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RESUMO/ABSTRACT

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An Economic Analysis**

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

JEL-Classi_cation: D02, D82, K14.

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Abstract

This paper analyzes the strategic implications for criminal trial of the existence of the famous *Miranda Right* to Silence in U.S. 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 Miranda reduces wrongful confessions and convictions, at the price, however, of setting free guilty defendants as well. The rate of silence is affected only when confidence for the respect of the right is perfect; otherwise guilty defendants prefer to pool with innocent ones at declaring themselves innocent.

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Introduction

The *Miranda Rights* is probably one of the most well-known institutions of American law doctrine. Every child knows it from the daily session in front of television, where in virtually any police thriller it is read to the suspect while getting handcuffed and led away. Miranda, besides of guaranteeing legal defence to a suspect, confers to him the 'right to silence', meaning that he need not make any statements to police, prosecutors, and not even to the court: exercizing the right means that interrogation has to end.

There has been an ongoing debate in the U.S. over the last fourty years about the implications of the introduction of the Miranda Rights in 1966. Most of the discussion centers around the effectiveness of criminal investigation and crime clearance rates. Without Miranda, a suspect or defendant could be subjected to interrogation even when not wanting to talk to the authorities, and it is believed by some that subtle coercive and persuasive techniques could induce one or the other rightful confession – and, hopefully, no wrongful one. From the empirical point of view, a large majority of legal and social science analysts seem to have come to the conclusion that introduction of Miranda has initially caused some moderate decreases in confession and conviction rates, but along the years the impact seems to have diminished.[1]

It may be illuminating to look at these issues from the perspective of game theory. We will address in this paper the effects of the 'right to silence' for criminal trial. The right 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 to not use the fact of silence as such 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 by juris, even if properly instructed by the judge. 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 against the advantage that the right to silence may offer – to guilty as well as innocent defendants.

We will look at the strategic situation from the viewpoint 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

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[1] For a contemporary review, see Leo (2001). A controversial debate of this issue has been going on between Cassell (1996, 1998), on the one hand, and Schulhofer (1996), on the other. For early evidence, see Seeburger and Wettick (1967).

also exercise his right to stay quiet. Pleading guilty entitles to a lesser sentence but instant conviction. During trial new information enters the scene,[2] that, as such, either reveals the 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 regimes: either the juri is allowed to use unrestrictedly its (rational) beliefs, or it restricts itself, with certain probability, to not use, at information sets where the defendant is silent, any inference to his disadvantage. In the latter case the verdict is reached by using the commonly known prior evidence only.

The only closely related literature from law-and-economics literature is Seidmann (2005). There exist some common points with his analysis but as many differences. In Seidmann's article the defendant can be one 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. In our paper the witness knows or does not know, and it reports this fact truthfully to court. Seidmann assumes the particular setting in which innocent types always tell the truth. Given that wrongful confession and silence by innocent defendants are far from being a remote possibility, our approach is more general in this respect since all types of defendants are assumed to have the same strategic options, and decision to use them is endogenous. As results from our analysis emerge, we will have a closer look at the differences in the implications of both approaches.

The framework of our model is presented in Section 1. The results for the most interesting cases of parameter constellations are discussed in Section 2. A complete characterization of all Perfect Bayesian Equilibria is provided in the Appendix. Section 3 summarizes the results and looks at some avenues for future research in the area.

1   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

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[2]This could be a new witness, or a known witness that reveals new information. It could also be some new scientific method, say a state-of-the-art forensic test, for example.

strategy. G and I, of course, mean statement of guilt and innocence, respectively, whereas Q denotes the defendant exercizing his right to remain silent. Admission of guilt ends the trial, with the defendant being convicted to some sentence that is lesser than the one received when convicted without confession. One can think of the punishment as being implied by some prior plea bargain between defence and prosecution.

After the signal is sent, and the defendant has not confessed, the witness is heard. We assume that the witness knows of guiltyness or innocence of the defendant with probability r, whereas with probability $1 - r$ he is not informed. 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:

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

  (ii) If 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 freedom as in (A) to choose its beliefs.

