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RESUMO/ABSTRACT

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This paper analyzes the strategic implications of the existence of the right to silence in criminal trial in the context of Roman law doctrine. The right confers to the defendant the privilege that, in the context of a signalling game, i. e. the trial, no adverse conclusions may be drawn from his exercise of the right. It is shown that respect for the right to silence does not have signi_cant strategic consequences. In particular, no in_uence on conviction rates exists, neither rightful nor wrongful ones.

KEYWORDS: Miranda Right, right to silence, economic analysis of law, signalling game.

JEL Classification: D02, D82, K14.

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Abstract

This paper analyzes the strategic implications of the existence of the right to silence in criminal trial in the context of Roman law doctrine. The right confers to the defendant the privilege that, in the context of a signalling game, i. e. the trial, no adverse conclusions may be drawn from his exercise of the right. It is shown that respect for the right to silence does not have significant strategic consequences. In particular, no influence on conviction rates exists, neither rightful nor wrongful ones.
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Introduction

Recently there has been a surging interest in the economics literature in what in American legal culture is called the *Miranda Right* – the 'right to silence' of a suspect during criminal investigation as well as during court proceedings. Seidmann (2005), for example, has analyzed the strategic implications of this right for the cases of English and American juri rules. The crucial difference between the two is that, in the 'English game' inferences from the silence of a defendant can be drawn, whereas for the 'American game' the juri is not allowed in this case to draw adverse inferences. Seidmann's main finding is that, respecting the right to silence can protect innocent suspects with high a-priori probability of being guilty and, at the same time, does not affect the confession rate.[1]

It is interesting to look at this issue in the context of a 'Roman game' where, in contrast to 'American' and 'English games', confession does not automatically end proceedings, triggering immediate conviction, eventually as a consequence of some plea bargain. Rather it is possible that the defendant confesses, having in mind a lesser sentence, but his lawyer, who in Roman law doctrine is somehow an independent actor in administration of justice, insists that all evidence be presented and pondered by the juri. The right to silence then is an alternative option to making a statement about what really is of interest – guilt or innocence. From the strategic point of view, respect for the right forces the juri, or a judge, to not use the fact of silence as a pretext for presumption of guilt, but to rely on either prior evidence, that is (and should be) known to all parties at the time trial begins, or evidence that may manifest itself during proceedings. There is, however, considerable uncertainty as to whether this right is always respected. Therefore, the defendant when deciding whether to remain silent faces considerable uncertainty, being forced to trade off the benefits of a reduced sentence for confession, should he be convicted, against the advantage that the right to silence may offer – to guilty as well as innocent defendants.

We will look at this issue from the perspective of signalling theory (Spence(1973), Milgrom and Roberts (1986)) in a stylized model of court proceedings: a defendant may be guilty or innocent of a crime he has been accused of. At the start of the trial, some evidence is known to all parties and all hold a common prior as to the probability that this evidence shows that the defendant is guilty. The defendant is asked for his plea, guilty or innocent, but he may also exercise his right to silence. Pleading guilty gives the right to a lesser sentence if convicted. During trial new information enters the scene,[2] that, as such, either reveals the

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[1]There has been an ongoing debate in the U.S. over the last fourty years about the implications of the introduction of the Miranda right in 1966 that centers more on the effectiveness of criminal investigation and crime clearance rates. For early evidence, see Seeburger and Wettick (1967). Contemporary reviews and assessments of the empirical literature can be found in Cassell (1996, 1998), Schulhofer (1996) and Leo (2001).

[2]This could be a new witness, or a known witness that reveals new information. It could

defendant's type or is inconclusive. Both possibilities occur with certain commonly known probabilities. In case of inconclusiveness, the juri may use the prior probability for finding the verdict – but it may also draw conclusions from the defendants initial statement. We will then examine two cases: either the juri is allowed to use its (rational) beliefs, or it restricts itself, with certain probability, not to use, at information sets where the defendant is silent, any inference to his disadvantage. In the latter case the verdict is reached by using only the commonly known prior evidence.

The most closely related literature is Seidmann (2005), where the defendant can be any of several innocent types and one guilty type. The guilty type sees his probability of being guilty always increased after a key witness is heard since he is always confused by the latter with exactly one of the innocent types. An innocent type is identified with certain probability, whereas with inverse probability he just is confused with the guilty one. Therefore, the witness just never does not know anything. Further crucial differences are that, in Seidmann's setting a guilty plea basically ends the game, and he looks at equilibria where innocent defendants always tell the truth, namely that they are innocent.

Framework

We imagine an idealized framework of a court proceeding, with the defendant first being asked to make his plea. Then a witness is heard, and finally, the juri gives its verdict.

The defendant may be guilty, G, or innocent, I, being the a-priori probability of the G-type $p_G \in (0,1)$ and that of the I-type $p_I = 1 - p_G$. He may send one of three possible signals from the set $\{G, Q, I\}$, with the possibility to use a mixed strategy. G and I, of course, mean statement of guilt and innocence, respectively, whereas Q denotes the defendant exercizing his right to remain silent. After the signal is sent, the witness is heard, even if the defendant declares himself guilty. We assume that the witness knows of guiltyness or innocence of the defendant with probability r, whereas with probability $1 - r$ he does not know. In either case, the witness truthfully reveals the respective fact to the juri. The juri, after having observed the signal and the witness' statement, decides about acquittal, A, or conviction, C, of the defendant. If the witness claims to be informed, then the juri decides correspondingly without further inference, disregarding any statement made by the defendant. For the case of an uninformed witness, the juri will engage in Bayesian inference and form its beliefs.

Concerning the juri's verdict, after the witness has revealed its ignorance, we will analyze two different sets of rules:

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also be some new scientific method, say a state-of-the-art forensic test, for example.

(A) In order to decide about conviction or acquittal, the juri can use arbitrary beliefs at any information set.

(B) In order to make the same decision, the juri honors with probability s the right of the defendant to be silent (signal Q), in the following sense:

    (i) If the signal Q is off the equilibrium path, then a-priori probability p_G must be used for decision making.

