosecution, and contest between them is virtually non-existent (Miyazawa 2002; Hirano 1989). On the contrary, by (ii), if the access to effective counsel is well-guaranteed, more cases should be filed and scrutinized in court. The latter scenario (ii) looks *bona fide* adversarial; i.e., an impartial contest should be promoted, and as a result, an acquittal can be rendered with sufficient likelihood (Feeley 1987; Miyazawa 2002). This conjecture between the two systems mirrors the comparative observation that defendants' rights are less respected in Japan than in the U.S. (Johnson and Shinomiya 2007).

Parametrically, the *pseudo*-adversarial system is built upon large a, positive b, and small e (representing deliberate prosecutors, pro-defendant judges, and compromised defense counsels) while the *bona fide* system on small a, null b, and large e (aggressive prosecutors, impartial judges, and competent counsels). As we interpreted the parameter e above, so, below, we interpret a and b in relation to criminal systems.

For a, more cases are handled through open court in the *bona fide* system than in the *pseudo*-adversarial system. This theoretical prediction is consistent with qualitative studies on prosecutorial offices. In many jurisdictions of the U.S., prosecutors are publicly elected and are thereby accountable for their performances to the local electorate. Given that citizens tend to demand harsh punishments for criminal offenders, prosecutors are urged to bring more cases to court (Johnson 2002a: 15, 37, 106-107). In contrast, Japanese prosecutors, who are career bureaucrats rather than elected officials, may confront opposing pressures from the media. Given that the vast majority of cases end with a guilty verdict, the media pays close attention to not-guilty verdicts especially for felonious cases (Noguchi 2006). The media often bitterly criticizes erroneous charges, charges which, because of the criticisms that inevitably follow, prosecutors would like to avoid. In short, American prosecutors face political pressure to file more cases, while Japanese prosecutors strive to avoid the risk of charging an innocent. The difference in the size of a may capture these contrasting environments in which Japanese and American prosecutors find themselves.

For b, a judge's bias in favor of the prosecution does not necessarily explain the very high conviction rate of the Japanese judiciary. In fact, our model predicts the opposite—to suppress excessive indictments, the *pseudo*-adversarial arrangement requires a larger quantum of evidence for conviction than what the *bona fide* system presumes. However, once suspects are indicted, judges approve almost all prosecutors' accusations. In practical terms, this means that the facts of a case should not be determined by less informed judges, but by prosecutors. In contrast, the *bona fide* adversarial system works better when arbiters are impartial. In this sense, a jury system may better fit the *bona fide* system because lay citizens are more insulated than professional judges from external pressures such as the media (Feeley 1987; Shinomiya 2002).

To summarize, the *pseudo*-adversarial system accommodates bench trials, bureaucratic prosecutorial offices, and compromised defense, while the *bona fide* system accommodates jury trials, elected prosecutors, and competent defense attorneys. Our next investigation, which considers the pre-committed rule for prosecution, may further reinforce the claim that the Japanese prosecutorial system better fits the *pseudo*-adversarial system.

6 Pre-Committed Rule for Prosecution

The literature suggests that the variety in organizational structure among prosecutorial offices may explain cross-nation variation in judicial performance. We next spell out how the structure of the prosecutorial office functions and why the manner of its functioning matters in a criminal justice system.

Imagine two prosecutorial offices with different organizational structures: one is hierarchically organized through a career system, so that all the prosecutors are subject to central control and decision-making; the other is highly decentralized in that each prosecutor is elected from a local district and thus independently accountable to his constituency. The former may correspond to the Japanese criminal system while the latter to the U.S. one (Johnson 2002a: 119-120, 153-159, 230; Noguchi 2006).

In the former, the prosecutorial office can establish and enforce a unified rule for prosecutorial decisions, and judges can discover this rule by researching past cases, responding to it when they adjudicate. In the latter, on the other hand, prosecutorial decisions are made on a case-by-case basis, as we have presumed so far. We demonstrate that the pre-committed rule for prosecution in the former may enhance the social welfare at least in some circumstances.

Suppose that the prosecutorial office P can bind itself to a rule of pure strategy $\overline{\sigma}_P(\bar{s}_P^{CM})$, and the judge J adjusts her standard of proof $\bar{s}_J$ to the rule. P determines the rule $\bar{s}_P^{CM}$ to maximize its *ex-ante*, not *interim*, payoff.

Definition 5 *$(\bar{s}_P^{CM}, \bar{s}_J^{CM})$ denotes the thresholds with P's commitment device; i.e.,*

$$\bar{s}_P^{CM} = \arg\max_{\bar{s}_P} \int_{\bar{s}_P}^{1} [\Pr(C|s_P, \overline{\sigma}_J(\bar{s}_J), e) - a] \left[\Pr(G) f_P(s_P|G) + \Pr(I) f_P(s_P|I)\right] ds_P (w+l)$$

subject to the constraint that J takes her best response $\overline{\sigma}_J(\bar{s}_J^{CM})$ to $\overline{\sigma}_P(\bar{s}_P^{CM})$ (Lemma 2).

Proposition 4 *(i) Starting with interior equilibrium ($\bar{s}_P^{EQ} \in (0,1)$ and $\bar{s}_J^{EQ} \in (0,1)$), the pre-committed rule induces the prosecutorial office P to indict less ($\bar{s}_P^{CM} > \bar{s}_P^{EQ}$) and the judge J to convict more ($\bar{s}_J^{CM} < \bar{s}_J^{EQ}$). (ii) As a consequence, the rate of indictment decreases, and the rate of conviction increases: $IR(\bar{s}_P^{CM}) < IR(\bar{s}_P^{EQ})$ and $CR(\bar{s}_P^{CM}, \bar{s}_J^{CM}, e) > CR(\bar{s}_P^{EQ}, \bar{s}_J^{EQ}, e)$.*

The prosecution P is motivated to set up a rule which allows fewer cases to file because by doing so, the judge J becomes more confident with convictions and thus lowers the standard of proof. This reaction of J to the rule is consistent with P's interest.

This rule may also enhance the social welfare, depending on the defense quality e.

Corollary 1 *There exists $e^{CM} > 0$ such that if $e \in [0, e^{CM})$ and $b = 0$, then $V(\bar{s}_P^{CM}, \bar{s}_J^{CM}|e) > V(\bar{s}_P^{EQ}, \bar{s}_J^{EQ}|e)$.*

Corollary 1 holds that if the defense quality is low, the rule for prosecution can increase the social welfare, moving the equilibrium $(\bar{s}_P^{EQ}, \bar{s}_J^{EQ})$ closer to the optimal decision profile $(\bar{s}_P^{FB}, \bar{s}_J^{FB})$. This corollary makes sense because if the defense quality is low, informative evidence is unlikely to be produced in court. In this case, the prosecutor, not the judge, should be more influential in criminal procedure.

7 Persistence of Adversarial Variation

We have so far treated the effectiveness of defense counsel e as an exogenous parameter of the model and have explained the divergence in judicial performance across criminal systems by the differences in this effectiveness. Our final analyses in this section endogenize the parameter e and address how this divergence can persist even in the long run. We offer two theoretical explanations for this persistence: (i) the production of defense effectiveness exhibits increasing returns to the accuracy of adjudication (measured by the social welfare); (ii) lawyers do not have enough incentive to develop skills for criminal defense.