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 off-equilibrium, against the G(-uilty) type of defendant if he chooses to be silent. On the other hand, favourable inference to the benefit of the I(-nnocent) type is not hampered.

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[3]In Seidmann (2005) each innocent type just claims his type. Therefore, requirement (ii) is not required in his analysis.

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 give an incentive to the defendant to come forward with the truth (probably also in order to save the juri's and judge's time). For the I-type of defendant we make the assumption that he earns an additional non-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 captures 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 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 the former one. So we assume

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

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

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

2   Results

A thorough analysis of all equilibria is given in the Appendix. In this section we will look at the most interesting cases where differences between the two regimes potentially may be most accentuated.

Observe that the following behaviour makes part of this game:

1. If the type of the defendant 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

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

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

First of all, in any rational solution of the game, for $a > rb$ the worst that may 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.[4] 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, with payoff a only being matched in case that he is always 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. We will exclude these trivial cases from further analysis and instead concentrate on the interesting one, $a < rb$, where potentially pooling of the two types may occur – with the possibility that the two regimes for juri behaviour imply different results.

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 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, the belief $p(G|Q) > \tilde{p}_G^*$ 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 $\min\{p(G|Q), p_G\} \geq \tilde{p}_G^*$. If $p(G|Q) < \tilde{p}_G^*$ 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, for 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 rationally updated beliefs as in (B) has the same consequences and creates the same incentives for the defendant. We can then state the following proposition.

Proposition 1 *The following Perfect Bayesian Equilibria in mixed strategies exist for $a < rb$ and $p_G > \tilde{p}_G^*$:*

(i) Pooling (G, G). Necessary condition: $\delta_G \geq (1 - r)b - a$.

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[4]Recall that r is the probability of being identified by the witness.

(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 $(p_C^Q, p_C^I) = (\frac{a/b-r}{1-r}, 1)$ if witness report is inconclusive. Necessary condition: $\delta_Q \geq b - a$.[5]*

(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 $(p_C^Q, p_C^I) = (1, \frac{a/b-r}{1-r})$ if witness report is inconclusive.*

Equilibria are identical for both sets of juri rules, (A) and (B).

Proof: For equilibrium (i), (ii) and (iii), see Lemma 1, Lemma 10 and Lemma 11, respectively, in the Appendix. ∎

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, and not riskier, equilibrium (iii) be selected.

Finally, if $\delta_G \geq (1-r)b - a$, equilibrium type (i) becomes available – type I feels the cost of not telling the truth as lower as the benefit of a reduced sentence. Note also that an additional necessary condition for existence is $r < 0.5$,[6] i.e. the probability of the witness revealing the truth must not be too high. This is because a higher probability of revelation pegs the guilty type to G, and then the innocent one can choose his most preferred option I without fear of being mixed up with the guilty type. Clearly, equilibrium (i) 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 less risky.

Nevertheless, independently of undoubtedly interesting questions of equilibrium selection, from the perspective of the issue that has motivated our analysis, we can state that for strong a-priori evidence there is no difference for the two juri rules under consideration.

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[5]Note that this type of equilibrium does not show up in Seidmann (2005) because in his interpretation of the Miranda Right, $p_G > \tilde{p}_G^*$ must always be used at Q to decide over acquittal or conviction (which implies conviction in this case).

[6]This follows from $a < rb$ and $(1-r)b - a < 0$. The latter is necessary to guarantee $\delta_G \geq (1-r)b - a$.

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. We can state the following proposition.