    (ii) If the signal Q is on the equilibrium path, then the lower one of the two probabilities, $p(G|Q)$ or p_G, must be used for decision making.[3]

With probability $1 - s$ the juri just has the same option as in (A).

In both settings, the rational jury will do correct Bayesian updating, of course, and it uses these updates in setting (A), together with unrestricted beliefs at information sets off the equilibrium path, for coming to a verdict. In setting (B), however, although rational as well, the jury will not always use the updates, or arbitrary beliefs off equilibrium, for decision making: at information set Q decision is limited by rules (i) and (ii). So the juri compromises, with certain probability, not to use its rational inference or arbitrary conjectures against the G(-uilty) type of defendant if this one chooses to be silent.

Payoffs for the two suspect types are as follows: both types earn a direct payoff from acquittal of 0, $a < 0$ if convicted after having confessed, and b, with $b < a$, if convicted without confession. The relatively more moderate punishment a is traditionally meant to incentivate a defendant to come forward with the truth (probably also in order to save the juri's time). For the I-type of defendant we make the assumption that he earns an additional pecuniary payoff from either saying the truth, I, being quiet, Q, or wrongly admitting guilt, G, of 0, δ_Q and δ_G, respectively, with $\delta_G < \delta_Q < 0$. This models the idea that 'good guys' feel like telling the truth and only the truth, whereas the 'bad guys' do not care.

Payoff for the juri basically depends on making the correct decision. It derives the highest payoff, $c > 0$, if it convicts the G-type of defendant. Payoff for acquitting the I-type, $d > 0$, is not greater than c. Acquitting the G-type gives a payoff of $e < 0$. The worst situation is to convict the innocent I-type, giving a payoff f strictly lower than that before. So we assume

$$f < e < 0 < d \le c. \tag{1}$$

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[3]Note another difference to Seidmann's (2005) treatment of the consequences of the right to silence. He assumes that at *any* information set where the defendant is silent, the updated prior probability after testimony of the witness must be used to find the verdict. This excludes, however, the possibility to draw a favourable Bayesian inference from silence: if it were known that, in equilibrium, only innocent types show up at an information set with defendant's silence, then the juri should rationally acquit instead of looking at non-strategic probabilities. This does not hurt a defendant's right to silence.

We denote by p_A^j and p_C^j the probabilities of acquittal or conviction, respectively, after the jury hears one of the three possible statements by the defendant, $j = G, Q, I$ and in case of an inconclusive testimony. Obviously, $p_A^j + p_C^j = 1$. We denote by $\rho = \{(p_A^j, p_C^j)\}_{j=G,Q,I}$ the mixed strategy of the juri. As to the defendant, we denote by q_j^i the probability of sending signal j when type is $i = G, I$. Obviously, we have $q_G^i + q_Q^i + q_I^i = 1$.

In the following we will derive all Perfect Bayesian Equilibria (Fudenberg and Tirole (1991a, 1991b)) for this signalling model (Spence (1973)) and look at the differences that might emerge for the two regimes of juri behaviour.

Preliminary Results

The following behaviour makes part of any equilibrium:

1. If the type of the defendent is revealed by the witness, then type G is convicted, type I acquitted.

2. If the juri is not informed, then it is indifferent between acquittal and conviction iff

$$
\tilde{p}_G^* \cdot c + (1 - \tilde{p}_G^*) \cdot f \quad \overset{!}{=} \quad \tilde{p}_G^* \cdot e + (1 - \tilde{p}_G^*) \cdot d
$$
$$
\Leftrightarrow \tilde{p}_G^* \quad = \quad \frac{d - f}{(c - e) + (d - f)} < 1, \tag{2}
$$

where $\tilde{p}_G$ is the juri's belief that it faces the G(uilty)-type of defendant at a certain information set.

Payoff for defendent-type $i = G, I$, given his statement $j = G, Q, I$ and given the juri's mixed strategy ρ, then is $u(j, \rho|i)$, where

$$
u(G, \rho|G) = [r + (1 - r)p_C^G] \cdot a \tag{3}
$$
$$
u(Q, \rho|G) = [r + (1 - r)p_C^Q] \cdot b \tag{4}
$$
$$
u(I, \rho|G) = [r + (1 - r)p_C^I] \cdot b \tag{5}
$$

for type G, and

$$
u(G, \rho|I) = (1 - r)p_C^G \cdot a + \delta_G \tag{6}
$$
$$
u(Q, \rho|I) = (1 - r)p_C^G \cdot b + \delta_Q \tag{7}
$$
$$
u(I, \rho|I) = (1 - r)p_C^I \cdot b \tag{8}
$$

for type I.

In order to decide under which conditions the two types of defendants may use mixed strategies, one has to figure out in which cases they feel indifferent between the various types of messages they can send.

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G-Type

$$\mathbf{G} \sim \mathbf{Q} \quad \Leftrightarrow \quad p_C^Q = \frac{r(a-b) + (1-r)p_C^G \cdot a}{(1-r)b}. \tag{9}$$

In order to guarantee that the fraction is between 0 and 1, we must have

$$p_G^C \geq -\frac{r}{1-r} \cdot \frac{a-b}{a}. \tag{10}$$

$$\mathbf{G} \sim \mathbf{I} \quad \Leftrightarrow \quad p_C^I = \frac{r(a-b) + (1-r)p_C^G \cdot a}{(1-r)b}, \tag{11}$$

where we also require (10) for the same reason as before.

$$\mathbf{Q} \sim \mathbf{I} \quad \Leftrightarrow \quad p_C^Q = p_C^I. \tag{12}$$

I-Type

$$\mathbf{G} \sim \mathbf{Q} \quad \Leftrightarrow \quad p_C^Q = \frac{(1-r)p_C^G \cdot a + \delta_G - \delta_Q}{(1-r)b}. \tag{13}$$