7.1 The Social Benefit of Effective Counsel

If a defense counsel assists a judge in collecting evidence, as our model presumes, an effective defender system will promote the social welfare. Therefore, if the effectiveness e can be raised without cost, the social planner will attain the highest effectiveness possible ($e = 1$). However, if a public defender system for indigent defendants requires an enormous amount of resources, the social planner confronts the dilemma of whether she should guarantee a certain degree of defense effectiveness or not. The next lemma suggests that the impact of improving defense effectiveness depends on the thresholds of indictment and conviction $(\bar{s}_P, \bar{s}_J)$.

Lemma 5 *(i) The marginal social benefit of defense effectiveness* $\frac{\partial V(\bar{s}_P,\bar{s}_J|e)}{\partial e}$ *decreases in* $\bar{s}_P$ *unless* $\bar{s}_J = 0$. *(ii) It increases in* $\bar{s}_J \in (0, \hat{s}_J)$.

Lemma 5 implies: (i) if more cases are filed, it makes more sense to improve defense effectiveness; (ii) an effective defense may not serve the public interest if it is already too difficult to win an acquittal.

Furthermore, as the defense becomes more effective, the optimal thresholds of indictment and conviction (with optimized a^{FB} and b^{FB}) may change: $\bar{s}_P^{FB}(e)$ falls in $e > \hat{e}$ while $\bar{s}_J^{FB}(e)$ rises in $e > \hat{e}$ (Lemma 4). This transition from the prosecutor as *de facto* adjudicator to the judge as *de facto* adjudicator makes the role of the defense even more important because a defense counsel serves judges, not prosecutors, for adjudication.

Proposition 5 *(i)* $V(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)|e)$ *does not change in* $e < \hat{e}$. *(ii) It increases in* $e > \hat{e}$ *at increasing rates.*

Insofar as the defense quality remains low ($e < \hat{e}$), an improvement in the defense system might not contribute to the social welfare since all the indictees are convicted anyway, and a defense counsel virtually plays no role in court (Lemma 4). On the contrary, if the defense system is already well-developed ($e > \hat{e}$), a further improvement in the counsel quality is beneficial because it will reduce the possibility of false conviction. Moreover, Proposition 5-(ii) suggests that the social welfare function exhibits increasing returns to defense effectiveness. In other words, the social welfare function $V(\bar{s}_P^{FB}, \bar{s}_J^{FB}|e)$ is convex with respect to e.

In light of the social welfare function's convex relationship with respect to e, the optimal effectiveness e^{FB} plausibly takes a corner, not interior, solution. This convexity may explain the persistence of the two extreme procedures: (i) the *bona fide* adversarial system, where impartial judges resolve cases based on evidence produced by the two litigious parties in conflict; (ii) the *pseudo*-adversarial system, where the prosecution is so advantageous that few acquittals can be expected. These two extreme patterns in criminal proceeding appear as the two corner solutions.

For instance, suppose that the marginal cost of defense effectiveness is $m > 0$. Given the initial effectiveness $\underline{e}$, the social planner controls e to maximize $V(\bar{s}_P^{FB}, \bar{s}_J^{FB}|e) - m(e - \underline{e})$ subject to $e \geq \underline{e}$. Because $V(\bar{s}_P^{FB}, \bar{s}_J^{FB}|e)$ is strictly convex with respect to e, the solution takes either corner $e^{FB} \in \{\underline{e}, 1\}$, depending on the size of $\underline{e}$. This simple result suggests the potential *undesirability* of developing a defender system with effective counsel in an adversarial procedure.

According to the traditional firm theory, non-concavity of firms' objective functions may explain the persistence of divergence among firms' organizational structures (cf. Roberts 2007). Our analysis applies this argument to the criminal procedure.

7.2 An Individual Lawyer's Skill vs. the Bar's Overall Defense Effectiveness

We lastly hypothesize another obstacle that may hinder the development of an effective criminal defense system. We extend the model by incorporating the skill of each individual lawyer and argue that lawyers would lack motivation for developing criminal defense skills if a court pronounces the defendant guilty in most cases.

Consider a continuum of criminal lawyers with a population whose size is normalized to be one. An individual lawyer i's skill for criminal defense is denoted as e_i, so that $e = \int_0^1 e_i di$. Each lawyer is interested in the *ex-ante* probability of his client's dismissal or acquittal given pure strategies $(\overline{\sigma}_P(\bar{s}_P), \overline{\sigma}_J(\bar{s}_J))$:

$$\Pr(D \cup A|\bar{s}_P, \bar{s}_J, e_i) = \int_0^{\bar{s}_P} [\Pr(G) f_P(s_P|G) + \Pr(I) f_P(s_P|I)] ds_P$$
$$+ \int_{\bar{s}_P}^1 \int_0^{\bar{s}_J} [\Pr(G) g(s_J, s_P|G) + \Pr(I) g(s_J, s_P|I, e_i)] ds_J ds_P,$$

where the first term is the probability of dismissal and the second term the probability of acquittal. Given the decision profile $(\bar{s}_P, \bar{s}_J)$, the marginal increase in this *ex-ante* probability from improving a lawyer i's skill is shown as

$$\frac{\partial \Pr(D \cup A|\bar{s}_P, \bar{s}_J, e_i)}{\partial e_i} = \Pr(I) \int_{\bar{s}_P}^1 f_P(s_P|I) ds_P \int_0^{\bar{s}_J} \phi(s_J) ds_J \geq 0.$$

If the skill of each lawyer e_i is private information, but the overall skill in the bar e is publicly observable, the equilibrium $(\bar{s}_J^{EQ}, \bar{s}_P^{EQ})$ depends on the overall skill e but not on private skill e_i. If an individual lawyer does not influence the aggregate quality $(\frac{de}{de_i} \approx 0)$, the increase in the probability $\frac{\partial \Pr(D \cup A|\bar{s}_P, \bar{s}_J, e_i)}{\partial e_i}$ is i's only motivation. With the optimal policy bundle $(a^{FB}(e), b^{FB}(e))$,

$$\frac{\partial \Pr(D \cup A|\bar{s}_P^{EQ}, \bar{s}_J^{EQ}, e_i)}{\partial e_i} = \frac{\partial \Pr(D \cup A|\bar{s}_J^{FB}, \bar{s}_P^{FB}, e_i)}{\partial e_i}.$$

Corollary 2 $\frac{\partial \Pr(D \cup A|\bar{s}_J^{FB}, \bar{s}_P^{FB}, e_i)}{\partial e_i}$ *is equal to zero for $e < \hat{e}$ and increases in $e > \hat{e}$ at increasing rates.*

Corollary 2 implies that each lawyer has little incentive to polish his skill for criminal defense if the aggregate effectiveness of defense in the bar is sufficiently low $(e < \hat{e})$ as it is in what we call the *pseudo*-adversarial system. If the prosecution files only strong cases in court, a defense counsel would anticipate an acquittal to be very unlikely, and his effort to acquire the skills necessary for criminal defense might not be rewarded. Predicting this consequence, a lawyer would bypass this effort and concentrate rather on civil cases or the like which will presumably yield a higher level of occupational satisfaction (Johnson 2002a: 241; Murayama 2002; Shinomiya 2002).