Proposition 2 *The following Perfect Bayesian Equilibria in mixed strategies exist for $a < rb$ and $p_G < \tilde{p}_G^*$:*

(i) *Pooling (G, G). Necessary condition: (A) $\delta_G \geq (1 - r)b - a$, (B) $\delta_G \geq (1 - r)b - a$ and $s \leq 1 - \frac{\delta_G - \delta_Q}{(1-r)b}$.*

(ii) *Pooling (Q, Q) with juri acquitting when witness report is inconclusive. Necessary condition: $\delta_Q \geq (1 - r)b$ for both, (A) and (B).*

(iii) *Separating (Q, I) with juri acquitting at both, Q and I, when witness report is inconclusive. Necessary condition: Only for rule set (B) and $s = 1$.*

(iv) *Pooling (I, I) with juri acquitting when witness report is inconclusive. Same for (A) and (B).*

Proof: For equilibrium (i), (ii), (iii) and (iv), see Lemma 1, 5, 6 and 7, respectively, in the Appendix. ∎

Let us once more start our analysis with the case of excessively high costs for not telling the truth and for being silent, $\delta_G < (1 - r)b - a$ and $\delta_Q < (1 - r)b$. 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 conceivable to separate the types – without being able to convict the bad guys, though.

Now let us suppose that the costs for the innocent type of being silent and of lying are sufficiently low to allow him to consider Q and G as well as possible statements. 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 also Pareto-dominated by (iv), but the latter is also riskier: in the worst case, both types could get convicted if witness or juri make an error. Therefore, it is not so clear which one of the two should be selected. In fact, both equilibria may have been around in reality before the surpreme court introduced the Miranda Rights. However, an increasing respect for the right ($s \to 1$) has eliminated equilibrium (i), leaving (iii) and (iv) – meaning that less wrongful confessions, and convictions, occur, at the price, however, of a lower conviction

rate and expected punishment for guilty defendants. This theoretical result is consistent with empirical evidence discussed in Cassell and Fowles (1998), among others. At the same time, it also gives an endogenous explanation of Seidmann's (2005) assumption that innocent types always say the truth. Seidmann also reports that, after the introduction of the Criminal Justice Act in 1994 in Great Britain which allows juries "... to draw an adverse inference from a suspect's refusal to answer some material questions" (p. 605), the confession rate did not significantly change, but the silence rate went down significantly. A decrease in the silence rate is consistent with the disappearance of equilibrium (iii) as soon as the slightest hint appears that silence might be interpreted by the juri as tacit admission of guilt. On the other hand, an unchanged confession rate is consistent with a slight increase in the juri's propensity to interpret silence as admission of guilt: as long as $s > 1 - \frac{\delta_G - \delta_Q}{(1-r)b}$, equilibrium (i) does not emerge, and having the option to draw inferences from silence does not mean necessarily that juris automatically use it – at least if they are sufficiently intelligent to understand the signalling context in which they are embedded.

Why would society be interested in having the Miranda Right to Silence in the first place? Suppose that the ordering of alternatives by the juri, (1), were the social ordering. Ex-ante expected social welfare for the two equilibria then would be $W^G = p_G c + (1 - p_G)f$ and $W^I = p_G[rc + (1 - r)e] + (1 - p_G)d$ for pooling on G and on I, respectively. Welfare turns out to be higher for pooling equilibrium (I, I) if the disutility from convicting an innocent citizen is sufficiently high.[7] Of course, with this moral burden one is better-off setting him free, although at the price that the same happens with the bad guy when he cannot be identified by the witness. The Miranda Right to Silence just accomplishes this task by removing pooling equilibrium (G, G) from the scene.

3 Conclusion

This paper has illustrated the strategic implications of the 'right to silence' for criminal trial in the context of modern U.S. law doctrine and has given the best explanation until now for empirical observations. Unlike in contemporary English law culture and before the Miranda decision, no adverse inferences may be drawn from the silence of a defendant. In case of weak a-priori evidence, the important consequence from the introduction of the right is a reduction in the rate of wrongful confession and implied conviction, but also guilty defendants are more likely to be set free, and their expected punishment decreases. Creating this combination of contrary effects may well be an intentional desire by society,

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[7]Note that $W^I > W^G$ iff $(1 - p_G)(d - f) > p_G(1 - r)(c - e)$. Furthermore, from (2) we deduce $\frac{\partial \tilde{p}_G^*}{\partial(d-f)} > 0$. Therefore, one can always guarantee $p_G < \tilde{p}_G^*$ when decreasing f because $\tilde{p}_G^*$ increases.

and the surpreme court's decision, as well as its continuing confirmation and strengthening of the right, could just reflect this intention.

