Procedural Concerns*

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Abstract

Different to other scientific disciplines traditional economic theory has remained remarkably silent about procedural aspects of strategic interactions. Much to the contrast, among psychologists there is by now a broad consensus that not only expected outcomes shape human behaviour, but also procedures that are used to take decisions. It is argued that procedural concerns are especially pervasive in the resolution of conflicts. In our paper we show that procedural concerns are in fact an inherent feature of the interaction of reciprocal agents. More precisely, using Dufwenberg and Kirchsteiger (2004)'s theory of sequential reciprocity we demonstrate that procedural choices determine the control that people have over outcomes. The control over outcomes in turn influences peoples' evaluations of responsibilities and intentions. Finally three applications are discussed to highlight the impact and importance of procedural concerns in strategic interactions.

Introduction

Imagine a group of three friends. One of them has a free ticket for the local concert of their favorite music band. Unfortunately, however, he cannot go himself, as he has an exam the following day. As his friends love the band as much as he does, he would like to give the ticket to one of them instead. He is indifferent as to whom of the two to give it. He knows, however, that if one of them feels unkindly treated, he will get into a quarrel with him. It is easy to see that this situation bears much resemblance to the '*So long, Sucker*' game already analyzed by Nalebuff and Shubik (1988) and Dufwenberg and Kirchsteiger (2004). A player (A), i.e. the *ticket holder*, is driven to choose an *unlucky* player, i.e. the friend that does not receive the ticket, out of two players (B) and (C). Subsequently the *unlucky* player is allowed to choose an action which is either kind, i.e. not quarreling, or unkind, i.e. quarreling, towards player (A). As in the '*So long, Sucker*' game, it seems also here, at first sight, that the *ticket holder* is trapped: by choosing who gets the ticket he inevitably has to be unkind to one of his friends, creating the risk of trouble. At a second glance, however,

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when asked how this conflict could be resolved, one is intuitively driven to suggest that he should flip a coin to take the decision as in this way he avoids being unkind to either of them.

This example and our intuition of how to resolve the conflict effectively highlight two essential aspects of any human interaction. First, very often there are numerous ways in which decisions can be taken. On the one hand, the friend holding the ticket could decide to take the decision himself as to whom to give it, but, on the other hand, he could also let *chance* decide by flipping a coin. Secondly, as a consequence of the first, one can easily see that decisions are inherently associated with *procedures* which characterize the way in which they are taken. The *ticket holder*, in our example, has to decide how he wants to take the decision before he can effectively take it.

Different to other scientific disciplines traditional economic theory has remained remarkably silent about procedural aspects of strategic interactions. Much to the contrary of this, among psychologists there is by now a broad consensus that not only expected outcomes shape human behaviour, but also procedures that are used to take decisions [e.g. Thibaut and Walker (1975), Lind and Tyler (1988), Collie et al (2002), Anderson and Otto (2003) and Blader and Tyler (2003)]. It is argued that *procedural concerns* are especially pervasive in the resolution of conflicts. Prominent examples of conflict resolutions are to be found in the areas of workplace relations and the public acceptability of policies and laws. First, psychologists have found evidence that behavioral reactions to promotion decisions, bonus allocations, dismissals etc. strongly depend on the perceived fairness of selection *procedures* [e.g. Lemons and Jones (2001), Konovsky (2000), Bies and Tyler (1993), Lind, Greenberg, Scott and Welchans (2000) and Roberts and Markel (2001)]. Second, it has been shown that public compliance with policies and laws strongly depends on the perceived fairness of their enforcement *procedures* [e.g. Tyler (1990), Wenzel (2002), Murphy (2004), De Cremer and van Knippenberg (2003) and Tyler (2003)]. Interestingly, workplace relations and the public acceptability of policies and laws are two areas that also play an eminent role in the economic literature. Nevertheless economists have so far neglected the impact of procedural choices on strategic interactions.

Psychologists explain the impact of *procedures* on human interactions with the help of attribution theory [e.g. Heider (1958), Kelley (1967), Kelley (1973), Ross and Fletcher (1985)]. Attribution theory rests on the assumption that people need to infer causes and assign responsibilities for why outcomes occur. It is argued that especially when outcomes are unfavorable and perceptions of intention are strong, there is a tendency to assign responsibility for outcomes to people. The assignment of responsibility and blame in turn has been shown to affect the occurrence and intensity of anger and aggression [Blount (1995)]. In other words, people care about others' intentions and reciprocate kind with kind and unkind with unkind behaviour. As *procedures* explicitly influence the control that people have over final outcomes, they obviously also influence the evaluation of responsibilities and intentions. To exemplify, imagine a workplace situation in which a principal wants to promote one out of two agents. If he chooses to take the decision on who is to be promoted intransperantly behind closed doors, agents are driven to attach a high degree of responsibility for the outcome to the principal. His choice is hence interpreted as intentional, which fosters perceptions of favoritism. If, to the contrast, the principal uses a transparent *procedure* which credibly shows that the decision is based on an unbiased criterion, i.e. a criterion which 'a priori' ensures that both agents have the same chance to be promoted, the principal is not blamed for the final outcome.

In line with attribution theory Blount (1995) experimentally showed that the responder behaviour in ultimatum games is very sensitive to the way, i.e. procedure, in which a proposal is made. In her experiments proposals in the ultimatum game were either made by a proposer actively having a stake in the final outcome of the game, by a neutral third party not having any monetary stake in the final outcome or by chance. She observed that the same proposal triggered significantly lower rejection rates in case a neutral third party or chance had chosen the proposal compared to situations in which the proposal was made by a stakeholder. According to attribution theory lower rejection rates in case of neutrality of the proposer or explicit randomizations hint at the fact that responders attach a lower degree of responsibility and intentionality for outcomes to other stakeholders as they do not have any influence over proposals. In other words, the responders' willingness to punish other stakeholders seems to decrease the lower the others' influence over the final division of the pie.

As said before economists have remained remarkably silent so far about the impact of procedures on the behaviour in strategic interactions. Only two recent economic papers have started to address the issue of procedural choices in strategic interactions [Bolton et al (2005), Trautmann (2006)]. In contrast to attribution theory, however, they extend models of distributional concerns to account for the impact of *procedural choices* on strategic behaviour. Bolton et al (2005) only present a sketch of a possible model based on the model of inequity aversion of Bolton and Ockenfels (2000). Trautmann, on the other hand, manipulates Fehr and Schmidt (1999)'s model of inequality aversion suggesting that agents' utilities depend on 'expected outcome differences' 'ex ante' as well as 'ex post' to any outcome realization. In the context of our 'mother-candy' example this means that even after the flipping of a coin the mother's utility depends on the 'ex ante' expected outcome difference. The expected outcome differential for the children is lowest when flipping a coin. Hence, inequality avers mothers would prefer flipping a coin to any other *procedure* because it ensures a zero expected outcome differential. Although Trautmann's functional form is able to accommodate the experimental finding that rejection rates in random ultimatum games are lower then in the standard ultimatum games, it can only be applied to single decision situations. It cannot be applied to more complicated strategic interactions as the calculation of expected payoffs needs expectations about the other player's play.

In contrast to Bolton et al (2005) as well as Trautmann (2006) our paper follows the psychologists' view. As a main result, using psychological game theory we show that *procedural concerns* are in fact an inherent feature of the interaction of reciprocal agents. By introducing moves of nature into the class of games analyzed by Dufwenberg and Kirchsteiger (2004) we, first, formally define the concepts of *procedural game* and *procedure* and, second, show how the later determines the attribution of responsibilities and the evaluation of intentions. Responsibilities and intentions, in turn, determine the degree of any subsequent reciprocation. In brief, *procedures* are associated with explicit probability distributions defined over pure actions. In our concert-ticket example the two pure actions of friend (A) obviously are: *i*) giving the ticket to friend (B) and *ii*) giving the ticket to friend (C). The flipping of a coin assigns the probability $\frac{1}{2}$ to both of them. The more skewed this probability distribution is towards a certain pure action, the stronger the impression that the decision maker is intentionally aiming at this outcome. At the extreme this means, if friend (A) takes the decision directly, i.e. without explicitly randomizing, to give the ticket to friend (B), the *unlucky* friend (C) assigns full responsibility and intentionality to the decision of friend (A). In this situation player (C)'s kindness perceptions are obviously shaped by the fact that player (A) has directly chosen player (B) without giving him any 'credible' *chance* to also get the ticket. Dufwenberg and Kirchsteiger (2004)'s class of sequential games, for example, only allows for these kind of *procedures* that imply full responsibility and intentionality. In other words, in their setting agents are always held fully responsible for all consequences of their actions. To the contrary of this, in our class of *procedural games* we allow for a richer domain of *procedures*. Agents can choose between different procedures, which 'credibly' differ in the probabilities that they assign to different pure actions. To exemplify, when player (A) decides to flip a coin in our introductory example both pure actions, *i*) and *ii*), are 'ex ante' equally probable. The outcome is pure *chance* and, hence, no responsibility and intentionality is associated with it. As a consequence, reciprocal agents react differently to the same outcomes, i.e. choice of pure actions, depending on the *procedure* which has led to them.