	Bona fide adversarial system	*Pseudo*-adversarial system
Archetypal example	Some jurisdictions in the U.S.	Japanese judiciary
Adjudicator	Lay citizens	Professional judges
Standard of proof	Low	High
Conviction rate	Low	High
Prosecutor	Publicly elected	Bureaucratic
Incentives (not) to indict	Political pressure for indictment	Career penalty on mistaken charge
Indictment rate	High	Low
Defense attorney	Competent	Compromised
Incentives to develop defense skills	High	Low

Table 1: Comparative implications between the two systems.

8 Conclusion

In this article, we have outlined a formal theory of criminal procedure that illuminates the interconnection between various institutional aspects such as a judge's standard of proof beyond reasonable doubt, a prosecutor's discretionary rule for indictment, and a defendant's right to effective counsel. What sets our theory apart as unique is that it holds implications not only to a particular form of criminal justice but to comparative studies at large. Table 1 summarizes our model's implications for comparative studies.

If a defendant's right to counsel is not well protected, a criminal justice system should rely on prosecutors' case screenings to exploit their informational advantage over judges since decisive evidence cannot be expected from the compromised defense. Our model suggests that such a system can be arranged through career penalty on prosecutors' erroneous indictments, organizational reforms to enable a pre-committed rule for prosecution, and a high standard of proof to prevent excessive indictments. If the prosecutorial decision can be adequately controlled through these policy instruments, enriching the defender system might not be so urgent. As a consequence, the efficient criminal justice system without effective defense counsel seems to favor the prosecution on the surface and deviates from the idealistic image of the adversarial procedure. This is the system we have labeled *pseudo*-adversarial.

On the contrary, if the judiciary guarantees a defendant's right to effective counsel, informative evidence from the defense might be submitted to the court. In this scenario, the judge induces evidence from both parties in dispute, letting them shape the litigation. Such a procedure can be considered a part of the *bona fide* adversarial system. To facilitate the contest, a jury system could serve as an institutional guarantor of arbiters' neutrality. Our normative analyses imply that if a policy maker seeks to bring about the *bona fide* adversarial system in the Japanese judiciary, the reform must be a comprehensive policy package covering not only the adjudication and the prosecution, but also the defense.

Our final analyses investigate why both forms of adversarial procedure have been maintained for so long. We present two reasons for this question. First, the social benefit from developing a more effective defender system is limited in the *pseudo*-adversarial system, while it is greater in the *bona fide* adversarial system. If so, both systems can be regarded as optimal responses to diverse environments. Second, given that an acquittal is very difficult to win in the *pseudo*-adversarial system, lawyers may not have enough incentives to polish their skills for criminal defense, which plays an integral role in the *bona fide* adversarial system. Without skillful defense attorneys, the transition to the *bona fide* adversarial system would be difficult or socially undesirable.

Finally, we offer several directions for future research. Since our model has been developed in a simplified fashion, it is easy to consider theoretical extensions that can comparatively illustrate various forms of (public or retained) defender systems (Huang et al. 2010), (formal or informal) plea bargaining (Foote 2002; Johnson 2002b; Stephen et al. 2008; Mongrain and Roberts 2009), and emphasis on defendants' confessions (Johnson 2002a: 243-276). Another interesting comparative research topic would be contingent remuneration for criminal defense, which is ubiquitous in Japan but is largely banned in the rest of the world (Lushing 1992; Karlan 1993). Overlooked in both the theoretical and empirical literature, this topic holds promise.

A Appendix

Proof of Lemma 1. (i) By Assumption 1-(ii) and the property that $\frac{g(s_J,s_P|I,e)}{g(s_J,s_P|G)} = \frac{f_P(s_P|I)}{f_P(s_P|G)}$ when $e = 0$, $\frac{f_P(s_P|I)}{f_P(s_P|G)}$ decreases in s_P. (ii) Because $\frac{g(s_J,s_P|I,e)}{g(s_J,s_P|G)}$ decreases in s_J

by Assumption 1-(ii) where

$$\begin{aligned}\frac{g(s_J, s_P|I, e)}{g(s_J, s_P|G)} &= \frac{\widetilde{f}_J(s_J|s_P) + e\phi(s_J)}{\widetilde{f}_J(s_J|s_P)} \frac{f_P(s_P|I)}{f_P(s_P|G)} \\ &= \left(1 + e\frac{\phi(s_J)}{\widetilde{f}_J(s_J|s_P)}\right) \frac{f_P(s_P|I)}{f_P(s_P|G)},\end{aligned}$$

$\frac{\phi(s_J)}{\widetilde{f}_J(s_J|s_P)}$ also decreases in s_J. This monotonicity with $\widetilde{f}_J(s_J|s_P) > 0$ and $\int_0^1 \phi(s_J)ds_J = 0$ implies that the sign of $\phi(s_J)$ changes only once. ■

Proof of Lemma 2. We are interested in the probability of conviction given J's pure strategy:

$$\begin{aligned}\Pr(C|s_P, \bar{\sigma}_J(\bar{s}_J), e) &= \sum_{s \in \{G,I\}} \Pr(s|s_P) \int_{\bar{s}_J}^1 f_J(s_J|s_P, s, e)ds_J \\ &= \int_{\bar{s}_J}^1 \tilde{f}_J(s_J|s_P)ds_J + e\Pr(I|s_P)\int_{\bar{s}_J}^1 \phi(s_J)ds_J.\end{aligned}$$

(i) Since MLRP implies the first-order stochastic dominance (Wolfstetter 1999: 139), MLRP of $\tilde{f}_J(s_J|s_P)$ (Assumption 1-(i)) implies that $\int_{\bar{s}_J}^1 \tilde{f}_J(s_J|s_P)ds_J$ increases in s_P. Since $\Pr(I|s_P)$ decreases in s_P (Lemma 1-(i)) and $\int_{\bar{s}_J}^1 \phi(s_J)ds_J < 0$, $\Pr(C|s_P, \bar{\sigma}_J(\bar{s}_J), e)$ also increases in s_P. (ii) $\Pr(C|s_P, \bar{\sigma}_J(\bar{s}_J), e)$ apparently decreases in $\bar{s}_J$. (iii) It also decreases in e because $\int_{\bar{s}_J}^1 \phi(s_J)ds_J < 0$ for any $\bar{s}_J \in (0, 1)$. ■

The next claim will be used for the proofs of Lemmas 3 and 4.

Claim 1 *For two arbitrary continuous functions $h(x, y)$ and $k(x, y)$, define*

$$\Delta(y, \underline{x}) \equiv \frac{\int_{\underline{x}}^1 k(x, y)dx}{\int_{\underline{x}}^1 h(x, y)dx}.$$

(i) If (a) $\frac{k(x,y)}{h(x,y)}$ decreases in both x and y and if (b) $\frac{h(x,y)}{h(x',y)}$ decreases in y for any $x < x'$, then $\Delta(y, \underline{x})$ decreases in y. (ii) If (c) $\frac{k(x,y)}{h(x,y)}$ decreases in x, $\Delta(y, \underline{x})$ decreases in $\underline{x}$.