On the other hand, with much progress made in forensic science over the last decades, it appears that a-priori guilt or innocence can be established with much more accuracy than before – even without a suspect's collaboration – meaning that he will be cited in front of court only if guilt seems very likely. Moreover, pressure has grown over police and prosecution to make their cases as 'bulletproof' as possible. In this case, when initial evidence grows stronger, the existence or not of the Miranda Right does not make any difference. Empirical evidence supports the implications of this view: as reported by Leo (2001), most legal and social science analysts agree that for some years after the introduction of Miranda, confession and conviction rates have slightly decreased, but thereafter the effect seems to have vanished.

It might be interesting for further research to extend the setting from trial to the preceeding stage of criminal investigation, where the Miranda Right already is in full effect, but potential for exploiting alternative sources of information about the case is higher than during trial phase. In this context it could also be worthwhile to incorporate the Miranda Right into an analysis of a framework where the defendant can potentially actively contribute to the finding of truth by transmitting information that may be corroborated with certain probability by an independent witness, say. This would allow one to look at some interesting questions, for example, how does the right to silence perform in a situation where an innocent defendant could increase the likelihood of his guilt when transmitting correct information to police or the court.

Epilogue

On March 13, 1963, $8.00 in cash was stolen from a Phoenix, Arizona bank worker. Police suspected and arrested Ernesto Miranda for committing the theft. During several hours of questioning, Mr. Miranda, who was never offered a lawyer, confessed not only to the $8.00 theft, but also to kidnapping and raping an 18-year-old woman 11 days earlier. Based largely on his confession, Miranda was convicted and sentenced to twenty to thirty years in jail.

Miranda's attorneys appealed. First unsuccessfully to the Arizona Supreme Court, and next to the U.S. Supreme Court. On June 13, 1966, the U.S. Supreme Court, in deciding the case of MIRANDA v. ARIZONA, 384 U.S. 436 (1966), reversed the Arizona Court's decision, granted Miranda a new trial at which his confession could not be admitted as evidence, and established the "Miranda" rights of persons accused of crimes.

Ernesto Miranda was given a second trial at which his confession was not presented. Based on the evidence, Miranda was again convicted of kidnapping

and rape. He was paroled from prison in 1972 having spent 11 years of his life in jail.

In 1976, Ernesto Miranda, at age of 34, was stabbed to death in a fight. Police arrested a suspect who, after choosing to exercise his Miranda right of silence, was released.

Source: Court TV's Crime Library,
http://www.crimelibrary.com/notorious_murders/not_guilty/miranda/

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 those of type I, and finally those of the juri, fitting them together as a Perfect Bayesian Equilibrium if it is possible. For this purpose, we always choose a belief of facing the guilty guy at any information set off the equilibrium path. This belief, of course, cannot always be used in setting (B) for the purpose of determining conviction or aquittal.

1) G uses G

I **chooses** G **(Pooling Equilibrium (G,G)):** Payoff for type G is a, for type I it is $a + \delta_G$. We have to distinguish the two regimes:

(A) Type G neither deviates to Q nor to I because $b < a$. Type I does not deviate to Q iff $(1-r)b + \delta_Q \leq a + \delta_G$, i.e. $\delta_G - \delta_Q \geq (1-r)b - a$ (a). He won't choose I iff $(1-r)b \leq a + \delta_G$, i.e. $\delta_G \geq (1-r)b - a$ (b). Note that (b) implies (a).

(B) For $p_G > \tilde{p}_G^*$, the same applies as in (A) because at Q there can always be conviction in regime (B). For $p_G \leq \tilde{p}_G^*$, the juri acquitts with respect for the right to silence. Then type G does not deviate to Q iff $rb + (1-r)(1-s)b \leq a$, i.e. $s \leq 1 - \frac{a/b - r}{1-r}$ (a). He won't choose I because $b < a$. As to type I, he does not deviate to Q iff $(1-r)(1-s)b + \delta_Q \leq a + \delta_G$, i.e. $s \leq 1 - \frac{a + \delta_G - \delta_Q}{(1-r)b}$ (b), and I isn't attractive for him iff $(1-r)b \leq a + \delta_G$, i.e. $\delta_G \geq (1-r)b - a$. Note that (b) implies (a).