The necessary condition for having the fraction between 0 and 1 is

$$p_G^C \leq \frac{(1-r) \cdot b + \delta_Q - \delta_G}{(1-r) \cdot a}, \tag{14}$$

which in turn requires that parameters must be such that

$$(1-r) \cdot b \leq \delta_G - \delta_Q. \tag{15}$$

$$\mathbf{G} \sim \mathbf{I} \quad \Leftrightarrow \quad p_C^I = \frac{(1-r)p_C^G \cdot a + \delta_G}{(1-r)b}. \tag{16}$$

Here we need to have

$$p_G^C \leq \frac{(1-r) \cdot b - \delta_G}{(1-r) \cdot a}, \tag{17}$$

which in turn requires

$$(1-r) \cdot b - \delta_G \leq 0. \tag{18}$$

$$\mathbf{Q} \sim \mathbf{I} \quad \Leftrightarrow \quad p_C^Q = p_C^I - \frac{\delta_Q}{(1-r)b}. \tag{19}$$

For this to be possible it is necessary to guarantee that

$$p_I^C \geq \frac{\delta_Q}{(1-r) \cdot b}. \tag{20}$$

It is illustrative to contrast the preference relations of the two types concerning the three pure strategies. Table 1 reads as 'indifference in the respective first column implies the preference relationship in the respective second one'. So the first row, for example, says that if type G is indifferent between G and Q, then type I prefers Q over G, and if the latter type is indifferent between the same two alternatives, then type G prefers G over Q.

		Type		
G	I	I	G
$G \sim Q$	$Q \succ G$	$G \sim Q$	$G \succ Q$
$G \sim I$	$I \succ G$	$G \sim I$	$G \succ I$
$Q \sim I$	$I \succ Q$	$Q \sim I$	$Q \succ I$

Table 1: Implications of indifference of a player for the respective other.

It is then quite obvious that both types won't mix the same two strategies in any equilibrium.

Results

A complete treatment of all possibilities for the two regimes is given in the Appendix. Here we will have a look at the most interesting cases.

First of all, for $a > rb$ the worst to happen to type G when sending signal G is strictly better than the best that can happen to him with any of the other choices. So G would always stick with G, and type I, by the intuitive criterion (Cho and Kreps (1987)) should therefore always send signal I. The 'rebate' from making a confession is sufficiently high to warrant the G(-uilty) type to accept it. For $a = rb$ signal G weakly dominates anything else from type G's perspective, whereby payoff a is matched only in case that he always is acquitted with any of the other options. Also in this case it appears reasonable to assume that he would stick to option G – only to be sure – and then type I would again be best-off with signal I. The interesting case is therefore $a < rb$, which will be assumed in what follows.

A-priori Strong Evidence: $p_G > \tilde{p}_G^*$

If $p_G > \tilde{p}_G^*$ then there is strong enough evidence for conviction prior to hearing the witness, and when the answer of the witness is not informative, then, unless the

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signalling framework is revealing, a-priori information is used by the juri when coming to a decision.

It is quite clear that, for this case, Perfect Bayesian Equilibria are the same for both sets of rules guiding the juri: if an outcome can be sustained as an equilibrium with rule (A), then, if information set Q is off-equilibrium, $p(G|Q) > \tilde{p}_G^*$ sustains this equilibrium, and so does $p_G > \tilde{p}_G^*$ for rule (B). If Q is on the equilibrium path, then, if $p(G|Q) \geq \tilde{p}_G^*$, also $\min\{p(G|Q), p_G\} \geq \tilde{p}_G^*$, and in case of $p(G|Q) < \tilde{p}_G^*$ we have $\min\{p(G|Q), p_G\} = p(G|Q)$, implying the same consequence in (B) as in (A). On the other hand, looking at an equilibrium for rule (B), it is clear that it also goes through in (A) because, Q being off equilibrium, choosing $p(G|Q) > \tilde{p}_G^*$ has the same implication as $p_G > \tilde{p}_G^*$, and with Q on the equilibrium path, choosing in setting (A) the same beliefs as in (B) has the same consequences and creates the same incentives for the defendant.

The following Perfect Bayesian Equilibria in mixed strategies can then be identified (see Appendix):

(i) Pooling (G, G), with juri convicting. Necessary condition: $\delta_G \geq (1-r)(b-a)$. See Lemma 1.

(ii) Semi-Pooling $((G, Q), Q)$, with G-type defendant mixing with $q_Q^G = \frac{(1-p_G)\tilde{p}_G^*}{p_G(1-\tilde{p}_G^*)}$, and juri mixing with $(p_C^G, p_C^Q, p_C^I) = (1, \frac{a/b-r}{1-r}, 1)$. Necessary condition: $\delta_Q \geq b - a$. See Lemma 8.[4]

(iii) Semi-Pooling $((G, I), I)$, with G-type defendant mixing with $q_I^G = \frac{(1-p_G)\tilde{p}_G^*}{p_G(1-\tilde{p}_G^*)}$, and juri mixing with $(p_C^G, p_C^Q, p_C^I) = (1, 1, \frac{a/b-r}{1-r})$. See Lemma 9.

Note that equilibrium type (iii) does always exist, whereas the other two disappear if the cost for the innocent type, I, of lying, δ_G, and of being silent, Q, δ_Q, respectively, are too high. In the latter case, type I always sticks with the truth, but he cannot distinguish himself completely from the G(-uilty) guy (because $a < rb$) who chooses, with strictly positive probability, but not always, to mimic the innocent one. Therefore, the guilty are not always convicted and the innocent not always acquitted.

Now suppose that costs of being silent for the I-type become lower, such that $\delta_Q \geq b - a$, so that equilibrium type (ii) appears. Clearly (ii) and (iii) are similar, with the unique difference being the costs of being silent imposed on the innocent type. From the point of view of equilibrium selection we would therefore expect that the Pareto-dominant equilibrium (iii) be selected.