Proof. (i) $\Delta(y, \underline{x})$ can be rewritten as:

$$\Delta(y, \underline{x}) = \int_{\underline{x}}^1 \frac{k(x, y)}{h(x, y)} m(x|y, x \geq \underline{x})dx,$$

where

$$m(x|y, x \geq \underline{x}) \equiv \frac{h(x, y)}{\int_{\underline{x}}^{1} h(x, y)dx}.$$

$m(x|y, x \geq \underline{x})$ can be interpreted as the conditional density of x on $[\underline{x}, 1]$. By (b),

$$\frac{m(x|y, x \geq \underline{x})}{m(x'|y, x \geq \underline{x})} = \frac{h(x, y)}{h(x', y)}$$

decreases in y for any $x < x'$ (MLRP). Since MLRP suffices FOSD, for $y > y'$,

$$\int_{\underline{x}}^{x} m(\tilde{x}|y, x \geq \underline{x})d\tilde{x} < \int_{\underline{x}}^{x} m(\tilde{x}|y', x \geq \underline{x})d\tilde{x}.$$

This FOSD with (a) guarantees (i).

(ii) Since the distribution function

$$\int_{\underline{x}}^{x} m(\tilde{x}|y, x \geq \underline{x})d\tilde{x} = \frac{\int_{\underline{x}}^{x} h(\tilde{x}, y)d\tilde{x}}{\int_{\underline{x}}^{1} h(\tilde{x}, y)d\tilde{x}}$$

decreases in $\bar{x}$ for any $x \in (0, 1)$, for $\underline{x} > \underline{x}'$,

$$\int_{\underline{x}}^{x} m(\tilde{x}|y, x \geq \underline{x})d\tilde{x} < \int_{\underline{x}'}^{x} m(\tilde{x}|y, x \geq \underline{x}')d\tilde{x}.$$

This FOSD with (c) suffices (ii). ■

Proof of Lemma 3. (i) Define

$$\Delta(s_J, \sigma_P(\cdot), e) \equiv \frac{\int_0^1 \sigma_P(s_P)g(s_J, s_P|I, e)ds_P}{\int_0^1 \sigma_P(s_P)g(s_J, s_P|G)ds_P}.$$

By Assumption 1-(i), for any $s_P < s_P'$,

$$\frac{\sigma_P(s_P)g(s_J, s_P|G)}{\sigma_P(s_P')g(s_J, s_P'|G)} = \frac{\sigma_P(s_P)\tilde{f}_J(s_J|s_P)f_P(s_P|G)}{\sigma_P(s_P')\tilde{f}_J(s_J|s_P')f_P(s_P'|G)},$$

which decreases in s_J. By Assumption 1-(ii) and Claim 1-(i), $\Delta(s_J, \sigma_P(\cdot), e)$ decreases in s_J. (ii) With pure strategy $\bar{\sigma}_P(\bar{s}_P)$,

$$\Delta(s_J, \bar{\sigma}_P(\bar{s}_P), e) = \frac{\int_{\bar{s}_P}^1 g(s_J, s_P|I, e) ds_P}{\int_{\bar{s}_P}^1 g(s_J, s_P|G) ds_P},$$

which decreases in $\bar{s}_P$ by Claim 1-(ii). (iii) $\Delta(s_J, \bar{\sigma}_P(\bar{s}_P), e)$ can be rewritten as:

$$\begin{aligned}\Delta(s_J, \bar{\sigma}_P(\bar{s}_P), e) &= \frac{\int_{\bar{s}_P}^1 g(s_J, s_P|I, e=0) ds_P + e\phi(s_J)\int_{\bar{s}_P}^1 f_P(s_P|I) ds_P}{\int_{\bar{s}_P}^1 g(s_J, s_P|G) ds_P} \\ &= 1 + e\phi(s_J)\frac{\int_{\bar{s}_P}^1 f_P(s_P|I) ds_P}{\int_{\bar{s}_P}^1 g(s_J, s_P|G) ds_P}.\end{aligned}$$

The direction of the effect of e on $\Delta(s_J, \bar{\sigma}_P(\bar{s}_P), e)$ is equal to the sign of $\phi(s_J)$. ■

Proof of Proposition 1. (i) By Lemma 2-(i), for $a \in (0,1)$, P's optimal $\bar{s}_P$ is uniquely determined for any $\bar{\sigma}_J(\bar{s}_J)$ and does not decrease in $\bar{s}_J$. By Lemma 3-(i), J's optimal $\bar{s}_J$ is uniquely determined and does not increase in $\bar{s}_P$ unless $\bar{s}_P = 1$. Therefore there do not exist multiple non-trivial equilibria with $\bar{s}_P < 1$. (ii) Because $\Pr(C|s_P, \bar{\sigma}_J(\bar{s}_J = 0), e) = 1$ and $\Pr(C|s_P, \bar{\sigma}_J(\bar{s}_J = 1), e) = 0$ for any s_P, if $\bar{s}_P^{EQ} \in (0,1)$, $\bar{s}_J^{EQ}$ must be in $(0,1)$. In an equilibrium with interior thresholds, it must hold that $\Pr(G|s_J = \bar{s}_J^{EQ}, \bar{\sigma}_P(\bar{s}_P^{EQ}), e) = q$ and $\Pr(C|s_P = \bar{s}_P^{EQ}, \bar{\sigma}_J(\bar{s}_J^{EQ}), e) = a$. (iii, iv) The effects of a and q are immediate from Lemmas 2 and 3. (v) Suppose that $\bar{s}_J^{EQ} < \hat{s}_J$ for some e. Then for any $e' > e$, $\Pr(G|s_J = \bar{s}_J^{EQ}, \bar{\sigma}_P(\bar{s}_P^{EQ}), e') < q$ and $\Pr(C|s_P = \bar{s}_P^{EQ}, \bar{\sigma}_J(\bar{s}_J^{EQ}), e') < a$. Let $(\bar{s}_P^{EQ'}, \bar{s}_J^{EQ'})$ be an equilibrium for e'. We prove (v) by contradiction. Suppose that $\bar{s}_P^{EQ'} \le \bar{s}_P^{EQ}$. Then Lemma 2 implies that $\bar{s}_J^{EQ'} < \bar{s}_J^{EQ}$ while Lemma 3 does that $\bar{s}_J^{EQ'} > \bar{s}_J^{EQ}$. This is a contradiction. ■

Claim 2 *There exists $q \in (0,1)$ that satisfies Assumption 2 (i, ii) simultaneously.*