These results can be gathered in the following lemma.

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

(A) *iff* $\delta_G \geq (1-r)b - a$.

(B) *iff* $\delta_G \geq (1-r)b - a$. *For* $p_G > \tilde{p}_G^*$ *no further conditions are required. For* $p_G \leq \tilde{p}_G^*$ *we additionally require* $s \leq 1 - \frac{a + \delta_G - \delta_Q}{(1-r)b}$.

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 for type *G* is *a*. For type *I*, who is the only one possible at information set *Q*, payoff is δ_Q. We do not need to distinguish the two legal regimes. Type *G* does not deviate to *Q* iff $rb \le a$, and he never deviates to *I* because $b < a$. As to type *I*, he won't go for *G* because $a + \delta_G \le \delta_Q$, and he wouldn't choose *I* iff $\delta_Q \ge (1-r)b$. Hence:

Lemma 2 *A separating equilibrium* (G, Q) *exists iff* $rb \le a$ *and* $\delta_Q \ge (1-r)b$. *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 type *G* is *a*, for type *I* it is 0. We have to distinguish the two regimes:

(A) Type *G* does not deviate to *Q* because $b < a$, and *I* is not attractive for him iff $rb \le a$. Type *I* under no circumstances deviates because he obtains his maximum of 0.

(B) For $p_G > \tilde{p}_G^*$ the same as in (A) applies. For $p_G \le \tilde{p}_G^*$, type *G* does not deviate to *Q* iff $rb + (1-r)(1-s)b \le a$, i.e. $s \le 1 - \frac{a/b-r}{1-r}$. He won't choose *I* iff $rb \le a$. As in (A), type *I* never deviates. Therefore:

Lemma 3 *A separating equilibrium* (G, I) *does exist in (A) iff* $rb \le a$. *For setting (B), and for* $p_G \le \tilde{p}_G^*$, *we additionally require* $s \le 1 - \frac{a/b-r}{1-r}$.
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:**   This strategy cannot include *I* because he would get strictly more than with the other alternatives. Also (G, Q) together is not possible because $a + \delta_G < \delta_Q$. Therefore, no such mixing is possible.

2) G uses Q

I **uses** *G* **(Separating Equilibrium (Q,G)):**   We have to distinguish the two settings. **(A)** Payoff for type *G* is *b*, for type *I* it is $a + \delta_G$. *G* deviates to *G* because there he obtains *a*. **(B)** Two cases must be distinguished:

(i) $p_G > \tilde{p}_G^*$ (juri convicts): Same case as in (A), with type *G* deviating.

(ii) $p_G \le \tilde{p}_G^*$ (juri acquits): Payoff for type *G* is $b[r + (1-r)(1-s)]$, for type *I* it is $a + \delta_G$. Type *G* does not deviate to *G* iff $a \le b[r + (1-r)(1-s)]$, i.e. $s \ge 1 - \frac{a/b-r}{1-r}$, and *I* isn't worthwhile either. As to type *I*, he won't deviate to *Q* iff $(1-r)(1-s)b + \delta_Q \le a + \delta_G$, i.e. $s \le 1 - \frac{a/b-(\delta_G-\delta_Q)/b}{1-r}$. This requires $\delta_G - \delta_Q \ge (1-r)b - a$. *I* won't go for *I* iff $\delta_G \ge (1-r)b - a$. Therefore we can state the following lemma.

Lemma 4 *In setting (B) a separating equilibrium (Q, I) exists iff $rb \leq a$, $p_G \leq \tilde{p}_G^*$, $\delta_G \geq (1-r)b - a$, and $s \in [1 - \frac{a/b - r}{1-r}, 1 - \frac{a/b - (\delta_G - \delta_Q)/b}{1-r}]$.*
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 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 $a + \delta_G < \delta_Q$. 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 $p_C^Q \leq \frac{a/b - r}{1-r}$ (a). 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 $a + \delta_G \leq (1-r)p_C^Q b + \delta_Q$ i.e. $p_C^Q \leq \frac{a + \delta_G - \delta_Q}{(1-r)b}$ (b). Not having him deviate to I requires $(1-r)b \leq (1-r)p_C^Q b + \delta_Q$, i.e. $p_C^Q \leq \frac{(1-r)b - \delta_Q}{(1-r)b}$ (c). Note that (a) implies (b).