The organization of the paper is as follows. In the next section we formally define *procedures* and characterize a *procedural game* in which agents choose for *procedures* rather than actions and strategies. In the second section we point at the impact of *procedures* on the behaviour of reciprocal agents. More precisely, we formally define reciprocity in the context of our *procedural game* and in this way explain the impact of *procedural choices* on the strategic interaction of reciprocal agents. We furthermore show that the concept of *sequential reciprocity equilibria* (SRE) defined by Dufwenberg and Kirchsteiger (2004) can also be applied to our class of *procedural games* in which agents choose for *procedural strategies*. Finally three applications are discussed to highlight the impact and importance of *procedural concerns* in strategic interactions.

Procedures

In this section we proceed in two steps. First, we intuitively sketch our argument with the help of two examples. In a second step we *i*) formally define the concept of *procedures* and *ii*) fully characterize our class of *procedural games* in which agents do not choose for actions and strategies, as usually assumed in game theory, but for *procedures*. This class of multi-stage games in which agents choose for *procedures* is thenceforth used in the subsequent sections to analyze the impact of *procedural choices* on the strategic interaction of reciprocal agents.

As a starting point consider games Γ_1 and Γ_2 in Figure 1 and 2:

[Figure 1] and [Figure 2]

The sole difference between games Γ_1 and Γ_2 is that in Γ_2 player 1 cannot only choose his pure actions (L) and (R), as in Γ_1, but can also choose (M). As can easily be seen, however, player 1's pure action (M) is nothing else than choosing an explicit randomization device, (0), assigning probabilities α_2 and $(1-\alpha_2)$ to his pure actions (L) and (R) respectively. 'Flipping a coin' or 'throwing a dice' constitute explicit randomization devices, for example. 'Flipping a coin' assigns the probability $\frac{1}{2}$ to both pure actions (L) and (R), i.e. $\alpha_2 = (1-\alpha_2) = \frac{1}{2}$.

'Throwing a dice', on the other hand, leads to $\alpha_2 = \frac{5}{6}$ and $(1 - \alpha_2) = \frac{1}{6}$, if, for example, (L) is chosen, whenever numbers 1 to 5 come up, and (R) is chosen, if 6 appears. Obviously, 'flipping a coin' and 'throwing a dice' are but two 'credible' ways in which a decision can be taken. In reality one usually disposes of many different ways. Nevertheless the two examples already show that different ways, or in our words explicit randomization devices, are associated with differing explicit probability distributions with which an action is indirectly chosen by *chance*.

But not only choices like (M) can be characterized as choices for explicit randomization devices. Taking the thought about the 'credible' ways and the differing explicit probability distributions to the extreme shows that also pure actions like (L) and (R) can equally be defined as choices for explicit randomization mechanisms. Imagine, for example, that player 1 in Γ_1 and Γ_2 chooses for his pure actions (L). This is equivalent to saying that player 1 chooses for *chance* to take the decision between (L) and (R) assigning probability 1 to his pure action (L). Hence, although (L) represents a pure action, it can nevertheless be reinterpreted in a way in which the decision is indirectly taken by *chance* randomizing with a degenerated probability distribution over the set $\{(L), (R)\}$.

This shows that in our two examples, Γ_1 and Γ_2, any choice for a pure actions, i.e. (L) and (R), and any choice for an explicit randomization mechanism, i.e.(M), can likewise be reinterpreted as a choice for an explicit randomization device through which the actual decision is subsequently taken by *chance*. Consider, for example, game Γ_3 in Figure 3, which is a restatement of game Γ_1 in the spirit of this intuition:

[Figure 3][1]

As one can see, in Γ_3 we reformulate all strategic choices of game Γ_1 into choices for explicit randomization mechanisms, i.e. *chance* or player 0, through which decisions are subsequently taken. As said before, in game Γ_1 each player has the choice between two pure actions. Player 1 can decide between (L) and (R), and player 2 can decide between (l) and (r) or (l''') and (r''') depending on player 1's choice. Equivalently, in game Γ_3 every player has to decide between two explicit randomizations devices. Player 1, for example, has to decide between $\omega(h_1^0)$ and $\omega'(h_1^0)$ in the initial history h_1^0. On the one hand, by choosing $\omega(h_1^0)$ he can decide to let *chance* take the decision between (L) and (R) assigning probability 1 to (L), i.e. $\alpha_1 = 1$. On the other hand, by choosing $\omega'(h_1^0)$ he can decide to let *chance* take the decision assigning probability 1 to (R), i.e. $(1 - \alpha_2) = 1$. In both cases player 1 only determines *how chance* subsequently takes the decision, rather then taking the decision himself. Hence, notwithstanding the formal equivalence, an interpretive difference exists between games Γ_1 and Γ_3. Choosing for an explicit randomization mechanism implies that players do not take decisions themselves. They merely determine *how* decisions are taken by *chance*. In other words, players decide about the *procedures* which are used. The example in Figure 3, thus, uncovers that strategic decision making is not only about choosing actions but also about *how* actions are chosen. For this reason we call game Γ_3 a *procedural game*.

This brings us to a more formal definition of our class of *procedural games*. Formally, let the set of players be $\mathcal{N} = \{0, 1, ..., N\}$ where 0 denotes the uninterested player *chance*.

[1] Dotted lines in Figures 3-7 refer to actions that are chosen with probability zero, e.g. $(1 - \alpha_1) = 0$ and $\alpha_2 = 0$. They are only indicated for clarification and not continued for subsequent stages.

Denote as $\mathcal{H}$, with the empty sequence $\varnothing \in \mathcal{H}$, the finite set of histories, h, and $\mathcal{X}$ the finite set of decision nodes x, such that h^x is the sequence of decisions on the path to the decision node x. The player function, $\mathcal{C}$, assigns to each nonterminal history $h^x \in \mathcal{H}$ a member $i \in \mathcal{N}$ who moves after that history h^x. Therefore, let h_i^x be the history h on the path to the decision node x which is controlled by player $i \in \mathcal{N}$ and $\mathcal{H}_i$ the set of all histories after which player i has to move throughout the game. At each history, h_i^x, after which player $i \in \mathcal{N} \backslash \{0\}$ has to move, he disposes of a nonempty finite set of pure actions $\mathcal{A}(h_i^x)$ and a finite set of explicit randomization devices, $\Omega(h_i^x)$, through which he can choose an action from $\mathcal{A}(h_i^x)$. As already suggested in example Γ_3 players in our *procedural games* do not choose for actions $a \in \mathcal{A}(h_i^x)$ directly, but choose for explicit randomization mechanisms, denoted $\omega(h_i^x) \in \Omega(h_i^x)$, through which a decision is indirectly taken by *chance*. The choice for a specific explicit randomization mechanism, $\omega(h_i^x)$, in history h_i^x by player $i \in \mathcal{N} \backslash \{0\}$ leads to a specific decision node $v \in \mathcal{X}$ defined by h_0^v in which *chance* takes the actual decision using the explicit probability distribution $\rho(\omega(h_i^x))$ associated with $\omega(h_i^x)$ defined on $\mathcal{A}(h_0^v)$, with $\mathcal{A}(h_0^v) = \mathcal{A}(h_i^x)$. Hence, the choice for a pure action a (e.g. (L) in Γ_2), for example, translates in our *procedural game* into a choice for an explicit randomization mechanisms, $\omega(h_i^x)$, that is associated with a degenerated probability distribution $\rho(\omega(h_i^x))$ which assigns probability 1 to the pure action a in the set of possible actions $\mathcal{A}(h_0^v) = \mathcal{A}(h_i^x)$. The choice for an explicit randomization (e.g. (M) in Γ_2), on the other hand, is a choice for an explicit randomization mechanism, $\omega'(h_i^x)$, that is associated with a non-degenerated probability distribution $\rho(\omega'(h_i^x))$ defined on $\mathcal{A}(h_0^v) = \mathcal{A}(h_i^x)$. As said before, the set of player i's degenerated as well as non-degenerated explicit randomization mechanisms in any history h_i^x is $\Omega(h_i^x)$. The associated set of explicit probability distributions is furthermore denoted as $\mathcal{P}(h_i^x)$, where $\mathcal{P}(h_i^x) = \{\rho(\omega(h_i^x)) \mid \omega(h_i^x) \in \Omega(h_i^x)\}$. It can easily be seen that the minimum number of explicit randomization mechanisms that a player can decide between in any history h_i^x in our *procedural game* equals the number of pure actions that he has in the traditional extensive form representation.

As said before, by choosing for explicit randomization mechanisms players do not take decisions directly but only determine *how chance* should subsequently take them. To exemplify, player 1's set of explicit randomizations mechanisms in h_1^0 of game Γ_3 is $\Omega(h_1^0) = \{\omega(h_1^0), \omega'(h_1^0)\}$ where $\omega(h_1^0)$ and $\omega'(h_1^0)$ are respectively associated with the explicit probability distributions $\rho(\omega(h_1^0)) = (\alpha_1 = 1, (1-\alpha_1) = 0)$ and $\rho(\omega'(h_1^0)) = (\alpha_2 = 0, (1-\alpha_2) = 1)$. Intuitively, as player 1 only decides about the randomization device, $\omega(h_1^0)$ or $\omega'(h_1^0)$, through which *chance* takes the actual decision, one can say that player 1 only decides about the *procedure*, which is used to take a decision.