Proof. The claim is necessary and sufficient for the condition that

$$\Pr(G|s_P = 0) < \Pr(G|s_J = \hat{s}_J, \bar{\sigma}_P(\bar{s}_P = 0), e = 0),$$

which will be shown below. With $\bar{s}_P \in [0,1)$,

$$\begin{aligned}\Pr\left(G|s_J, \bar{\sigma}_P(\bar{s}_P), e=0\right) &= \frac{1}{1+\frac{\Pr(I)}{\Pr(G)}\frac{\int_{\bar{s}_P}^1 \tilde{f}_J(s_J|s_P)f_P(s_P|I)ds_P}{\int_{\bar{s}_P}^1 \tilde{f}_J(s_J|s_P)f_P(s_P|G)ds_P}} \\ &= \frac{1}{1+\frac{\Pr(I)}{\Pr(G)}\int_{\bar{s}_P}^1 \frac{f_P(s_P|I)}{f_P(s_P|G)}n(s_P|s_J)ds_P}\end{aligned}$$

where $n(s_P|s_J)$ is the conditional density function of s_P:

$$n(s_P|s_J) \equiv \frac{\tilde{f}_J(s_J|s_P)f_P(s_P|G)}{\int_{\bar{s}_P}^1 \tilde{f}_J(s_J|\tilde{s}_P)f_P(\tilde{s}_P|G)d\tilde{s}_P}.$$

Since $\frac{f_P(s_P|I)}{f_P(s_P|G)}$ decreases in s_P by Assumption 1-(ii) with $e=0$,

$$\int_{\bar{s}_P}^1 \frac{f_P(s_P|I)}{f_P(s_P|G)}n(s_P|s_J)ds_P < \frac{f_P(\bar{s}_P|I)}{f_P(\bar{s}_P|G)}.$$

(Notice that $\int_{\bar{s}_P}^1 n(s_P|s_J)ds_P = 1$.) This implies that for $\bar{s}_P \in [0,1)$,

$$\Pr(G|s_P = \bar{s}_P) < \Pr(G|s_J, \bar{\sigma}_P(\bar{s}_P), e=0).$$

With $s_J = \hat{s}_J$ and $\bar{s}_P = 0$, the claim holds. ■

Proof of Lemma 4. We prove the lemma in three steps.

Step 1. We derive some useful properties on $V(\bar{s}_P, \bar{s}_J|e)$. (a-1) $\frac{\partial V(\bar{s}_P,\bar{s}_J|e)}{\partial \bar{s}_J} \gtreqless 0$ if and only if $\Pr(G|s_J = \bar{s}_J, \bar{\sigma}_P(\bar{s}_P), e) \lesseqgtr q$, where

$$\begin{aligned}\frac{\partial V(\bar{s}_P, \bar{s}_J|e)}{\partial \bar{s}_J} &= \left[\Pr(I)\int_{\bar{s}_P}^1 g(\bar{s}_J, s_P|I)ds_P + \Pr(G)\int_{\bar{s}_P}^1 g(\bar{s}_J, s_P|G)ds_P\right] \\ &\times \left[q - \Pr(G|s_J = \bar{s}_J, \bar{\sigma}_J(\bar{s}_J), e)\right].\end{aligned}$$

(a-2) $\bar{s}_J^{FB}(e) < \hat{s}_J$ for any e because $\Pr(G|s_J \geq \hat{s}_J, \bar{\sigma}_P(\bar{s}_P), e) > q$ for any $(\bar{s}_P, e)$ by Assumption 2-(ii) and Lemma 3.

(b-1) $\frac{\partial V(\bar{s}_P,\bar{s}_J|e)}{\partial \bar{s}_P} \gtreqless 0$ if and only if $\Pr(G|s_P=\bar{s}_P, C, \bar{\sigma}_J(\bar{s}_J), e) \lesseqgtr q$, where

$$\frac{\partial V(\bar{s}_P,\bar{s}_J|e)}{\partial \bar{s}_P} = \left[\Pr(I)\int_{\bar{s}_J}^1 g(s_J,\bar{s}_P|I)ds_P + \Pr(G)\int_{\bar{s}_J}^1 g(s_J,\bar{s}_P|G)ds_P\right]$$
$$\times\left[q - \Pr(G|s_P=\bar{s}_P, C, \bar{\sigma}_J(\bar{s}_J), e)\right].$$

$\Pr(G|s_P, C, \bar{\sigma}_J(\bar{s}_J), e)$ is the probability that the convicted defendant is truly guilty in the case of s_P:

$$\Pr(G|s_P, C, \bar{\sigma}_J(\bar{s}_J), e) \equiv \frac{1}{1+\frac{\Pr(G)}{\Pr(I)}\Theta(s_P,\bar{s}_J,e)},$$

where

$$\begin{aligned}\Theta(s_P,\bar{s}_J,e) &\equiv \frac{\int_{\bar{s}_J}^1 g(s_J,s_P|I,e)ds_J}{\int_{\bar{s}_J}^1 g(s_J,s_P|G)ds_J}\\ &= \frac{f_P(s_P|I)}{f_P(s_P|G)} + e\frac{\int_{\bar{s}_J}^1 \phi(s_J)ds_J}{f_P(s_P|G)\int_{\bar{s}_J}^1 \tilde{f}_J(s_J|s_P)ds_J}.\end{aligned}$$

(b-2) $\Pr(G|s_P, C, \bar{\sigma}_J(\bar{s}_J), e) = \Pr(G|s_P)$ if either $e=0$ or $\bar{s}_J=0$. (b-3) $\Pr(G|s_P, C, \bar{\sigma}_J(\bar{s}_J), e)$ increases in s_P, and it also increases in $\bar{s}_J$ unless $e=0$ by Claim 1 and Assumption 1-(ii). (b-4) $\Pr(G|s_P, C, \bar{\sigma}_J(\bar{s}_J), e)$ increases in e because $\int_{\bar{s}_J}^1 \phi(s_J)ds_J < 0$ for any $\bar{s}_J \in (0,1)$. (b-5) $\bar{s}_P^{FB}(e) \leq \hat{s}_P$ for any e because by claims (b-2, 3) above, $\Pr(G|s_P, C, \bar{\sigma}_J(\bar{s}_J), e) \geq \Pr(G|s_P)$ for any $(s_P, \bar{s}_J, e)$ and by plugging $s_P = \hat{s}_P$, $\Pr(G|s_P=\hat{s}_P, C, \bar{\sigma}_J(\bar{s}_J), e) \geq \Pr(G|s_P=\hat{s}_P) = q$.