We can state these results in the following lemma.

Lemma 5 *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 $p_G \leq \tilde{p}_G^*$, $a \leq rb$ and $s = 1$.

Lemma 6 *A separating equilibrium (Q, I) does exist only in setting (B) and for $p_G \leq \tilde{p}_G^*$, $a \leq rb$ and $s = 1$.*

***I* chooses a strictly mixed strategy:** It is not possible to have type I use I in a strict mix because he is identified, and then he earns strictly more than with any other option. So it remains to look at (G, Q). Because of I's indifference, we must have $a + \delta_G = (1-r)p_C^Q b$, i.e. $p_C^Q = \frac{a+\delta_G}{(1-r)b}$. For this we need $\delta_G \geq (1-r)b - a$. This implies tht type G in Q earns $rb + (1-r)\frac{a+\delta_G}{(1-r)b}b = rb + a + \delta_G$. But then he should use G. Therefore, this is not possible in equilibrium.

3) G uses I

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

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

***I* uses I (Pooling Equilibrium (I,I)):** For the two setting, the following applies:

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

  ii) $p_G \leq \tilde{p}_G^*$ (juri acquits): 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 $a + \delta_G < 0$. He won't choose Q either because $(1-r)b + \delta_Q < 0$.

  iii) $p_G = \tilde{p}_G^*$ (juri mixes C and 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 $p_C^I \leq \frac{a/b - r}{1-r}$ (a). 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 $a + \delta_G \leq (1-r)p_C^I b$, i.e. $p_C^I \leq \frac{a+\delta_G}{(1-r)b}$ (b), and under no circumstances it would be of strict advantage to deviate to Q because with it I would earn $(1-r)b + \delta_Q$ only. Note that (a) implies (b).

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

  ii) $p_G \leq \tilde{p}_G^*$ (juri acquits): 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 because $b[r + (1-r)(1-s)] \leq rb$. Type I does not deviate to G because $a + \delta_G < 0$. He won't choose Q either because $(1-r)(1-s)b + \delta_Q < 0$.

  iii) $p_G = \tilde{p}_G^*$ (juri mixes C and 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 $p_C^I \leq \frac{a/b - r}{1-r}$ (a). Note that this requires $a \leq rb$. He does not deviate to Q at all because of earning b only. Type I does not deviate to G iff $a + \delta_G \leq (1-r)p_C^I b$, i.e. $p_C^I \leq \frac{a+\delta_G}{(1-r)b}$ (b), and under no circumstances it would be of strict

advantage to deviate to Q because with it I would earn $(1-r)b + \delta_Q$ only. Again note that (a) implies (b).

Lemma 7 *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 ($a = rb$) the defendant is acquitted in equilibrium. For $p_G = \tilde{p}_G^*$, and with $a < rb$, the juri may use a mixed strategy with $p_C^I \in (0, \frac{a/b-r}{1-r}]$. 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)

For G's indifference between the three strategies we need $a = rb + (1-r)p_C^Q b = rb + (1-r)p_C^I b$, i.e. $p_C^Q = p_C^I = \frac{a/b-r}{1-r}$. This requires $a \leq rb$. But then type I should not use Q because in I he is convicted with the same probability, but saves δ_Q. He shouldn't opt for G either because $a + \delta_G < (1-r)\frac{a/b-r}{1-r}b = a - br$. So it is only possible that type I chooses I. **(A)** Type G is identified in Q, so he better went for G. **(B)** For $p_G > \tilde{p}_G^*$ the same holds as in (A). For $p_G < \tilde{p}_G^*$ there should always be acquittal in I. In Q, however, there is acquittal only with probability s. But then we need $a = rb$. For $p_G = \tilde{p}_G^*$, note that because type G is strictly mixing, he cannot always choose I. But then there is acquittal in I, but in Q not always, unless $s = 1$. Therefore, we can state the following lemma.