Finally, if $\delta_G \geq (1-r)(b-a)$, then equilibrium type (i) becomes available – type I feels the cost of not telling the truth as lower as the benefit of a reduced

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[4]Note that it is this type of equilibrium that is excluded in Seidmann (2005) because in his interpretation of the Miranda Right, $p_G > \tilde{p}_G^*$ must be used at Q to decide over acquittal or conviction (which implies conviction in this case).

sentence if convicted. Clearly, this equilibrium is the worst for both types since both are always convicted, so equilibrium type (i) is strictly dominated for each type of defendant by either (ii) or (iii). Nevertheless, with equilibrium types (ii) and (iii) there is, of course, a risk of getting a heavier-handed sentence in the worst case. So equilibrium type (i) is the risk-dominant one.

Nevertheless, for strong a-priori evidence, there is no difference for the two juri rules considered.

A-priori Weak Evidence: $p_G < \tilde{p}_G^*$

In this case equilibria for both sets of rules may be different because, even with beliefs indicating the G-type at information set Q, the defendant is not always convicted. The following equilibria can be identified (see Appendix):

(i) Pooling (G, G) with juri acquitting. Necessary condition: (A) $\delta_G \geq (1-r)b$, (B) $\delta_G \geq (1-r)b$ and $s \leq 1 - \frac{\delta_G - \delta_Q}{(1-r)b}$. See Lemma 1.

(ii) Pooling (Q, Q) with juri acquitting. Necessary condition: $\delta_Q \geq (1-r)b$ for both, (A) and (B). See Lemma 4.

(iii) Separating (Q, I) with juri acquitting at both, Q and I. Necessary condition: $s = 1$ and only for rule set (B). See Lemma 5.

(iv) Pooling (I, I) with juri acquitting. Same for (A) and (B). See Lemma 6.

Let us again start our analysis with the case of excessively high costs for not telling the truth and for being silent, $\delta_G, \delta_Q < (1-r)b$ and $\delta_Q < b - a$. In this case, only equilibria of types (iii) and (iv) can exist. Type (iii) is possible only if the right to silence is perfectly respected. In fact, in this case, the bad guy ousts himself as such by the signal sent, but he cannot be convicted because of his silence. It seems that having the right to silence makes it possible to separate the types without being able to convict the bad guys.

Now let us suppose that the costs for the innocent type of being silent and of lying are sufficiently low to allow him also to consider Q and G as an answer. Then also equilibria (i) and (ii) become available. Equilibrium type (ii) is Pareto-dominated by (iv) because the latter does not impose the cost of lying on the innocent type. Moreover (iv) is not riskier than (ii). So we may eliminate (ii).

For rule set (A), and for (B) with the right to silence not too much respected, equilibrium (i) is better for type G because he gets a lesser sentence when identified by the witness, but type I bears the cost of making a wrongful confession. Nevertheless, if the right to silence is perfectly respected one ends up with either equilibrium (iii) or (iv), and then, in terms of implications, there is no difference between both sets of rules, (A) and (B).

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Therefore, also if a-priori evidence is weak, it appears that a well-respected right to silence does not have much of an influence on strategic decisions of defendants, allowing only the guilty type to reveal his type without getting him convicted, though.

Conclusion

This paper has illustrated the strategic implications of the 'right to silence' for criminal trial in a 'Roman' setting where confession, unlike in English and American law, does not automatically trigger conviction. It has been shown that the existence of the right does not alter the expected outcome of a stylized but realistic 'trial game' in terms of conviction or acquittal of the two types. Therefore, the option is a somehow redundant alternative to claiming innocence, as long as only rational conclusions are drawn from silence (and lying is not punished as such) – so either silence or claiming innocence seem quite similar to cheap talk (Crawford and Sobel (1982)). But why is this the case? The reason is that, if prior evidence is weak, then the guilty type can always decide to pool with the innocent one, achieving his goal to be acquitted. Therefore, in order to avoid deviation to silence, if this is off-equilibrium, one does not need strong beliefs that there the bad guy shows up – in fact, it is even weakly sufficient to believe that the good guy arrives. For the case of strong evidence of facing the bad guy, either this evidence or a belief of facing him with certainty is sufficient to avoid deviation to silence if this behaviour is out-of-equilibrium. If silence is on the equilibrium path, then this is only possible if the guilty type is not always convicted, beause otherwise he would choose to confess guilt. This means that the juri is just indifferent between acquittal and conviction. Therefore, the Bayesian belief of guilt is lower than a-priori probability, so, by part (ii) of our rule guiding a juri that respects the right to silence, the Bayesian update is used – as in the case of no respect for the right at all. Note that just this latter point is the crucial difference to Seidmann (2005): for him the Miranda right means that no inference at all from silence may be drawn – not even if it is of advantage to the innocent.

Appendix

In this appendix we turn to the identification of all equilibria in pure and mixed strategies. From the methodological point of view we iterate through all possible strategies of defendant-type G, then for the those of type I, and finally those of the juri, fitting them together as a Perfect Bayesian Equilibrium if it is possible.

1) G uses G

I chooses *G* (**Pooling Equilibrium (G,G))**: In this pooling equilibrium there are three possibilities, depending on whether the juri convicts, acquits or uses a mixed strategy. This in turn depends on whether the probability of facing the G-type is sufficiently high or not.

i) $p_G \geq \tilde{p}_G^*$ (juri convicts): (**A**) Payoff for type G is a, for type I its $(1-r)a + \delta_G$. Type G does not deviate because in both alternatives he would obtain b only. Type I would receive $(1-r)b$ in I, so he does not deviate iff $\delta_G \geq (1-r)(b-a)$. As to option Q, he would have payoff $(1-r)b + \delta_Q$, making it unworthy to deviate iff $\delta_G - \delta_Q \geq (1-r)(b-a)$. Note that this latter condition is implied by the earlier one. (**B**) For a-priori probabilities the juri convicts, so restricted behaviour leads to the same result.