(c) $\frac{\partial^2 V(\bar{s}_P,\bar{s}_J|e)}{\partial \bar{s}_J \partial e}$ is positive for $\bar{s}_J < \hat{s}_J$ and $\bar{s}_P < 1$ by Lemma 1-(ii), where

$$\frac{\partial^2 V(\bar{s}_P,\bar{s}_J|e)}{\partial \bar{s}_J \partial e} = q\Pr(I)\int_{\bar{s}_P}^1 f_P(s_P|I)ds_P\phi(\bar{s}_J).$$

(d) $\frac{\partial^2 V(\bar{s}_P,\bar{s}_J|e)}{\partial \bar{s}_P \partial e}$ is negative for $\bar{s}_J \in (0,1)$ by Lemma 1-(ii) and $\int_0^1 \phi(s_J)ds_J = 0$, where

$$\frac{\partial^2 V(\bar{s}_P,\bar{s}_J|e)}{\partial \bar{s}_P \partial e} = q\Pr(I)f_P(\bar{s}_P|I)\int_{\bar{s}_J}^1 \phi(s_J)ds_J.$$

Step 2. To prove (i), we first show by contradiction that (e) there exists $e' > 0$ such that for $e \leq e'$,

$$\Pr(G|s_P=\bar{s}_P, C, \bar{\sigma}_J(\bar{s}_J), e) < q$$

for any $(\bar{s}_P, \bar{s}_J)$ satisfying $\Pr(G|s_J = \bar{s}_J, \bar{\sigma}_P(\bar{s}_P), e) = q$. Suppose that for $e' > 0$, there exists $e \in (0, e']$ such that

$$\Pr(G|s_P = \bar{s}_P, C, \bar{\sigma}_J(\bar{s}_J), e) \geq q = \Pr(G|s_J = \bar{s}_J, \bar{\sigma}_P(\bar{s}_P), e).$$

Since $\Pr(G|\bar{s}_P, C, \bar{\sigma}_J(\bar{s}_J), e)$ and $\Pr(G|\bar{s}_J, \bar{\sigma}_P(\bar{s}_P), e)$ are continuous with respect to e, there exists $(\bar{s}_J, \bar{s}_P)$ such that

$$\Pr(G|s_P = \bar{s}_P, C, \bar{\sigma}_J(\bar{s}_J), e = 0) \geq q = \Pr(G|s_J = \bar{s}_J, \bar{\sigma}_P(\bar{s}_P), e = 0).$$

This means that

$$\Pr(G|\bar{s}_P) \geq \Pr(G|s_J = \bar{s}_J, \bar{\sigma}_P(\bar{s}_P), e = 0)$$

because $\Pr(G|s_P = \bar{s}_P, C, \bar{\sigma}_J(\bar{s}_J), e = 0) = \Pr(G|\bar{s}_P)$ by (b-2) of Step 1. This contradicts the condition that

$$\Pr(G|\bar{s}_P) < \Pr(G|s_J = \bar{s}_J, \bar{\sigma}_P(\bar{s}_P), e = 0)$$

proven in Claim 2.

We next show by contradiction that (f) $(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)) = (\hat{s}_P, 0)$ for any $e \leq e'$. Suppose $\bar{s}_J^{FB}(e) > 0$ for some $e \leq e'$. Since $\bar{s}_J^{FB}(e) < \hat{s}_J$ by (a-2) of Step 1, $\bar{s}_J^{FB}(e)$ is an interior solution such that $\frac{\partial V(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)|e)}{\partial \bar{s}_J} = 0$, or equivalently $\Pr(G|s_J = \bar{s}_J^{FB}(e), \bar{\sigma}_P(\bar{s}_P^{FB}(e)), e) = q$. By (e), $\Pr(G|s_P = \bar{s}_P^{FB}(e), C, \bar{\sigma}_J(\bar{s}_J^{FB}(e)), e) < q$, and by (b-1), $\frac{\partial V(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)|e)}{\partial \bar{s}_P} > 0$. Thus an increase in $\bar{s}_P > \bar{s}_P^{FB}(e)$ raises the social welfare. This contradicts that $\bar{s}_P^{FB}(e)$ is the first best, and therefore $\bar{s}_J^{FB}(e) = 0$. By (b-1, 2) and Assumption 2-(i), $\bar{s}_P^{FB}(e) = \hat{s}_P$. Claims (e, f) are sufficient for (i).

Step 3. We next prove (ii). By (a-2, b-5), if e is large enough that $\bar{s}_P^{FB}(e) > 0$ and $\bar{s}_J^{FB}(e) > 0$, $(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)) \in (0, \hat{s}_P] \times (0, \hat{s}_J)$ must be interior such that

$$\Pr(G|s_J = \bar{s}_J^{FB}(e), \bar{\sigma}(\bar{s}_P^{FB}(e)), e) = q$$

and

$$\Pr(G|s_P = \bar{s}_P^{FB}(e), C, \bar{\sigma}_J(\bar{s}_J^{FB}(e)), e) = q.$$

For $\tilde{e} > e$, neither (g) $\bar{s}_J^{FB}(e) \geq \bar{s}_J^{FB}(\tilde{e})$ and $\bar{s}_P^{FB}(e) \geq \bar{s}_P^{FB}(\tilde{e})$ nor (h) $\bar{s}_J^{FB}(e) \leq$

$\bar{s}_J^{FB}(\tilde{e})$ and $\bar{s}_P^{FB}(e) \leq \bar{s}_P^{FB}(\tilde{e})$ can happen. If (g) holds, then by Lemma 3,

$$\Pr(G|s_J = \bar{s}_J^{FB}(\tilde{e}), \bar{\sigma}(\bar{s}_P^{FB}(\tilde{e})), \tilde{e}) < \Pr(G|s_J = \bar{s}_J^{FB}(e), \bar{\sigma}(\bar{s}_P^{FB}(e)), e) = q,$$

which implies that the social welfare is improved with an $\bar{s}_J$ higher than $\bar{s}_J^{FB}(\tilde{e})$. This is a contradiction. If (h) holds, then by (b-3, 4),

$$\Pr(G|s_P = \bar{s}_P^{FB}(\tilde{e}), C, \bar{\sigma}_J(\bar{s}_J^{FB}(\tilde{e})), \tilde{e}) > \Pr(G|s_P = \bar{s}_P^{FB}(e), C, \bar{\sigma}_J(\bar{s}_J^{FB}(e)), e) = q,$$

and the social welfare is improved with an $\bar{s}_P$ lower than $\bar{s}_P^{FB}(\tilde{e})$. This is a contradiction.

We lastly show by contradiction that (j) $\bar{s}_J^{FB}(e) > \bar{s}_J^{FB}(\tilde{e})$ and $\bar{s}_P^{FB}(e) < \bar{s}_P^{FB}(\tilde{e})$ cannot happen. Suppose $\bar{s}_J^{FB}(e) > \bar{s}_J^{FB}(\tilde{e})$ and $\bar{s}_P^{FB}(e) < \bar{s}_P^{FB}(\tilde{e})$. By (c, d), $\frac{\partial^2 V(\bar{s}_P, \bar{s}_J|e)}{\partial \bar{s}_J \partial e} > 0$ and $\frac{\partial^2 V(\bar{s}_P, \bar{s}_J|e)}{\partial \bar{s}_P \partial e} < 0$ for $\bar{s}_J \in (0, \hat{s}_J)$, implying that

$$\int_e^{\tilde{e}} \int_{\bar{s}_P^{FB}(e)}^{\bar{s}_P^{FB}(\tilde{e})} \frac{\partial^2 V(\bar{s}_P, \bar{s}_J|e)}{\partial \bar{s}_P \partial e} d\bar{s}_P de + \int_e^{\tilde{e}} \int_{\bar{s}_J^{FB}(e)}^{\bar{s}_J^{FB}(\tilde{e})} \frac{\partial^2 V(\bar{s}_P, \bar{s}_J|e)}{\partial \bar{s}_J \partial e} d\bar{s}_J de < 0,$$

or equivalently

$$\begin{aligned} & V(\bar{s}_P^{FB}(\tilde{e}), \bar{s}_J^{FB}(\tilde{e})|e) - V(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)|e) \\ > \; & V(\bar{s}_P^{FB}(\tilde{e}), \bar{s}_J^{FB}(\tilde{e})|\tilde{e}) - V(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)|\tilde{e}). \end{aligned}$$