This brings us to a formal definition of *procedures*:

Definition 1 *A procedure, $\omega(h_i^x) \in \Omega(h_i^x)$, for player $i \in \mathcal{N} \backslash \{0\}$ in history $h_i^x \in \mathcal{H}_i$ is a tuple:*

$$\langle \rho(\omega(h_i^x)), \mathcal{A}(h_0^v) \rangle,$$

where:

1. *$\rho(\omega(h_i^x))$ is the explicit probability distribution associated with $\omega(h_i^x)$ defined on $\mathcal{A}(h_0^v)$*

2. *$\mathcal{A}(h_0^v) = \mathcal{A}(h_i^x)$, and*

3. h_0^v *directly succeeds* h_i^x*.*

As said before, usually one has many different 'credible' ways to take a decision. One can take decisions 'directly'[2], by 'flipping a coin' or by 'throwing a dice', for example. In any history of the game all these ways, or in other words *procedures*, associate different explicit probabilities to the feasible pure actions. Hence, the set $\Omega(h_i^x)$ is the set of feasible *procedures* of player i in history h_i^x. Above we have already seen that the set of possible *procedures* for player 1 in history h_1^0 of game Γ_3 is $\Omega(h_1^0) = \{\omega(h_1^0), \omega'(h_1^0)\}$. Furthermore player 2's set of *procedures* in h_2^4 of game Γ_3, for example, is $\Omega(h_2^4) = \{\omega(h_2^4), \omega'(h_2^4)\}$, where $\omega(h_2^4)$ and $\omega'(h_2^4)$ are respectively associated with the explicit probability distributions $p(\omega(h_2^4)) = (\beta_3 = 1, (1-\beta_3) = 0)$ and $p(\omega'(h_2^4)) = (\beta_4 = 0, (1-\beta_4) = 1)$.

In example Γ_3 *procedures* are used to choose for pure actions. We do not exclude, however, the possibility of *procedures* that choose between *procedures* and *procedures* that choose between *procedures* that choose between *procedures* etc. Procedures, $\omega(h_i^x) \in \Omega(h_i^x)$, rather have to be understood as reduced *procedures.* At any history h_i^x the explicit probability distribution associated with a reduced *procedure*, $\rho(\omega(h_i^x)) \in \mathcal{P}(h_i^x)$, basically subsumes the probability distributions of procedures of all levels into one explicit distribution defined on $\mathcal{A}(h_i^x)$. It is assumed that all players learn the outcome of a reduced *procedure* directly after its realization. In analogy to strategies in extensive form games we denote a collection of *procedures* for any player $i \in \mathcal{N} \setminus \{0\}$ that specifies a *procedure* for each history after which player i moves a *procedural strategy,* ω_i. A *behavioral procedural strategy*, $m_i \in \mathcal{M}_i$, of player i, on the other hand, has to be understood as an implicit randomization at each history $h_i^x \in \mathcal{H}_i$ over the set of possible *procedures* $\Omega(h_i^x)$. Note, a *behavioral procedural strategy*, $m_i \in \mathcal{M}_i$, is an implicit randomization over the set of explicit randomizations at each history $h_i^x \in \mathcal{H}_i$. We assume throughout that players choose for *behavioral procedural strategies.* Given a *behavioral procedural strategy*, m_i, for each player $i \in \mathcal{N} \setminus \{0\}$ and the commonly known system of probability distributions, $\mathcal{P} = \cup_{i \in \mathcal{N} \setminus \{0\}} \mathcal{P}_i$, where $\mathcal{P}_i = \cup_{h_i^x \in \mathcal{H}_i} \mathcal{P}(h_i^x)$, we can compute a probability distribution over endnodes, $z \in \mathcal{Z}$. By assigning payoffs to endnodes, we can derive an expected payoff function, $\pi_i : \mathcal{Z} \times \mathcal{P} \rightarrow \Re$, for every player $i \in \mathcal{N} \setminus \{0\}$ which depends on what *behavioral procedural profile*, m in $\mathcal{M}$, where $\mathcal{M} = \times_{\mathcal{N} \setminus \{0\}} \mathcal{M}_i$, is played. In what follows we will assume that payoffs are material payoffs like money or any other measurable quantity of some good.

Summarizing, a *procedural game* is a tuple:

$$\Gamma = \left\langle \mathcal{N}, \mathcal{M}, \mathcal{P}, (\pi_i : \mathcal{Z} \times \mathcal{P} \rightarrow \Re)_{\mathcal{N} \setminus \{0\}} \right\rangle. \quad (1)$$

As becomes clear from the definition of the *procedural game*, it formally represents an extension of the class of games analyzed by Dufwenberg and Kirchsteiger (2004). In addition to behaviour strategies, i.e. implicit randomizations, our class of *procedural games* also allows for explicit randomizations. As seen above, the integration of explicit randomizations in their setting has allowed for the separation of *procedures* and actions in the context of our *procedural game.*

[2]Note, 'directly' refers to any *procedure* which is associated with a degenerated explicit probability distribution like $\omega(h_1^0)$ and $\omega'(h_1^0)$ in history h_1^0 of example Γ_3.

This concludes the definition of *procedures* and the characterization of the class of *procedural games* which is the basis of our subsequent analysis. Starting from two simple examples, i.e. Γ_1 and Γ_2, we have formalized the idea that players choose for *procedures* rather than actions. In the remainder of the paper we use this class of *procedural games* in order to isolate the impact of *procedures* on strategic behaviour. More precisely, the following section uses this characterization of *procedural games* to analyze the impact of *procedural choices* on the interaction of reciprocal agents.

Procedural choices and reciprocity

It is easy to see that if agents are only interested in their own expected material payoff, they would always behave the same in histories representing starting points of identical subgames. Looking at game Γ_4 in Figure 4, for example, this means that players would react the same in histories h_2^4 or h_2^5.

[Figure 4][1]

However, in contradiction to the above it stands out from the evidence by Blount (1995) and Bolton et al (2005) that, for example, in ultimatum games rejection rates for the same proposal significantly decrease if proposals are made by a random draw. In other words proposer behaviours in ultimatum games have been shown to significantly depend on *how* a certain proposal has come about. Psychologists have termed this dependence *procedural fairness* or *procedural concerns* and explain the observed behaviour with the help of *attribution theory*. Remember, according to *attribution theory* agents behave reciprocally and evaluate the (un)kindness of themselves and others taking into consideration their as well as the others' possible influence on (expected) outcomes. The less influence people have over outcomes at the time of their decision the less they are held responsible for it. Therefore, in order to demonstrate how *procedural concerns* can theoretically be reconciled with economic theory, we broaden the behavioral presumption in this section by assuming that agents are reciprocal. This means we formally define reciprocity in the context of our *procedural game* and show how it can explain the aforementioned evidence on *procedural concerns*.

Generally speaking, reciprocity means that agents do not only care about their own material payoff but also about the intentions of others [e.g. Rabin (1992), Dufwenberg and Kirchsteiger (2004) and Falk and Fischbacher (2006)]. They act kindly or unkindly depending on whether others are kind or unkind to them. Before we can more formally characterize the motivation of reciprocal agents and precisely define kindness and perceived kindness, however, it is necessary to highlight four theoretical peculiarities: kindness and perceived kindness of any player towards/from any other player *i*) cannot be measured directly, *ii*) might change after different histories of a game, *iii*) should be unaffected by inefficient *procedural strategies* and *iv*) realizations of the moves of *chance*.

i) Kindness and perceived kindness cannot be measured directly as they depend on each player's *procedural strategies*, beliefs about the others' *procedural strategies* and beliefs about the others' beliefs. Therefore, to model kindness we assume that every player holds a belief over the *behavioral procedural strategies* as well as a belief over the other players' beliefs. In the spirit of Dufwenberg and Kirchsteiger (2004) we model beliefs as *behavioral* *procedural strategies,* $m_i \in \mathcal{M}_i, \forall i \in \mathcal{N} \setminus \{0\}$. However, in order to avoid confusion we introduce a separate notation for beliefs. Let $\mathcal{B}_{ij} = \mathcal{M}_j, \forall i, j \in \mathcal{N} \setminus \{0\}$ be the set of possible beliefs of player i about the *behavioral procedural strategy* of player j (i.e. first-order belief). Furthermore let $\mathcal{C}_{ijq} = \mathcal{B}_{jq} = \mathcal{M}_q, \forall i, j, q \in \mathcal{N} \setminus \{0\}$ be the set of possible beliefs of player i about the belief of player j about the *behavioral procedural strategy* of player $q \neq j$ (i.e. second-order belief). Obviously, players do not have beliefs about the moves of the player *chance*. They do know, however, the explicit probability distributions associated with them and, as said above, learn any realization directly after it has occurred. Therefore, let $(a)_{h^x}$ denote the collection of all passed realizations of moves of *chance* on the path up to history h^x.