ii) $p_G \leq \tilde{p}_G^*$ (juri acquits): (**A**) Payoff for type G is ra, for type I its δ_G. Type G does not deviate because in both alternatives he would obtain b only. Type I would receive $(1-r)b$ in I, so he does not deviate iff $\delta_G \geq (1-r)b$. As to option Q, he would have payoff $(1-r)b + \delta_Q$, making it unworthy to deviate iff $\delta_G - \delta_Q \geq (1-r)b$. Note that also here this latter condition is implied by the earlier one. (**B**) Type G does not deviate to Q because $b[r + (1-r)(1-s)] \leq ra$, and I isn't attractive either for the same reason as in (**A**). Type I does not deviate to Q iff $(1-r)(1-s)b + \delta_Q \leq \delta_G$, i.e. $s \leq 1 - \frac{\delta_G - \delta_Q}{(1-r)b}$. This requires $\delta_G - \delta_Q \geq (1-r)b$. He does not deviate to I iff $\delta_G \geq (1-r)b$. Again, this latter condition implies the previous one.

iii) $p_G = \tilde{p}_G^*$ (juri mixes C and A): (**A**) Payoff for G is $[r + (1-r)p_C^G]a$, for I its $(1-r)p_C^G a + \delta_G$. Type G never deviates because in doing so he would receive payoff b only. Type I does not deviate to Q iff $\delta_G - \delta_Q \geq (1-r)(b - p_C^G a)$, and I is not attractive iff $\delta_G \geq (1-r)(b - p_C^G a)$. Note that the earlier condition is implied by the latter, which can be written as $p_C^G \leq \frac{(1-r)b - \delta_G}{(1-r)a}$. For this to be possible we require $\delta_G \geq (1-r)b$. Hence, given that this condition is fulfilled with strict inequality, the juri can use any mixing with $p_C^G \in (0, \frac{(1-r)b - \delta_G}{(1-r)a}]$. (**B**) Type G does not deviate to Q iff $b[r + (1-r)(1-s)] \leq [r + (1-r)p_C^G]a$, i.e. $p_C^G \leq \frac{b/a[r + (1-r)(1-s)] - r}{1-r}$ (a). He would not go for I because he can only earn b. Type I does not deviate to Q iff $(1-r)(1-s)b \leq (1-r)p_C^G a + \delta_G$,

or equivalently, $p_C^G \leq \frac{(1-r)(1-s)b - \delta_G}{(1-r)a}$ (b). For this to be possible, we need $\delta_G \geq (1-r)(1-s)b$. He won't deviate to I iff $(1-r)b \leq (1-r)p_C^G a + \delta_G$, i.e. $p_C^G \leq \frac{(1-r)b - \delta_G}{(1-r)a}$ (c). This requires $\delta_G \geq (1-r)b$ and is implied by the first inequality involving δ_G. Note that (b) implies (c).

These results can be gathered in the following lemma.

Lemma 1 *A pooling equilibrium on (G, G) does exist.*

(A) *For $p_G \geq \tilde{p}_G^*$ the necessary condition for existence is $\delta_G \geq (1-r)(b-a)$, and in this case the juri convicts when observing G. For $p_G \leq \tilde{p}_G^*$ the necessary condition for existence is $\delta_G \geq (1-r)b$, and in this case the juri acquits when observing G. For $p_G = \tilde{p}_G^*$ and $\delta_G > (1-r)b$ the juri may use a mixed strategy with $p_C^G \in (0, \frac{(1-r)b - \delta_G}{(1-r)a}]$.*

(B) *For $p_G \geq \tilde{p}_G^*$ the same equilibrium exists as in (A). For $p_G \leq \tilde{p}_G^*$ the necessary condition for existence is $\delta_G \geq (1-r)b$ and $s \leq 1 - \frac{\delta_G - \delta_Q}{(1-r)b}$, and in this case the juri acquits when observing G. For $p_G = \tilde{p}_G^*$ and $\delta_G > (1-r)(1-s)b$ the juri may use a mixed strategy with*

$$ p_C^G \in \left(0, \min \left\{ \frac{(1-r)(1-s)b - \delta_G}{(1-r)a}, \frac{b/a[r + (1-r)(1-s)] - r}{1-r} \right\} \right]. \quad (21) $$

In all cases, besides of the restrictions of setting (B), out-of-equilibrium beliefs are chosen such that the juri convicts the defendant at the respective information set.

I chooses Q (Separating Equilibrium (G,Q)): Payoff of type G is a, whereas type I earns δ_Q. **(A)** Type G does not deviate to Q iff $rb \leq a$, whereas he never deviates to I because with that he earns b. Type I won't deviate to G because there he would only receive $(1-r)a + \delta_G$, and he wouldn't choose I iff $(1-r)b \leq \delta_Q$. **(B)** Interpreting the statement Q as coming from the I-type only is of advantage to him, so using the result from Bayesian updating does not hurt him. The separating equilibrium is the same for **(A)** and **(B)**.

Lemma 2 *A separating equilibrium (G, Q) exists iff $rb \leq a$ and $\delta_Q \geq (1-r)b$. It is the same for rules (A) and (B). Out-of-equilibrium beliefs are chosen such that the juri convicts the defendant at information set I.*

I chooses I (Separating Equilibrium (G,I)): Payoff for G is a, for I it is 0. **(A)** Type G does not deviate to Q because with that he earns b. He does not choose to deviate to I iff $rb \leq a$. Type I does not deviate to neither G nor Q, because his payoffs would be $(1-r)a + \delta_G$ and $(1-r)b + \delta_Q$, respectively. **(B)**

For $p_G \geq \tilde{p}_G^*$ the juri convicts if using prior information. Therefore, the outcome is the same as in (**A**). If $p_G < \tilde{p}_G^*$ then the juri will acquit with probability s at the (supposed) out-of-equilibrium information set Q, leaving type G with payoff $b[r + (1-r)(1-s)]$ and type I with payoff $(1-r)(1-s)b + \delta_Q$. So I does not deviate, and G does not deviate iff $s \leq 1 - \frac{a/b-r}{1-r}$. The following lemma states this result.