By definition of $(\bar{s}_P^{FB}(\tilde{e}), \bar{s}_J^{FB}(\tilde{e}))$,

$$V(\bar{s}_P^{FB}(\tilde{e}), \bar{s}_J^{FB}(\tilde{e})|\tilde{e}) - V(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)|\tilde{e}) \geq 0.$$

Therefore,

$$V(\bar{s}_P^{FB}(\tilde{e}), \bar{s}_J^{FB}(\tilde{e})|e) > V(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)|e).$$

This is a contradiction because $(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e))$ is optimal under e. The elimination of (g, h, j) suffices (ii). ■

Proof of Proposition 2. We first show that for any $(\bar{s}_P, \bar{s}_J) \in [0,1) \times (0,1)$ and $e \in [0,1]$, there exists $(a,b) \in (0,1) \times R$ which implements $(\bar{s}_P, \bar{s}_J)$ as a unique equilibrium. For arbitrary $(\bar{s}_P, \bar{s}_J) \in [0,1) \times (0,1)$ and $e \in [0,1]$, choose (a,b) such that

$$q + b = \Pr(G|s_J = \bar{s}_J, \bar{\sigma}_P(\bar{s}_P), e)$$

and

$$a = \Pr(C|s_P = \bar{s}_P, \bar{\sigma}(\bar{s}_J), e),$$

where $a \in (0,1)$ because $\Pr(C|s_P, \bar{\sigma}(\bar{s}_J), e)$ decreases in $\bar{s}_J$ with $\Pr(C|s_P, \bar{\sigma}(\bar{s}_J = 0), e) = 1$ and $\Pr(C|s_P, \bar{\sigma}(\bar{s}_J = 1), e) = 0$. By Proposition 1, the equilibrium $(\bar{s}_P^{EQ}, \bar{s}_J^{EQ})$ is unique for (a, b, e) conditioned above.

(i) Suppose $e \leq \hat{e}$. By the argument above, for any $\epsilon \in (0,1)$, $(\bar{s}_P, \bar{s}_J) = (\hat{s}_P, \epsilon)$ is uniquely implemented as an equilibrium with (a_ϵ, b_ϵ) such that

$$q + b_\epsilon = \Pr(G|s_J = \epsilon, \bar{\sigma}_P(\bar{s}_P = \hat{s}_P), e)$$

and

$$a_\epsilon = \Pr(C|s_P = \hat{s}_P, \bar{\sigma}(\bar{s}_J = \epsilon), e).$$

As $\epsilon \to 0$, $(\bar{s}_P, \bar{s}_J) = (\hat{s}_P, \epsilon)$ converges to $(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)) = (\hat{s}_P, 0)$, so that the first-best thresholds $(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e))$ are approximately implemented as an equilibrium with (a_ϵ, b_ϵ):

$$\lim_{\epsilon \to 0} b_\epsilon = \lim_{\epsilon \to 0} \Pr(G|s_J = \epsilon, \bar{\sigma}_P(\bar{s}_P = \hat{s}_P), e) - q$$

and

$$\lim_{\epsilon \to 0} a_\epsilon = \lim_{\epsilon \to 0} \Pr(C|s_P = \hat{s}_P, \bar{\sigma}_J(\bar{s}_J = \epsilon), e) = 1.$$

Besides, $\bar{s}_J^{FB}(e) = 0$ implies that $\Pr(G|s_J = 0, \bar{\sigma}_P(\bar{s}_P = \hat{s}_P), e) - q \geq 0$ or $b^{FB}(e) \geq 0$ because otherwise the social welfare can be improved by an increase in $\bar{s}_J > 0$. By Lemma 3-(iii), $\Pr(G|s_J = 0, \bar{\sigma}_P(\bar{s}_P = \hat{s}_P), e) - q$ decreases in e. Thus $b^{FB}(e)$ must decrease in $e \in [0, \hat{e}]$.

(ii) $(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)) \in [0,1) \times (0,1)$ are uniquely implemented in an equilibrium under $(a^{FB}(e), b^{FB}(e))$ satisfying

$$a^{FB}(e) = \Pr(C|s_P = \bar{s}_P^{FB}(e), \bar{\sigma}(\bar{s}_J^{FB}(e)), e)$$

and

$$b^{FB}(e) = \Pr(G|s_J = \bar{s}_J^{FB}(e), \bar{\sigma}_P(\bar{s}_P^{FB}(e)), e) - q,$$

which is equal to zero because from Step 3 of the proof of Lemma 4, for $e > \hat{e}$,

$(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e))$ satisfies

$$\Pr(G|s_J = \bar{s}_J^{FB}(e), \bar{\sigma}_P(\bar{s}_P^{FB}(e)), e) = q.$$

In addition, as e rises, $\bar{s}_P^{FB}(e)$ falls, and $\bar{s}_J^{FB}(e)$ rises by Lemma 4. These indirect effects and the direct effect of e (Lemma 2-(iii)) decrease $a^{FB}(e)$. ■

Proof of Proposition 3. (i) The proof of (i) is immediate and thus is omitted. (ii) $CR(\bar{s}_P, \bar{s}_J, e)$ can be rewritten as:

$$CR(\bar{s}_P, \bar{s}_J, e) = E_{s_P}[\Pr(C|s_P, \bar{\sigma}_J(\bar{s}_J), e)|s_P \geq \bar{s}_P].$$

The distribution function of s_P conditional on $s_P > \bar{s}_P$ is

$$\frac{\int_{\bar{s}_P}^{s_P} \Pr(G) f_P(\tilde{s}_P|G) + \Pr(I) f_P(\tilde{s}_P|I) d\tilde{s}_P}{\int_{\bar{s}_P}^{1} \Pr(G) f_P(\tilde{s}_P|G) + \Pr(I) f_P(\tilde{s}_P|I) d\tilde{s}_P},$$

which decreases in $\bar{s}_P$, implying that the distribution of s_P conditional on a higher $\bar{s}_P$ first-order stochastically dominates the distribution of s_P conditional on a lower $\bar{s}_P$. This FOSD and Lemma 2-(i, iii) hold that $CR(\bar{s}_P, \bar{s}_J, e)$ increases in $\bar{s}_P$ and decreases in e. By Lemma 4, as e increases, $\bar{s}_P^{FB}$ decreases while $\bar{s}_J^{FB}$ increases. Thus an increase in e both directly and indirectly through $\bar{s}_P^{FB}$ and $\bar{s}_J^{FB}$ decreases $CR(\bar{s}_P^{FB}, \bar{s}_J^{FB}, e)$. ■

Proof of Proposition 4. (i) The proof consists of three claims: (a) $(\bar{s}_J^{CM}, \bar{s}_P^{CM})$ satisfies $\Pr(G|s_J = \bar{s}_J^{CM}, \bar{\sigma}_P(\bar{s}_P^{CM}), e) = q + b$; (b) $\bar{s}_P^{CM} \not< \bar{s}_P^{EQ}$; (c) $\bar{s}_P^{CM} \neq \bar{s}_P^{EQ}$.