ii) Players are assumed to have initial first- and second-order beliefs about the other players. As the game unravels these beliefs might change however. In order to capture this it is important to keep track of how each player's behaviour, beliefs, kindness and kindness perceptions differ across histories. We do this by updating *behavioral procedural strategies* as well as first- and second-order beliefs at each history that players control. In the spirit of Dufwenberg and Kirchsteiger (2004) we therefore formally define an (updated) *behavioral procedural strategy* as:

Definition 2 *With* $m_i \in \mathcal{M}_i$ *and* $h_i^x \in \mathcal{H}_i$*, let* $m_i(h_i^x) \in \mathcal{M}_i$ *be the (updated) behavioral procedural strategy that prescribes the same procedural choices as* m_i *except for the procedural choices of player* i *on the path to* h_i^x *which are made with probability 1.*

In correspondence with the collection of passed realizations of the moves of chance, $(a)_{h_i^x}$, the collection of passed procedural choices of player i on the path to h_i^x is denoted $(\omega_i)_{h_i^x}$. Hence, the updated behavioral procedural strategy $m_i(h_i^x)$ is identical to $(\omega_i)_{h_i^x}$ on the path to history h_i^x and identical to the initial behavioral procedural strategy, m_i, in all other histories. To exemplify consider again game Γ_4 in Figure 4. Let player 2's initial *behavioral procedural strategy* m_2 be an implicit randomization over his set of pure *procedures* at each history that he controls. Player 2 moves after history h_2^5, which means that the implicit randomization prescribed by his initial *behavioral procedural strategy* over his pure procedural choices, $\omega(h_2^5)$ and $\omega'(h_2^5)$, leads to some realization. Following this his updated *behavioral procedural strategy* becomes such that the implicit randomization at h_2^5 is substituted by its realization, but all other procedural choices at histories not reached remain the same. The updating of beliefs is assumed to work in an analogous fashion. Let, for example, player 2's initial belief about player 1's *behavioral procedural strategy* be $b_{21} = (\omega(h_1^0))$. If later on he finds himself in history h_2^5 in game Γ_4, his updated belief about player 1's *behavioral procedural strategy* becomes $b_{21}(h_2^5) = (\omega'(h_1^0))$, where $b_{21}(h_2^5)$ is player 2's updated first-order belief in history h_2^5 about player 1's *behavioral procedural strategy.* This shows that, parallel to the definition of $m_i(h_i^x)$, the updated first order belief $b_{ij}(h_i^x)$ is identical to the passed procedural choices of player j on the path to h_i^x, $(\omega_j)_{h_i^x}$, and identical to the initial belief, b_{ij}, in all other histories.

iii) For the same reason as in Dufwenberg and Kirchsteiger (2004) we restrict our attention to the set of *efficient procedural strategies*, $\mathcal{E}_i$. The set of *efficient procedural strategies*, $\mathcal{E}_i$, is defined as:

$$
\begin{aligned}
\mathcal{E}_i \;=\; & \Big\{ m_i \in \mathcal{M}_i \mid \text{there exists no } m_i' \in \mathcal{M}_i \text{ such that for all } h_i^x \in \mathcal{H}_i, (m_j)_{j\neq i} \in \Pi_{j\neq i}\mathcal{M}_j, \\
& q \in \mathcal{N}\backslash\{0\} \text{ it holds that } \pi_q\left(m_i'\left(h_i^x\right), \left(m_j\left(h_i^x\right)\right)_{j\neq i}\right) \geq \pi_q\left(m_i\left(h_i^x\right), \left(m_j\left(h_i^x\right)\right)_{j\neq i}\right) \\
& \text{with strict inequality for some } \left(h, \left(m_j\left(h_i^x\right)\right)_{j\neq i}, q\right)\Big\}.
\end{aligned}
$$

As already explained by Dufwenberg and Kirchsteiger (2004) strategic choices are inefficient if there exists at least one other choice which conditional on any history of play and subsequent choices by the others provides no lower material payoff for any player, and a higher expected material payoff for some player for some history of play and subsequent choices by the others. In other words any *behavioral procedural strategy* is inefficient if it involves 'wasteful play' following some history, $h_i^x \in \mathcal{H}_i$. As also pointed out by Dufwenberg and Kirchsteiger (2004), it is unreasonable to let kindness and perceived kindness be influenced by strategies or, in our context, *procedural strategies* that imply 'wasteful play'. More precisely, the fact that 'wasteful play' is possible should be irrelevant for drawing conclusions regarding the kindness of the others' 'efficient' choices.[3]

iv) As said above, kindness and perceived kindness should also be unaffected by the realizations of the move of *chance*. Intuitively this captures the idea that people are not held responsible for situations over which they had no control. Or, to put it positively, people are held responsible for situations in as much as they were/are able to influence them. To give an example, if the mother in our introductory situation chose to flip a coin to allocate the candy to one of her children, the children's kindness perceptions of the mother's choice would depend on her *procedural choice* even after the realization of the move of *chance*. She would not be held responsible for the realization itself as she was not able to influence it after she had taken the decision to flip a coin. Similarly, 'ex ante' the mother's kindness perception of her own choice are also based only on what she is able to influence, i.e. she does not hold herself responsible for the realization of the flip of the coin but only for her *procedural choice*. To capture this idea we define the *decision context* of a person i in any history h_i^x. In every history h_i^x the *decision context* comprises, first, all passed *procedural choices* on the path to history h_i^x, $(\omega)_{h_i^x}$, with $(\omega)_{h_i^x} = \left\{(\omega_i)_{h_i^x}, ..., (\omega_N)_{h_i^x}\right\}$. Remember, the knowledge of all passed *procedural choices* on the path to history h_i^x is included in the updated procedural profiles $m_i\left(h_i^x\right)$ and the updated first order beliefs $b_{ij}\left(h_i^x\right)$. Second, the *decision context* includes the realizations of the moves of *chance* on the path up to history h_i^x, $(a)_{h_i^x}$, and, third, the remaining explicit probability distributions, $(\mathcal{P})_{\neg h_i^x}$, where $\neg h_i^x$ indicates all histories beside the histories on the path up to h_i^x. Hence, formally speaking:

Definition 3 *The decision context in any history h_i^x is a tuple:*

$$
\left\langle (\omega)_{h_i^x}, (a)_{h_i^x}, (\mathcal{P})_{\neg h_i^x} \right\rangle.
$$

This means it is the collection of i) all passed procedural choices of all players on the path to h_i^x, $(\omega)_{h_i^x}$, ii) all passed realizations of the moves of chance on the path up to h_i^x, $(a)_{h_i^x}$, and iii) the unreached explicit probability distributions, $(\mathcal{P})_{\neg h_i^x}$.

[3] For a more detailed discussion of this issue refer to Dufwenberg and Kirchsteiger (2004).

Intuitively speaking the *decision context* can be understood as the 'informational background' which players use to evaluate their own kindness towards others and, hence, to take their decisions. It is also the 'informational background' which is used by other players in later stages to evaluate the kindness of passed choices by others. More precisely, the *decision context* helps others to decide in how far others were consciously aiming at a certain decision, i.e. pure action, or whether it was by *chance* that it was chosen.

Given these four points we can now capture the idea that players strive to be kind if treated kindly and are unkind if treated unkindly by assuming that every player $i \in \mathcal{N} \setminus \{0\}$ chooses a *behavioral procedural strategy*, m_i, that maximizes his utility defined as:

$$U_i = \pi_i + \sum_{j \neq i} Y_{ij} \cdot (\kappa_{ij} \cdot \lambda_{iji}), \tag{2}$$

where $i, j \in \mathcal{N} \setminus \{0\}$, κ_{ij} is the believed kindness of player i to player j and λ_{iji} is player i's belief about the kindness of player j towards himself.

More precisely, player i's utility is the sum of N terms. The first term π_i represents player i's self interest. It is his expected material payoff in any history h_i^x after which he moves. It obviously depends on his own *behavioral procedural strategy*, $m_i(h_i^x)$, his belief about the others' *behavioral procedural strategies*, $b_{ij}(h_i^x), \forall j \neq i$, all past outcomes/realizations of procedures $(a)_{h_i^x}$ until history h_i^x, and, finally, on the explicit probability distributions in all histories that have not been reached yet during the course of the game, $(\mathcal{P})_{\neg h^x}$. Hence:

$$\pi_i = \pi_i \left(m_i(h_i^x), (b_{ij}(h_i^x))_{j \neq i}, (a)_{h_i^x}, (\mathcal{P})_{\neg h^x} \right).$$

It can easily be seen that, as we allow for explicit randomizations in our class of *procedural games* our definition of expected material payoffs differs from the definition by Dufwenberg and Kirchsteiger (2005). It takes the player i's *decision context* in history h_i^x into account.