Lemma 8 *A class of semi-pooling equilibria $((G, Q, I), I)$ does exist for setting (B) iff $p_G \leq \tilde{p}_G^*$, $a = rb$ and $s = 1$. The juri always acquits in Q and I.*

5) G strictly mixes (G, Q)

I chooses I: **(A)** Type G is identified as such in 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 $p_G > \tilde{p}_G^*$. But then G strictly prefers G. If $p_G \leq \tilde{p}_G^*$, 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 9 *In setting (B) a separating equilibrium exists where type G strictly mixes (G, Q) with any probability and type I chooses I iff $a \geq rb$, $p_G \leq \tilde{p}_G^*$ and $s = 1 - \frac{a/b - r}{1 - r}$.*

I **chooses** Q: **(A)** Since G 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 because $a + \delta_G < a - br + \delta_Q$, 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 $p(G|Q) \leq p_G$ (because I always chooses Q), 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 10 *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 **chooses** G: **(A)** We must have $a = b$ for type G being indifferent. This contradicts $a > b$. **(B)** We require $p_C^Q = \frac{a/b - r}{1 - r}$ for G being indifferent. Then I's payoff with Q is $a - br + \delta_Q$ which is higher than $a + \delta_G$ with G. Therefore, this cannot be an equilibrium.

I **uses a strictly mixed strategy:** 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. So only (G, Q) can possibly occur in a strict mix. But both types cannot be simultaneously indifferent between the two because I has still to bear δ_G or δ_Q, respectively. Therefore, this cannot occur in an equilibrium.

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6) G strictly mixes (G, I)

I **chooses** *G*:   This would require $a = b$ for type G being indifferent.

I **chooses** *Q*:   This would require $a = b$ for type G being indifferent.

I **chooses** *I*:   For type G being indifferent, we need $a = rb + (1-r)p_C^I b$, i.e. $p_C^I = \frac{a/b - r}{1-r}$. This requires $a \leq rb$. Payoff for type I then is $a - br$. He does not divert to G because $a + \delta_G < a - br$.
(A) In Q there is conviction, so both, G and I, won't deviate. **(B)** For $p_G \geq \tilde{p}_G^*$ the same as in (A) applies. For $p_G < \tilde{p}_G^*$, we have $p(G|I) < \tilde{p}_G^*$, so p_C^I should be 0, and this only works with $a = br$.
We can therefore state the following.

Lemma 11 *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) $a \leq rb$. *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) $a \leq rb$. *For* $p_G \geq \tilde{p}_G^*$ *the equilibrium is the same as in (A). For* $p_G < \tilde{p}_G^*$, *in conjunction with* $a = rb$, *the equilibrium implies acquittal in* I.

I **uses a strictly mixed strategy:**   All three together are impossible because in Q type I is acquitted, implying $\delta_Q = a + \delta_G$, which is a contradiction. Mixing G and Q leads to the same conclusion. For Q and I together, we must have $\delta_Q = (1-r)p_C^I b$, i.e. $p_C^I = \frac{\delta_Q}{(1-r)b}$. Also, $a = rb + (1-r)\frac{\delta_Q}{(1-r)b}b = rb + \delta_Q$. Hence, $\delta_Q = a - rb$, requiring $a < rb$. For type G not deviating to Q, we need $rb \leq a$, which then is a contradiction. Finally, simultaneous mixing of G and I by both players is not possible due to the different relative costs of those options for the two. Therefore, no such equilibrium can exist.

7) G strictly mixes (Q, I)

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

I **chooses** *Q*:   By the same argument as before, this isn't an equilibrium either.

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 $(1 - s)b$ for type G. 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 **uses a strictly mixed strategy:** It is not possible to have types I and G simultaneously indifferent between Q and I because of the different relative costs of these options. Therefore, only G and I, on the one hand, and G and Q, on the other are possible. In both cases, however, we obtain a straightforward contradiction.

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

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