Lemma 3 *A separating equilibrium (G, I) does exist iff $rb \leq a$. In context (B), and for $p_G < \tilde{p}_G^*$, we require additionally $s \leq 1 - \frac{a/b-r}{1-r}$.*
In all cases, besides of the restrictions of setting (B), out-of-equilibrium beliefs are chosen such that the juri convicts the defendant at the respective information set.

I chooses a strictly mixed strategy: In face of type G's fixed strategy G, it is not possible for type I to mix strategy I with anything else because at I beliefs of the juri must be I-type, and then I's payoff is strictly higher than with anything else. Also, type I mixing G and Q is not possible because in Q beliefs must be I-type, and then he earns in Q always strictly more than in G, independently of setting (A) or (B). Hence, no equilibrium exists where type G chooses pure strategy G and type I strictly mixes.

2) G uses Q

I uses G (Separating Equilibrium (Q,G)): In both settings, (A) and (B), this clearly cannot be an equilibrium because type G would deviate to G.

I uses Q (Pooling Equilibrium (Q,Q)): It is irrelevant whether we are in setting (A) or (B) because $p(G|Q) = p_G$. Three cases must be distinguished.

i) $p_G \geq \tilde{p}_G^*$ (juri convicts): Payoff for G is b, for I it is $(1-r)b + \delta_Q$. But then type G is better-off with G.

ii) $p_G \leq \tilde{p}_G^*$ (juri acquits): Payoff for G is rb, for I it is δ_Q. Type G does not deviate to G iff $a \leq rb$. He won't deviate to I at all because with that he receives b. Type I does not deviate to G because $(1-r)a + \delta_G < \delta_Q$. He will not choose I iff $(1-r)b \leq \delta_Q$.

iii) $p_G = \tilde{p}_G^*$ (juri mixes C and A): Type G's payoff is $[r + (1-r)p_C^Q]b$, that of type I is $(1-r)p_C^Q b + \delta_Q$. G does not deviate to G as long as $a \leq b[r + (1-r)p_C^Q]$ or $p_C^Q \leq \frac{a/b-r}{1-r}$. This requires $a \leq br$. G does not deviate to I either because he would earn b only. As to type I, he does not deviate to G iff $(1-r)a + \delta_G \leq (1-r)p_C^Q b + \delta_Q$ i.e. $p_C^Q \leq \frac{(1-r)a+\delta_G-\delta_Q}{(1-r)b}$. Not having him deviate to I requires $(1-r)b \leq (1-r)p_C^Q b + \delta_Q$, i.e. $p_C^Q \leq \frac{(1-r)b-\delta_Q}{(1-r)b}$. This latter condition implies the former one.

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We can state these results in the following lemma.

Lemma 4 *A class of pooling equilibria (Q, Q) does exist iff $a \leq rb$, $p_G \leq \tilde{p}_G^*$ and $\delta_Q \geq (1 - r)b$ are fulfilled simultaneously. In the pure-strategy equilibrium the defendant is acquitted in equilibrium. For $p_G = \tilde{p}_G^*$, and with $\delta_Q > (1 - r)b$ and $a < br$, the juri may use a mixed strategy, with $p_C^Q \in (0, \min\{\frac{(1-r)b - \delta_Q}{(1-r)b}, \frac{a/b - r}{1-r}\}$. Out-of-equilibrium beliefs are chosen such that the juri convicts the defendant at information sets G and I. Equilibria are identical for settings (A) and (B).*

I **uses** I **(Separating Equilibrium (Q,I)):** **(A)** This cannot be an equilibrium because type G would deviate to I. **(B)** This cannot be an equilibrium either, unless for $p_G \leq \tilde{p}_G^*$ and $s = 1$.

Lemma 5 *A separating equilibrium (Q, I) does exist only in setting (B) and for $p_G \leq \tilde{p}_G^*$ and $s = 1$.*

I **chooses a strictly mixed strategy:** With the same argument as before, strategy I cannot make part of such an equilibrium. So it remains to look at mixing between G and Q. Then, however, type G would deviate to G to earn a higher payoff. Note that this argument is independent of setting (A) or (B). So there is no equilibrium with type G choosing Q and type I doing any mixing.

3) G uses I

I **uses** G **(Separating Equilibrium (I,G)):** This cannot be an equilibrium in none of the settings, (A) or (B), because type G would deviate to G.

I **uses** Q **(Separating Equilibrium (I,Q)):** This cannot be an equilibrium, in neither setting, because type G, again, would deviate to G.

I **uses** I **(Pooling Equilibrium (I,I)):** Again we have to distinguish three cases.

   i) $p_G \geq \tilde{p}_G^*$ (juri convicts): Type G would obviously deviate to G, in both settings.

   ii) $p_G \leq \tilde{p}_G^*$ (juri acquits): **(A)** Payoff for G is rb, for I it is 0. Type G does not deviate to G iff $a \leq rb$. He won't deviate to Q at all because with that he receives b. Type I does not deviate to G because $(1 - r)a + \delta_G < 0$. He will not choose Q either because $(1 - r)b + \delta_Q < 0$. **(B)** If not learning the type the juri acquits in Q with probability s, but convicts with probability $1 - s$. Hence, no type can be strictly better off by deviating to Q, and deviating to G is the same as in **(A)**.

iii) $p_G = \tilde{p}_G^*$ (juri mixes C and A): **(A)** Payoff for type G is $b[r + (1-r)p_C^I]$, for type I it is $(1-r)p_C^I b$. Type G won't deviate to G iff $p_C^I \leq \frac{a/b-r}{1-r}$. Note that this requires $a \leq rb$. Under no circumstances will he deviate to Q because of the lowest possible payoff b. Type I does not deviate to G iff $p_C^I \leq \frac{(1-r)a+\delta_G}{(1-r)b}$, and under no circumstances it would be of strict advantage to deviate to Q because with it I would earn $(1-r)b + \delta_Q$. **(B)** Also in this case deviation to Q can be discouraged because for $p_G = \tilde{p}_G^*$ conviction is optimal for the juri.