The following $N-1$ terms, $\sum_{j \neq i} Y_{ij} \cdot (\kappa_{ij} \cdot \lambda_{iji})$, in equation (2), on the other hand, represent player i's reciprocity payoff with respect to each other player $j \neq i$. The factor Y_{ij} is a non-negative reciprocity parameter which describes player i's sensitivity to the (un)kindness of player j. The higher Y_{ij} the more sensitive to reciprocity player i is. Finally the factors κ_{ij} and λ_{iji} capture respectively the kindness of player i to any other player j and player i's perceived kindness of player j towards him. Intuitively, kindness κ_{ij} is positive or negative depending on whether i is kind or unkind to j and perceived kindness λ_{iji} is positive (negative) if player i beliefs player j to be kind (unkind) to him. Notice, reciprocity is captured by the factorial specification of the kindness parameters, κ_{ij} and λ_{iji}. It drives players to match perceived kindness (positive λ_{iji}) with kindness (positive κ_{ij}) and perceived unkindness (negative λ_{iji}) with unkindness (negative κ_{ij}).

This brings us to the formal definition of kindness, κ_{ij}:

Definition 4 *The kindness of player i to another player $j \neq i$ at any history $h_i^x \in \mathcal{H}$ is given by the function $\kappa_{ij} : \mathcal{M}_i \times \Pi_{j \neq i} \mathcal{B}_{ij} \rightarrow \Re$ defined as:*

$$\kappa_{ij} = \pi_j \left(m_i(h_i^x), (b_{ij}(h_i^x))_{j \neq i}, (a)_{h_i^x}, (\mathcal{P})_{\neg h^x} \right) - \pi_j^{e_i} \left((b_{ij}(h_i^x))_{j \neq i}, (a)_{h_i^x}, (\mathcal{P})_{\neg h^x} \right).$$

The kindness of player i towards player j in history h_i^x is defined as the difference between the expected material payoff of player j , π_j, that player i intends to give j and the average expected material payoff, $\pi_j^{e_i}\left(\left(b_{ij}\left(h_i^x\right)\right)_{j\neq i},(a)_{h_i^x},(\mathcal{P})_{\neg h^x}\right)$, defined as:

$$\begin{aligned}
&\pi_j^{e_i}\left(\left(b_{ij}\left(h_i^x\right)\right)_{j\neq i},(a)_{h_i^x},(\mathcal{P})_{\neg h^x}\right)\\
=\;&\frac{1}{2}\left[\max\left\{\pi_j\left(m_i\left(h_i^x\right),\left(b_{ij}\left(h_i^x\right)\right)_{j\neq i},(a)_{h_i^x},(\mathcal{P})_{\neg h^x}\right)\mid m_i\left(h_i^x\right)\in\mathcal{M}_i\right\}\right.\\
&\left.+\min\left\{\pi_j\left(m_i\left(h_i^x\right),\left(b_{ij}\left(h_i^x\right)\right)_{j\neq i},(a)_{h_i^x},(\mathcal{P})_{\neg h^x}\right)\mid m_i\left(h_i^x\right)\in\mathcal{E}_i\right\}\right].
\end{aligned}$$

Think of $\pi_j^{e_i}$ as a norm for i describing the 'equitable' payoff for player j when i's beliefs about the other players' behavior are summarized by $\left(b_{ij}\left(h_i^x\right)\right)_{j\neq i}$, the passed realization on the path to h_i^x are $(a)_{h_i^x}$ and the unreached explicit probability distributions are given by $(\mathcal{P})_{\neg h^x}$. Thus, when $\pi_j^{e_i}=\pi_j$ then player i's kindness towards player j is zero. Intuitively the above definition means that player i is kinder the more he expects to give player j relative to the average that he could give him given his beliefs about the other players play. To exemplify consider, for example, history h_2^5 of game Γ_4. The *behavioral procedural strategy* of player 2, $m_2\left(h_2^5\right)$, as well as his first-order belief over the profile of player 1, $b_{21}\left(h_2^5\right)$, and the passed realized move of nature, $(a)_{h_2^5}=\{(L)\}$, define history h_2^5. Furthermore, player 2's *behavioral procedural strategy* together with his first-order belief and the remaining probability distributions, $(\mathcal{P})_{\neg h^x}$, on the other hand, define what player 2 is willing to give to player 1 in expected terms as well as what he could give him. Assume, for example, that player 2's *behavioral procedural strategy* in h_2^5 is $m_2\left(h_2^5\right)=\left(\omega\left(h_2^4\right),\omega\left(h_2^5\right),\omega\left(h_2^6\right),\omega\left(h_2^7\right)\right)$. As $\beta_3=1$ and $\beta_4=0$, it can easily be seen that player 2 intends to give player 1 $\pi_1\left(h_2^5\right)=1800$, i.e. according to $m_2\left(h_2^5\right)$ he will choose $\omega\left(h_2^5\right)$ after his history h_2^5. On the other hand, the average of the maximum and minimum which he could give to player 1 is $\pi_1^{e_2}\left(h_2^5\right)=\frac{1}{2}(1800)+\frac{1}{2}(0)=900$. Hence, player 2's kindness towards player 1 in h_2^5 is:

$$\begin{aligned}
\kappa_{21}\left(h_2^5\right) &= \pi_1\left(h_2^5\right)-\pi_1^{e_2}\left(h_2^5\right)=1800-900\\
&= 900.
\end{aligned}$$

The above definition of kindness is a necessary adaptation from Dufwenberg and Kirchsteiger (2004) in the context of our *procedural game*. It includes the *decision context* on which players base their decisions.

The definition of perceived kindness, λ_{iji}, also requires a change though. As said above, in the evaluation of intentions agents take into account in how far others were/are actually responsible for the unraveled play. Hence, it would be unreasonable to assume that player 2 in game Γ_4 perceived the kindness of player 1 in histories h_2^5 and h_2^6 differently. It is simply by *chance* that either of the two histories are reached. In order to capture this we assume that players always evaluate the other players' kindness on the basis of the *decision context* in which the others have taken their last *procedural choice*. Remember, a *decision context* characterizes the 'informational base' on which a decision is taken. As players know all passed *procedural choices* as well as the realizations of moves of *chance* along the path up to h_i^x, they obviously not only know their own current *decision context*, but they can also deduce all passed *decision contexts* which were the basis of the other players' last *procedural* *choices*. Denote the history in which any player $j \neq i$ has made his last procedural choice along the path up to h_i^x as $h_i^x\left(h_j^l\right)$. When player i evaluates the kindness of player j's *procedural choice* in history h_i^x, he, hence, uses player j's *decision context* in $h_i^x\left(h_j^l\right)$:

$$\left\langle (\omega)_{h_i^x\left(h_j^l\right)}, (a)_{h_i^x\left(h_j^l\right)}, (\mathcal{P})_{\neg h_i^x\left(h_j^l\right)} \right\rangle,$$

where $(\omega)_{h_i^x\left(h_j^l\right)}$ defines all passed *procedural choices on the path to* h_i^x up to history h_j^l, $(a)_{h_i^x\left(h_j^l\right)}$ defines all passed realizations of moves of *chance* on the path to history h_i^x up to history h_j^l and $(\mathcal{P})_{\neg h_i^x\left(h_j^l\right)}$ indicates all remaining explicit randomizations in h_j^l. Evaluating player j's kindness only on the basis of the *decision context* in which he has made his last *procedural choice* on the path up to history h_i^x ensures that player j is held solely responsible for the decisions that he has explicitly taken himself. To exemplify, in both histories h_2^5 and h_2^6 player 2 evaluates player 1's kindness on the basis of player 1's *decision context* at the history, h_1^0:

$$\left\langle (\omega)_{h_2^5\left(h_1^0\right)}, (a)_{h_2^5\left(h_1^0\right)}, (\mathcal{P})_{\neg h_2^5\left(h_1^0\right)} \right\rangle = \left\langle (\omega)_{h_2^6\left(h_1^0\right)}, (a)_{h_2^6\left(h_1^0\right)}, (\mathcal{P})_{\neg h_2^6\left(h_1^0\right)} \right\rangle,$$

in which player 1 had to take his last *procedural decision*, i.e. $h_j^l = h_1^0$. In other words, in histories h_2^5 and h_2^6 player 2 does not take the realization of the move of *chance* after history h_0^2 into account when evaluating the kindness of player 1. The realization of the move of *chance* after h_0^2 is by *chance* and hence not the responsibility of player 1.

Given this let perceived kindness be defined as:

Definition 5 *Player i's beliefs about how kind player $j \neq i$ is to i at history $h_i^x \in \mathcal{H}$ is given by the function $\lambda_{iji} : \mathcal{B}_{ij} \times \Pi_{i \neq j}\mathcal{C}_{iji} \rightarrow \Re$ defined as:*

$$\begin{aligned} \lambda_{iji} &= \pi_i \left(b_{ij}\left(h_i^x\right), \left(c_{ijq}\left(h_i^x\right)\right)_{q \neq j}, (a)_{h_i^x\left(h_j^l\right)}, (\mathcal{P})_{\neg h_i^x\left(h_j^l\right)} \right) \\ &\quad - \pi_i^{ej} \left(\left(c_{iji}\left(h_i^x\right)\right)_{i \neq j}, (a)_{h_i^x\left(h_j^l\right)}, (\mathcal{P})_{\neg h_i^x\left(h_j^l\right)} \right), \end{aligned}$$

where $h_i^x\left(h_j^l\right)$ is the last history after which player j has moved on the path to h_i^x.