(a) Given $\bar{s}_J = 0$, P's *ex-ante* payoff decreases in $\bar{s}_P$ for $a < 1$. P then prefers the minimum $\bar{s}_P$ such that J's optimal response is $\bar{s}_J = 0$, implying that $\Pr(G|s_J = \bar{s}_J^{CM}, \bar{\sigma}_P(\bar{s}_P^{CM}), e) = q + b$.

(b) We show by contradiction that $\bar{s}_P^{CM} < \bar{s}_P^{EQ}$ never holds. Suppose $\bar{s}_P^{CM} < \bar{s}_P^{EQ}$. Then $\bar{s}_J^{CM} > \bar{s}_J^{EQ}$ because by (a), both $(\bar{s}_P^{EQ}, \bar{s}_J^{EQ})$ and $(\bar{s}_P^{CM}, \bar{s}_J^{CM})$ satisfy that $\Pr(G|s_J = \bar{s}_J, \bar{\sigma}_P(\bar{s}_P), e) = q + b$ (on J's downward-sloping best response curve in Figure 1-(a)). Since $\bar{s}_P^{EQ}$ is the optimal response to $\bar{s}_J^{EQ}$, P's *ex-ante* payoff must be lower at $(\bar{s}_P^{CM}, \bar{s}_J^{EQ})$ than at $(\bar{s}_P^{EQ}, \bar{s}_J^{EQ})$. On the other hand, the fact that P's *ex-ante* payoff decreases in $\bar{s}_J$ implies that P's *ex-ante* payoff is lower at $(\bar{s}_P^{CM}, \bar{s}_J^{CM})$ than at $(\bar{s}_P^{CM}, \bar{s}_J^{EQ})$. This is a contradiction because P is never worse off by the pre-commitment.

(c) The effect of an infinitesimal increase of $\bar{s}_P$ from $\bar{s}_P^{EQ}$ on P's *ex-ante* payoff

$V_P(\bar{s}_P, \bar{s}_J^{BR}(\bar{s}_P))$ can be shown as:

$$\frac{\partial V_P(\bar{s}_P, \bar{s}_J^{BR}(\bar{s}_P))}{\partial \bar{s}_P} = \frac{\partial V_P(\bar{s}_P, \bar{s}_J)}{\partial \bar{s}_P} + \frac{\partial V_P(\bar{s}_P, \bar{s}_J)}{\partial \bar{s}_J}\frac{\partial \bar{s}_J^{BR}(\bar{s}_P)}{\partial \bar{s}_P},$$

where $\bar{s}_J^{BR}(\bar{s}_P)$ is J's best response against $\bar{s}_P$. By envelope theorem, the first term of the RHS of the equation above is zero while the second term is positive.

(b) and (c) suffice $\bar{s}_P^{CM} > \bar{s}_P^{EQ}$, which along with (a) leads to $\bar{s}_J^{CM} < \bar{s}_J^{EQ}$.

(ii) The proof is immediate and thus is omitted. ■

Proof of Corollary 1. We want to show that for sufficiently small e, $\frac{dV(\bar{s}_P, \bar{s}_J^{BR}(\bar{s}_P)|e)}{d\bar{s}_P} > 0$ given J's best response $\bar{s}_J^{BR}(\bar{s}_P)$ with $b = 0$, where

$$\frac{dV(\bar{s}_P, \bar{s}_J^{BR}(\bar{s}_P)|e)}{d\bar{s}_P} = \frac{\partial V(\bar{s}_P, \bar{s}_J|e)}{\partial \bar{s}_P} + \frac{\partial V(\bar{s}_P, \bar{s}_J^{BR}|e)}{\partial \bar{s}_J^{BR}}\frac{\partial \bar{s}_J^{BR}(\bar{s}_P)_{|b=0}}{\partial \bar{s}_P}.$$

For $e < e'$, where e' is defined in Step 2 of the proof of Lemma 4, the first term of the RHS is positive by (b-1), and $\frac{\partial V(\bar{s}_P, \bar{s}_J^{BR}|e)}{\partial \bar{s}_J^{BR}}$ of the second term zero by (a-1) because $\Pr(G|\bar{s}_P, C, \bar{\sigma}_J(\bar{s}_J), e) < q$ and $\Pr(G|\bar{s}_J = \bar{s}_J^{BR}, \bar{\sigma}_P(\bar{s}_P), e) = q$ from Step 2. The social welfare increases by P's commitment because by Proposition 4-(i), $\bar{s}_P^{CM} > \bar{s}_P^{EQ}$. ■

Proof of Lemma 5. From Step 1 of the proof of Lemma 4, $\frac{\partial^2 V(\bar{s}_P, \bar{s}_J|e)}{\partial e \partial \bar{s}_J} > 0$ for $\bar{s}_J < \hat{s}_J$ and $\frac{\partial^2 V(\bar{s}_P, \bar{s}_J|e)}{\partial e \partial \bar{s}_P} < 0$ for $\bar{s}_J > 0$. ■

Proof of Proposition 5. (i) The social welfare is constant on $e \in [0, \hat{e})$ because by definition of $V(\bar{s}_P, \bar{s}_J|e)$,

$$V(\bar{s}_P, \bar{s}_J = 0|e) = V(\bar{s}_P, \bar{s}_J = 0|e = 0).$$

(ii) By envelope theorem,

$$\begin{aligned} \frac{dV(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)|e)}{de} &= \frac{\partial V(\bar{s}_P^{FB}, \bar{s}_J^{FB}|e)}{\partial e} \\ &= \Pr(I)\int_{\bar{s}_P^{FB}(e)}^{1} f_P(s_P|I)ds_P \int_0^{\bar{s}_J^{FB}(e)} \phi(s_J)ds_J > 0. \end{aligned}$$

In addition, by linearity of $V(\bar{s}_P, \bar{s}_J|e)$ with respect to e, $\partial^2 V(\bar{s}_P, \bar{s}_J|e)/\partial e^2 = 0$.

$$\begin{aligned} \frac{d^2 V(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)|e)}{de^2} &= \frac{\partial^2 V(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)|e)}{\partial e \partial \bar{s}_P} \frac{\partial \bar{s}_P^{FB}(e)}{\partial e} \\ + \quad & \frac{\partial^2 V(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)|e)}{\partial e \partial \bar{s}_J} \frac{\partial \bar{s}_J^{FB}(e)}{\partial e}, \end{aligned}$$

which is positive because its first and second terms in the RHS are both positive by Lemmas 4 and 5. ■

Proof of Corollary 2. By envelope theorem,

$$\frac{d \Pr(D \cup A|\bar{s}_J^{FB}(e), \bar{s}_P^{FB}(e), e_i)}{de_i} = \frac{1}{q} \frac{dV(\bar{s}_P^{FB}(e), \bar{s}_J^{FB}(e)|e)}{de}.$$

Thus the effect of the change in e_i is the same as in e of Proposition 5. ■

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