Lemma 6 *A class of pooling equilibria* (I, I) *does exist for both settings, (A) and (B), iff* $p_G \leq \tilde{p}_G^*$ *and* $a \leq rb$. *In the pure-strategy equilibrium the defendant is acquitted in equilibrium. For* $p_G = \tilde{p}_G^*$, *and with* $a < rb$, *the juri may use a mixed strategy with* $p_C^I \in (0, \min\{\frac{(1-r)b+\delta_G}{(1-r)b}, \frac{a/b-r}{1-r}\}]$. *In all cases, besides of the restrictions of setting (B), out-of-equilibrium beliefs are chosen such that the juri convicts the defendant at the respective information set.*

I chooses a strictly mixed strategy: Given type G's supposed choice I, option G cannot make part of type I's strategy because G had incentives to deviate. Looking then at mixing between Q and I, we observe that, in this case, the G-type would deviate to Q unless he is always acquitted in I. Note that this argument holds for setting (B) because the supposed equilibrium would identify the player who chooses Q as the G-type. Then, however, also type I would strictly prefer I over Q. Therefore, no mixed strategy equilibrium can exist in which type G chooses the pure strategy I.

4) G strictly mixes (G, Q, I)

By taking into consideration the results from Table 1 it follows that type I must choose I. Then the juri's believe must be $p(G|G) = p(G|Q) = 1$, and $p(G|I) = \frac{p_G \cdot q_I^G}{p_G \cdot q_I^G + (1-p_G)}$. It then follows that $p_C^G = p_C^Q = 1$ because choices must be optimal given beliefs. Then, however, type G should strictly prefer G over Q. This argument holds independently of setting (A) or (B). Hence, this constellation is impossible in equilibrium.

5) G strictly mixes (G, Q)

In this case, I's choice can only be either I or Q because with G his destiny is the same, but he saves disutility by saying no lie.

I chooses I: **(A)** Type G is identified as such in G and Q and thus convicted. Then, however, it is strictly better to choose G. So this cannot be an equilibrium. **(B)** Although being identified in Q as type G, this type only will always be

convicted iff $p_G \geq \tilde{p}_G^*$. But then G strictly prefers G. If $p_G < \tilde{p}_G^*$, then he will be acquitted with probability s and convicted with probability $1 - s$, leading to payoff $b[r + (1 - r)(1 - s)] = a$. This implies $s = 1 - \frac{a/b - r}{1 - r}$. In I type G would earn rb, implying that deviation is not of strict advantage iff $a \geq rb$. Type I earns 0 in I, so he strictly prefers this option over all alternatives.

Lemma 7 *In setting (B) a separating equilibrium exists where type G strictly mixes (G, Q) with any probability and type I chooses I iff $a \geq rb$, $p_G < \tilde{p}_G^*$ and $s = 1 - \frac{a/b - r}{1 - r}$.*

I **chooses** Q: (**A**) Since A is indifferent between G and Q we must have $a = rb + (1 - r)p_C^Q b$, i.e. $p_C^Q = \frac{a/b - r}{1 - r}$. This requires $a \leq rb$. Payoff for type I then is $(1 - r)p_C^Q b + \delta_Q = a - rb + \delta_Q$. Type G does not deviate to I because $b < a$. Type I won't deviate to G, and he won't choose I iff $\delta_Q \geq b - a$. If $a = rb$ we have $p_C^Q = 0$, and therefore $p(G|Q) \leq \tilde{p}_G^*$, i.e. $q_Q^G \leq \frac{(1 - p_G)\tilde{p}_G^*}{p_G(1 - \tilde{p}_G^*)}$. If $a < rb$ then $p_C^Q \neq 0$, and the juri must be indifferent between conviction and acquittal. This requires $p(G|Q) = \tilde{p}_G^*$, i.e. $q_Q^G = \frac{(1 - p_G)\tilde{p}_G^*}{p_G(1 - \tilde{p}_G^*)}$. This is only possible for $p_G \geq \tilde{p}_G^*$. (**B**) Since $p(G|Q) \leq p_G$, and Q is on the equilibrium path, the juri always uses $p(G|Q)$ as base of its decision. Hence, the equilibrium is the same as in (A).

These results can be gathered in the following lemma.

Lemma 8 *A class of semi-pooling equilibria exists, where type G mixes (G, Q) and type I chooses Q iff $a \leq rb$ and $\delta_Q \geq b - a$. The juri's strategy is $(p_C^G, p_C^Q, p_C^I) = (1, \frac{a/b - r}{1 - r}, 1)$, where the out-of-equilibrium belief $p(G|I) = 1$ supports $p_C^I = 1$. If $a = rb$ the G-type can use any mixed strategy with $q_Q^G \in \left(0, \frac{(1 - p_G)\tilde{p}_G^*}{p_G(1 - \tilde{p}_G^*)}\right)$. If $a < rb$ and $p_G \geq \tilde{p}_G^*$ the G-type uses mixed strategy $q_Q^G = \frac{(1 - p_G)\tilde{p}_G^*}{p_G(1 - \tilde{p}_G^*)}$. This class coincides for both settings, (A) and(B).*

Note that technicaly $q_Q^G = 0$ is excluded here for $a = rb$ because it makes part of the corresponding pure-strategy equilibrium.

I **strictly mixes** Q **and** I: This would mean that, when observing I, the juri must acquit because only type I sends this signal. But then I is strictly better-off with claiming I than with anything else.

6) G strictly mixes (G, I)

In this case type I's choice can only be I or Q (see Table 1).

I **chooses** *I*: Then $p(G|G) = 1$, $p(G|I) = \frac{p_G q_I^G}{p_G q_I^G + (1-p_G)}$, but $p(G|Q)$ is not determined by Bayesian updating because Q is out-of-equilibrium. Hence, $p_C^G = 1$, and, by (11), $p_C^I = \frac{a-rb}{b-rb} \neq 1$.