As one can see, similar to the definition of kindness also perceived kindness is defined as the difference between what player i beliefs to receive in expected material payoff relative to the average that he could have gotten. To exemplify, assume now again that players find themselves in history h_2^5, with $a_2 = (1 - a_2) = \frac{1}{2}$ and $\beta_3 = 1$ and $\beta_4 = 0$. We have seen above that, given player 2's updated *behavioral procedural strategy*, his first-order belief and the past realizations of the moves of *chance* up to history h_2^5, player 2's kindness towards player 1 is 900 in h_2^5. In addition to player 2's updated first-order belief $b_{21}\left(h_2^5\right) = \left(\omega'\left(h_1^0\right)\right)$, let now player 2's updated second order belief be $c_{212}\left(h_2^5\right) = \left(\omega\left(h_2^4\right), \omega\left(h_2^5\right), \omega\left(h_2^6\right), \omega\left(h_2^7\right)\right)$. The kindness that player 2 perceives from player 1 is then given by:

$$\begin{aligned} \lambda_{212}\left(h_2^5\right) &= \pi_2 \left(b_{21}\left(h_2^5\right), c_{212}\left(h_2^5\right), (a)_{h_2^5\left(h_1^0\right)}, (\mathcal{P})_{\neg h_2^5\left(h_1^0\right)} \right) \\ &\quad - \pi_2^{e_1} \left(c_{212}\left(h_2^5\right), (a)_{h_2^5\left(h_1^0\right)}, (\mathcal{P})_{\neg h_2^5\left(h_1^0\right)} \right) \\ &= \left(\frac{1}{2}(1800) + \frac{1}{2}(200) \right) - \frac{1}{2}((1800) + (200)) \\ &= 0. \end{aligned}$$

This means, player 2 has the impression in history h_2^5 that player 1 intends to give him $\pi_2(h_2^5) = 1000$. As 1000 is also the 'equitable' payoff that player 1 could have given to him, player 2 judges player 1's kindness to be 0. Now consider history h_2^4, on the other hand, which is the starting point of an identical subgame. Player 2's perceived kindness of player 1's *behavioral procedural strategy* given his updated beliefs, $b_{21}(h_2^4) = (\omega_1(h_1^0))$ and $c_{212}(h_2^4) = (\omega(h_2^4), \omega(h_2^5), \omega(h_2^6), \omega(h_2^7))$ is:

$$\begin{aligned}\lambda_{212}\left(h_2^4\right) &= \pi_2\left(b_{21}\left(h_2^4\right), c_{212}\left(h_2^4\right), (a)_{h_2^4\left(h_1^0\right)}, (\mathcal{P})_{\neg h_2^4\left(h_1^0\right)}\right) \\ &\quad -\pi_2^{e_1}\left(c_{212}\left(h_2^4\right), (a)_{h_2^4\left(h_1^0\right)}, (\mathcal{P})_{\neg h_2^4\left(h_1^0\right)}\right) \\ &= (200) - \frac{1}{2}((1800) - (200)) \\ &= -600.\end{aligned}$$

Hence, although h_2^4 and h_2^5 are starting points of identical subgames, players perceives the situations totally differently, i.e. perceived kindness of 0 in h_2^5 vs. perceived kindness of -600 in h_2^4. It follows that as both histories are perceived differently, optimal reactions in one history might not be optimal in the other even though the subsequent situation seems to be the same. This exemplifies that reciprocal agents do care about the way a certain situation has come about or, in other words, reciprocity inherently leads to *procedural concerns.* This completes the description of the reciprocal preferences in the context of our *procedural game.*

Putting together the *procedural game*, Γ, as defined in (1) and the vector of utilities, $(U_i)_{i\in\mathcal{N}\setminus\{0\}}$, as defined in (2) we get a tuple

$$\Gamma^p = \left\langle \Gamma, (U_i)_{i\in\mathcal{N}\setminus\{0\}} \right\rangle. \tag{3}$$

We refer to Γ^p as a *procedural game with reciprocity preferences.* Note, as the 'psychological game with reciprocity preferences' defined by Dufwenberg and Kirchsteiger (2004) Γ^p is not a 'traditional game'. In line with Dufwenberg and Kirchsteiger (2004), utility functions, U_i, are defined on richer domains including subjective beliefs. Different to them, however, and also different to 'traditional games' agents in our setting choose for *procedures,* as defined in (1), rather than actions and strategies.

As a solution concept for our class of *procedural games with reciprocity preferences* we propose the *sequential reciprocity equilibrium* (SRE) defined by Dufwenberg and Kirchsteiger (2004). This means, each player in each history chooses his optimal *procedure* given his beliefs. The players' initial first and second order beliefs are required to be correct, and following each history of play the beliefs are updated as explained above.

Let $\mathcal{M}_i(h_i^x, m)$ be the non-empty set of *behavioral procedural strategies* that prescribe, for each player $i \in \mathcal{N}\setminus\{0\}$, the same choices as the strategy $m_i(h_i^x)$ for all histories other than h_i^x. Given this, the *sequential reciprocity equilibrium* (SRE) in the context of our *procedural game with reciprocity preferences* is defined as:

Definition 6 *The profile $m^* = (m_i^*)_{i\in\mathcal{N}\setminus\{0\}}$ is a sequential reciprocity equilibrium (SRE) if for all $i \in \mathcal{N}\setminus\{0\}$ and for each history $h_i^x \in \mathcal{H}$ it holds that*

1. $m_i^* \left(h_i^x\right) \in$

$$\arg\max_{m_i \in \mathcal{M}_i\left(h_i^x, m\right)} U_i \left(m_i \left(h_i^x\right), \left(b_{ij} \left(h_i^x\right), \left(c_{ijq} \left(h_i^x\right)\right)_{q \neq j} \right)_{j \neq i}, (a)_{h_i^x}, (\mathcal{P})_{\neg h_i^x} \right),$$

2. $b_{ij} = m_j^*$ *for all* $j \neq i$,

3. $c_{ijq} = m_q^*$ *for all* $j \neq i$, $q \neq j$.

The reasoning is essentially the same as in Dufwenberg and Kirchsteiger (2004). Condition 1 assures that a SRE is a strategy profile such that at history h_i^x player i makes choices which maximize his utility given his beliefs and given that he follows his equilibrium strategy at other histories. At the initial stage, conditions (2) and (3) guarantee that the initial beliefs are correct. At any subsequent history, condition (1) requires that beliefs assign probability one to the sequence of choices that define that history, but are otherwise as the initial beliefs.

Concluding, in this section we have formally defined the motivation of reciprocal agents in the context of our *procedural game* and have given a glimpse of the impact of *procedural choices* on the strategic interaction of reciprocal agents. In the following section we will more fully analyze the impact of *procedural choices* by applying the concept of the *sequential reciprocity equilibrium* to three examples.

Applications

In this section we apply the concept of the *sequential reciprocity equilibrium* to three examples. The first application is the '*Sequential Prisoners Dilemma*' also analyzed by Dufwenberg and Kirchsteiger (2004). The second is the '*So Long, Sucker*' game in the spirit of Nalebuff and Shubik (1988) and Dufwenberg and Kirchsteiger (2004). Finally, the third is a *Principal-Agent Situation* in which a principal searches for the optimal way to lay off one of his agents. Note, a full description of the strategic interaction and all possible equilibria that might arise in these three situations is beyond the scope of this paper. We, therefore, limit the analysis to the characterization of only one equilibrium to demonstrate the impact and importance of *procedural concerns*. Results and intuitions are presented in this section, mathematical proofs are relegated to the Appendix.

Example 1: *Sequential Prisoners Dilemma*

Consider the *Sequential Prisoners Dilemma* in Figure 5:

[Figure 5][1]

As can easily be seen, game Γ_5 is an adaptation of the sequential prisoners dilemma analyzed by Dufwenberg and Kirchsteiger (2004). The difference is that in Γ_5 player 1 cannot only choose to cooperate (c) and defect (d), as in Dufwenberg and Kirchsteiger (2004)'s setting, but can also explicitly randomize by choosing *procedure* (r). Dufwenberg and Kirchsteiger (2004) showed in the context of their setting that if player 2's sensitivity to reciprocity is strong enough, he cooperates if player 1 cooperates and defects if player 1 defects. Furthermore, they showed, first, that when both players' reciprocity sensitivities are high enough, both cooperation and defection are consistent with equilibrium play for player 1 and, second, that if player 1's sensitivity to reciprocity is low and player 2's sensitivity is high, cooperation is player 1's equilibrium behaviour for both monetary and reciprocity reasons.

As already hinted at in the intorduction, the equilibrium behaviours of players 1 and 2 in Dufwenberg and Kirchsteiger (2004) result from the fact that in their setting all choices make players attribute full intentionality to their co-players. To the contrast of this consider now game Γ_5 in which player 1 has the chance to explicitly randomize between his pure actions. The result changes:

Result 1 *If player 1's and 2's sensitivity to reciprocity, Y_1 and Y_2, is such that*

$$0 < Y_1 < \frac{1}{2}$$

and

$$Y_2 > \frac{1}{4\alpha_2 - 3}$$

and player 1's procedure $r\left(h_1^0\right)$ is associated with an explicit probability distribution such that $1 > \alpha_2 > \frac{3}{4}$, then the SRE is given by player 1 choosing $r\left(h_1^0\right)$ in history h_1^0 and player 2 choosing $c\left(h_2^4\right), c\left(h_2^5\right), c\left(h_2^6\right)$ and $d\left(h_2^7\right)$ in histories h_2^4, h_2^5, h_2^6 and h_2^7 respectively.[4]

Proof: see Appendix.

The intuition is the following. If α_2 is such that $1 > \alpha_2 > \frac{3}{4}$, player 2 perceives player 1's *procedural choice* as kind. If, in addition, his sensitivity to reciprocity Y_2 is high enough, i.e. $Y_2 > \frac{1}{4\alpha_2 - 3}$, then he reciprocates player 1's kindness by choosing (c) in history h_2^6. At the same time player 2 punishes player 1 in equilibrium at history h_2^7 which is the starting point of a payoff equivalent subgame. The difference between histories h_2^6 and h_2^7 is that the explicit probability α_2 is such that player 2 perceives player 1's choice of (r) as kind. He does not attribute enough responsibility for the outcome, i.e. history h_2^6, to player 1 to make it worth while to punish him. Furthermore, since Y_1 is relatively small, player 1 is mainly interested by money and his expected monetary payoff is highest by playing (r) given that player 2 does not play (d) following player 1's choice of (r).

This shows how *procedural choices* influence the kindness and perceived kindness of players and how this influences human interactions. Hence, Dufwenberg and Kirchsteiger (2004)'s results are sensitive to the availability of different *procedures*.

Example 2: *The 'So Long, Sucker' Game*

In the following we will apply the concept of the *sequential reciprocity equilibrium* to the example, Γ_6, in Figure 6.

[4]For simplicity we denote the sensitivity of reciprocity as Y_i in example 1 and 3. In example 2 we stick to Y_{ij} as defined in equation (2) to avoid confusion.

[Figure 6][1]

Example Γ_6 is an adaptation of the '*So Long, Sucker'* game also analyzed by Nalebuff and Shubik (1988) and Dufwenberg and Kirchsteiger (2004). With $\varepsilon = 0$, Γ_6 is a strategic situation in which player 1 has to decide on whom of two other players to give a zero payoff. Following his decision, the player who was unfavorably treated is called upon to decide whether player 1 should get 3 or whether both the others should equally get a payoff of 1. As already pointed out by Dufwenberg and Kirchsteiger (2004), intuitively it looks as if player 1 is 'a priori' worst off, as whoever he treats unfavorably will feel badly treated, and hence take revenge on player 1 by giving him the lowest possible monetary payoff.

However, if all players are solely motivated by purely selfish monetary concerns, this outcome is not guaranteed, as players 2 and 3 are indifferent between all their choices given that $\varepsilon = 0$. In order to allow for the possibility of revenge, Nalebuff and Shubik (1988) depart from the usual selfishness assumption, and assume that the players have lexicographically ordered objectives. As already described by Dufwenberg and Kirchsteiger (2004) this means that each player primarily maximizes his monetary payoff, but in case some choices yield exactly the same monetary payoff ties are broken so as to allow a player to take revenge. Dufwenberg and Kirchsteiger (2004), on the other hand, show that if agents behave reciprocally this outcome is also guaranteed for $\varepsilon \geq 0$. More precisely, they show that for any $\varepsilon \geq 0$ there exist sensitivities to reciprocity $Y_{21} > 0$ and $Y_{31} > 0$ for which taking revenge on player 1 is the best alternative for player 2 and 3. As said above, if players 2 and 3 are willing to take revenge even if it is costly, it seems that player 1 is trapped, as whatever he does, his action is perceived unkind by the player who has to take the subsequent decision.

As in the *Sequential Prisoners Dilemma* also in this application these results crucially depend on the fact that players 2 and 3 attribute full intentionality to player 1. In other words, Nalebuff and Shubik (1988)'s and Dufwenberg and Kirchsteiger (2004)'s result is contingent on the unavailability of other *procedures* for player 1 to resolve the conflict between him and the other players. Consider game Γ_7 in Figure 7:

[Figure 7][1]

As can easily be seen, the only difference between games Γ_6 and Γ_7 lies in the fact that in the later player 1 cannot only take his decision directly but can also flip a coin, i.e. choose $\omega_1' (h_1^0)$, to take it. Hence, he has an additional *procedure* which he can use to take his decision. It can be shown that with the help of this *procedure* player 1 can avoid the conflict with the others. More precisely:

Result 2 *If player 1, 2 and 3 have a sensitivity to reciprocity of*

$$Y_{12} = Y_{13} \geq 0,$$

$$Y_{21} \geq \frac{\varepsilon}{\varepsilon + 1}$$

and

$$Y_{31} \geq \frac{\varepsilon}{\varepsilon + 1},$$

then the only equilibrium is given by players 2 and 3 playing

$$\left(\omega_2'\left(h_2^4\right),\omega_2\left(h_2^5\right)\right)$$

and

$$\left(\omega_3'\left(h_3^6\right),\omega_2\left(h_3^7\right)\right)$$

respectively and player 1 choosing $\omega_1'\left(h_1^0\right)$.

This means, if players 2 and 3 are enough sensitive to reciprocity, they will punish player 1, if he chooses one of them directly, and will be kind to him, if he chooses to take the decision by e.g. 'flipping a coin'. Knowing this, player 1 will choose to flip a coin, given that his sensitivity to reciprocity is equal for players 2 and 3, as this gives him a higher monetary as well as reciprocity payoff. In other words, by choosing to flip a coin, player 1 can get out of the 'trap' identified by Nalebuff and Shubik (1988) and Dufwenberg and Kirchsteiger (2004). Players 2 and 3 respectively perceive player 1's *procedural strategy* $\omega_1\left(h_1^0\right),\omega_1''\left(h_1^0\right)$ as unkind and $\omega_1'\left(h_1^0\right)$ as kind. If player 1 chooses e.g. to flip a coin, they do not attribute the outcome of the randomization to player 1, as he is only responsible for choosing the *procedure* but not for the outcome itself. Player 1, on the other hand, chooses $\omega_1'\left(h_1^0\right)$ for monetary as well as reciprocity reasons.

This highlights ones more how *procedural choices* influence the strategic interaction of reciprocal agents.

Example 3: *Principal-Agent Situation*

As said in the introduction, *procedural concerns* are especially prevalent in workplace relations. Therefore, imagine a situation in which a principal, P, employs two agents, A_1 and A_2. At a certain point the principal and the agents learn that in the next but one period there will be a demand shock such that the principal is forced to lay off one of his agents. Let the principal have two *procedures* to decide whom of the two to lay off. He can either choose to take the decision '*behind closed doors*', (bcd), and communicate his decision after the first period, or he can use a '*tournament*', (t).

The situation unravels as follows. After learning the news the principal first has to decide on *how* to lay off one of his agents at the end of the first period. Following this, both agents choose their effort. For simplicity assume that agents can either choose '*high*', (h), or '*low*', (l), effort. At the end of the first period one agent is laid off. In the second period the agent that was not laid off chooses again '*high*' or '*low*' effort and the agent that was laid off can either decide to go to '*court*', (c), in order to appeal against the principal's decision or to accept it, i.e. '*no court*', (nc). As said before, the principal can either decide to take the decision *behind closed doors* or can use a *tournament*. Different to (bcd), in the '*tournament*' the principal commits himself to keep the agent with the higher effort also in the second period. If both choose (h) or (l) simultaneously in the first period under (t), the principal explicitly randomizes by flipping a coin.

Obviously the principal's income, $\varphi(\cdot)$, depends on the agent's effort choices. For simplicity assume that A_1's and A_2's impact on $\varphi(\cdot)$ is respectively 1 if *high* effort is chosen and 0 if *low*. In other words, assume that in the first period the principal's income is either

$\varphi(h,h) = 1+1 = 2$, $\varphi(h,l) = \varphi(l,h) = 0+1 = 1$ or $\varphi(h,h) = 0+0 = 0$ depending on the agents' effort choices. Extending the same logic also to the second period, the principal's income is either $\varphi(h) = 1$ or $\varphi(l) = 0$ in period 2. The agents' effort is not contractible so that the principal pays a fixed wage, $\omega \leq 1$, irrespective of the agents' choices. Furthermore, let the agent's effort costs be ξ if *high* effort is chosen and 0 otherwise. Let $\omega > 2\xi$. Lastly, assume that both the agent and the principal suffer if the laid off agent goes to *court.* Let the cost from going to *court* for, both, the principal and the agents be $\varepsilon > 2\xi$.