If $a = rb$ then $p_C^I = 0$, or equivalently, $p_A^I = 1$. Acquittal after hearing I then is only optimal if $p(G|I) \leq \tilde{p}_G^*$, which means $q_I^G \leq \frac{(1-p_G)\tilde{p}_G^*}{p_G(1-\tilde{p}_G^*)}$, i.e. the G-type should not use I too often.

If $a < rb$ then $p_C^I \neq 1$, meaning that the juri strictly mixes. This only happens if $p(G|I) = \tilde{p}_G^*$ or $q_I^G = \frac{(1-p_G)\tilde{p}_G^*}{p_G(1-\tilde{p}_G^*)}$. Note that $p(G|I) = \tilde{p}_G^*$ is only possible for $p_G \geq \tilde{p}_G^*$ since type I is always supposed to choose I.

For both cases ($a \leq rb$), we now look under which circumstances one or the other type of defendant has incentives to deviate from the prescribed strategy. In setting (A) we assume that, out-of-equilibrium, $p(G|Q) = 1$ in order to maximize disincentives to do so. For setting (B) we require that, with probability s the juri uses a-priori probabilities, whereas with probability $1 - s$ bases its decision on $p(G|Q) = 1$.

(A) Type G does not deviate to Q because we would have payoff b which is lower than a by using the mixed strategy (G, I). Type I does not deviate to Q iff $(1-r)b + \delta_Q \leq (1-r)p_C^I b$, a condition that is always fulfilled. Type I does not deviate to G iff $(1-r)a + \delta_G \leq (1-r)p_C^I b$ or $p_c^I \leq \frac{(1-r)a+\delta_G}{(1-r)b}$. Because of $p_C^I = \frac{a-rb}{b-rb}$, we require $r(a - b) \geq \delta_G$, which is always the case. So this makes up an equilibrium.

(B) For $p_G \leq \tilde{p}_G^*$ type G does not deviate to Q iff $b[r + (1-r)(1-s)] \leq a$, i.e. $s \leq 1 - \frac{a/b-r}{1-r} = 1 - p_C^I$ (a). For $p_G \geq \tilde{p}_G^*$ he does not deviate to Q iff $rb + (1-r)[sb + (1-s)b] \leq a$, i.e. $b \leq a$, which is always fulfilled. As to type I, he does not have incentives to deviate to G iff $(1-r)a + \delta_G \leq (1-r)p_C^I b = a - br$, i.e. $\delta_G \leq r(a - b)$, which is always satisfied. In case of $p_G \leq \tilde{p}_G^*$ not deviating to Q is optimal for $(1-r)(1-s)b + \delta_Q \leq a - br$, i.e. $s \leq 1 - \frac{a/b-r-\delta_Q/b}{1-r}$ (b), and for $p_G \geq \tilde{p}_G^*$ it is never of advantage to choose Q. Note that (a) implies (b).

Lemma 9 *A class of equilibria in strictly mixed strategies, with defendant type G strictly mixing using (G, I) and type I choosing I exists iff*

(A) *For $a = rb$, any $q_I^G \in (0, \frac{(1-p_G)\tilde{p}_G^*}{p_G(1-\tilde{p}_G^*)}]$ makes part of an equilibrium of this class. For $a < rb$ we require in addition $p_G \geq \tilde{p}_G^*$, and in this case we must have $q_I^G = \frac{(1-p_G)\tilde{p}_G^*}{p_G(1-\tilde{p}_G^*)}$. In both cases the juri's equilibrium strategy is $(p_C^G, p_C^Q, p_C^I) = (1, 1, \frac{a/b-r}{1-r})$, where $p_C^Q = 1$ is supported by the out-of-equilibrium belief $p(G|Q) = 1$.*

(B) *For $p_G \geq \tilde{p}_G^*$ same as in (A), as well as for $p_G < \tilde{p}_G^*$ in conjunction with $a = rb$.*

I **chooses** Q: Then $p_C^G = p_C^I = 1$ and $p_C^Q = 0$. Using (11), we obtain the contradiction $a = b$. Therefore, this cannot be part of an equilibrium.

I **strictly mixes** Q **and** I: In this case $p(G|G) = 1$, $p(G|I) = \frac{p_G q_I^G}{p_G q_I^G + (1-p_G) q_I^I}$, and $p(G|Q) = 0$, implying $p_C^G = 1$ and $p_C^Q = 0$. Also, by (11), $p_C^I = \frac{a-rb}{(1-r)b}$, and by (19), $p_C^I = \frac{\delta_Q}{(1-r)b}$. Therefore, parameters must satisfy $\delta_Q = a - rb < 0$. But then type G has an incentive to deviate to Q, because instead of a he would receive rb, which would be higher. Therefore, the case analyzed in the present paragraph cannot be part of an equilibrium.

7) G strictly mixes (Q, I)

Using the earlier results depicted in Table 1 this case is only compatible with type I choosing I or G.

I **chooses** G: In either setting type G would be identified as such an received the maximum sentence in I. Therefore, he were strictly better with saying G. Hence, this cannot be part of an equilibrium.

I **chooses** I: (**A**) G is identified in Q as such and, therefore, would be better-off choosing G. (**B**) For $p_G > \tilde{p}_G^*$ type G is convicted in Q in any case. So he should deviate to G. For $p_G \leq \tilde{p}_G^*$ there is acquittal in Q with probability s but conviction with probability $1 - s$, leading to expected payoff $(1-s)b$. Since type I is always supposed to choose I we have $p(G|I) < p_G \leq \tilde{p}_G^*$ leading to acquittal in I. Hence, type G would better choose I.

I **strictly mixes** I **and** G: (**A**) Type G is identified in Q as such and gets maximum penalty. Therefore, he would deviate to G. Hence, the constellation is not possible in equilibrium. (**B**) In G there must be acquittal. So type G should choose G unless also acquitted in Q and I. But in this case type I should strictly prefer I over G. So this cannot be an equilibrium.

This concludes the exhaustive analysis of existence of equilibrium in mixed strategies.

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