From the outset it is clear that the principal's profit is maximized if he can ensure *high* effort in both periods and *no court.* This would give him $3-3\omega$ in profit. However, it can also be seen that if agents are only concerned about their own material payoff, it is impossible for the principal to ensure a *high* effort in the second period independent of the *procedure* that he uses to take his decision. The agent that is also kept in the second period always prefers to shirk. On the other hand, it is easy for the principal to ensure *no court* by the agent that is laid-off, as this would be costly for the agent. More precisely, an agent that is only concerned about his own monetary payoff would not go to *court,* even if laid off, when it is costly for him.

Turning to the first period, consider the agents' behaviour under the *tournament.* Given the aforementioned second period behaviour, the agents are confronted with the following strategic situation in the first period:

		Agent 1: *High*	**Agent 1:** *Low*
Agent 2:	*High*	$(\omega - \xi) + 0.5\,\omega$, $(\omega - \xi) + 0.5\,\omega$	ω, $2\,\omega - \xi$
	Low	$2\,\omega - \xi$, ω	$\omega + 0.5\,\omega$, $\omega + 0.5\,\omega$

Table 1: Agents' 1. period incentive under *tournament.*

Note, in Table 1 the upper payoff refers to agent 1 and the lower to agent 2. Obviously agents only exert *high* effort if it is worth fighting to stay on working also in the second period. As can be seen from Table 1, in the context of the *tournament* this means, agents find it worth fighting if $\omega \geq 2\xi$. Hence, by setting $\omega \geq 2\xi$ the principal can ensure *high* effort under the *tournament* in the first period, if agents are only concerned about their own monetary payoff. Any wage $\omega < 2\xi$ would induce both agents to choose *low* effort independent of the other agent's effort choice. On the other hand, if the principal chooses to decide *behind closed doors*, one can easily see that the principal can always ensure *high* effort by implicitly mimicking the *tournament.* More precisely, if the principal decides to take the decision at the end of the first period *behind closed doors*, he can induce both agents to exert *high* effort by keeping the one with the higher effort and implicitly randomizing, if both choose the same effort.

Summarizing, if agents are only concerned about their own monetary payoff, their second period behaviour is identical under both *procedures* and their first period behaviour under the *tournament* can always be reproduced even *behind closed doors.* In other words, the *tournament* can never be strictly preferred by the principal to taking the decision *behind* *closed doors.*

Consider now a situation in which agents A_1 and A_2 behave reciprocally towards the principal, i.e. $Y_{A_1P} > 0$ and $Y_{A_2P} > 0$, but not towards each other, i.e. $Y_{A_1A_2} = Y_{A_2A_1} = 0$. Assume that the agents' initial first order beliefs are such that the principal implicitly mimics the *tournament*, if he chooses to take his decision *behind closed doors*. This means, the agents initially believe that, even if the principal takes his decision *behind closed doors*, he either chooses the agent with the higher effort or implicitly randomizes, if both have chosen the same effort. We have seen above, assuming agents that are only interested in their own monetary payoff, this behaviour by the principal leads to *high* effort in the first period and *low* effort as well as *no court* in the second independent of the *procedural choice* of the principal. If one assumes reciprocal agents, however, the situation changes. First, if the sensitivity to reciprocity is high enough both agents choose (l) in the first period and (h) and (c) in the second period, if the principal's *procedural choice* is (bcd), and, second, choose (h) in the first period and (h) and (nc) in the second period, if the principal decides to use the '*tournament*'. Given this, any profit maximizing principal chooses to take the decision using the *tournament.*

Consider result (3):

Result 3 *If agent 1's and 2's sensitivity to reciprocity is such that*

$$Y_i > \max\left\{\frac{4\xi}{(\varepsilon - 2\xi)}, \frac{2}{\omega + \varepsilon - \xi}, \frac{2(\varepsilon + \omega) - 6\xi}{\varepsilon - 2\xi}\right\}$$

where $i \in \{1, 2\}$, then agents A_1 and A_2 play (l) in the first period and (c), if laid off, and (h), if kept, in the second period under (bcd), and (h) in the first period and (nc), if laid off, and (h), if kept, in the second period under (t). Given this, any profit maximizing principal chooses to take the decision using the 'tournament' as this ensures the maximum profit of $3 - 3\omega$.

Intuitively, agents go to *court* in the second period under (bcd) because they attribute full intentionality to the principals lay off choice and update their beliefs accordingly. On the other hand, if the decision is taken via a *tournament*, then responsibility for the outcome is not attributed to the principal. Hence, the agent's beliefs do not change. This leads to a situation in which the *procedural choice* of the principal actually influences whether agents go to *court* or not. If the sensitivity to reciprocity towards the principal is strong enough, the agents go to *court* under (bcd) if laid off and choose *high* effort if kept in the second period. Furthermore they choose *no court* and *high* effort if kept under the *tournament* in the second period. Given this the difference between (bcd) and (t) in the first period results from the fact that the expected material payoff under (bcd) for the agents is lower. Hence, they perceive the *procedural choice* of the principal, (bcd), as unkind and choose *low* effort in the first period. The *tournament*, on the other side, is perceived to be kind. Hence *high* effort is chosen in the first period under the *tournament.*

This ones again shows *how* the interaction of reciprocal agents depends on *procedural choices.*

Conclusion

As we have seen, any decision in human interactions is inherently connected to a *procedure* which characterizes the way in which the decision is taken. This means it is impossible to take a decision without deciding on *how* to take it. It is widely accepted in other scientific disciplines and it has been shown experimentally that people react differently to identical outcomes depending on the *procedures* which have led to them. Hence, people are concerned about the way in which decisions are taken. Nevertheless economic theory has so far neglected the impact of *procedural choices* on human interaction. It has ignored *procedural concerns* as traditional economic theory is based on consequentialist preferences. However, if preferences are solely outcome oriented, it can hardly be explained why people should react differently to 'outcomewise' identical situations which only differ in the *procedures* which have led to them.

Only in recent years theories of reciprocity have contested the consequentialist view in economic theory by assuming that agents also receive a psychological payoff which, broadly speaking, depends on the agents' perceived intentions of others. As said before, when people behave reciprocally they evaluate the intentions of others and reciprocate kind with kind and unkind with unkind behaviour. The evaluation of intentions is implicitly connected to the assignment of responsibilities for outcomes. The assignment of responsibilities, in turn, is related to the amount of control that people have over outcomes. It has been shown in our paper that *procedural choices* influence the control that people have over outcomes and, hence, influence the attribution of responsibilities and the evaluation of intentions. Dufwenberg and Kirchsteiger (2004)'s theory of sequential reciprocity captures situations in which agents have full control over outcomes and, hence, are held fully responsible for all consequences of their actions. In contrast to this, in our class of procedural games agents can choose between different *procedures*, which differ in the probabilities that they assign to outcomes (e.g. the flipping of a coin in our mother-candy example). Given this we show, in line with attribution theory, that the less influence people have on outcomes the less responsibility and intentionality is attributed to them.

By defining a class of *procedural games* we have been able to distinguishing between *procedures* which are used to take decisions and the decisions themselves. Furthermore, assuming reciprocal agents and defining the *decision context* as the 'informational background' which any decision is based upon, we have demonstrated that *procedural concerns* are actually an inherent feature of any human interaction.

As shown in the last section *procedural concerns* and hence *procedural choices* have implications in many important economic areas. To exemplify we have demonstrated that Dufwenberg and Kirchsteiger (2004)'s result in the *Sequential Prisoners Dilemma* and their as well as Nalebuff and Shubik (1988)'s result in the '*So Long, Sucker'* game crucially depend on the availability of other *procedures* that might be able to mitigate the conflict between the different stakeholders. In our last application we have given an example which demonstrates how *procedural concerns* might influence workplace relations.

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Appendix

Proof to result (1):

In this proof we show under what conditions the behaviour as defined in result (1) is the equilibrium behaviour. Note, as defined in (6) we assume that players' beliefs are correct. Given this, we analyze under what conditions they can be sustained in equilibrium. It can easily be seen that if player 2's second order belief about player 1's belief is $\left(c\left(h_2^4\right), c\left(h_2^5\right), c\left(h_2^6\right), d\left(h_2^7\right)\right)$, then player 2's believed equitable payoff is $\pi_2^{e_1} = \frac{1}{2}(1) + \frac{1}{2}(0) = \frac{1}{2}$. Hence, player 2's perceived kindness if player 1 chooses $c\left(h_1^0\right)$ is

$$\lambda_{212}\left(h_2^4\right) = 1 - \frac{1}{2} = \frac{1}{2},$$

where 1 is player 2's expected monetary payoff and $\frac{1}{2}$ his equitable payoff given his second order belief.

Secondly, if player 1 plays $r\left(h_1^0\right)$ player 2's perceived kindness of player 1's *procedural choice* is

$$\begin{aligned} \lambda_{212}\left(h_2^5\right) &= \lambda_{212}\left(h_2^6\right) \\ &= \alpha_2(1) + (1-\alpha_2)(-1) - \frac{1}{2} \\ &= 2\alpha_2 - \frac{3}{2}, \end{aligned} \tag{4}$$

and, thirdly, if player 1 plays $d\left(h_1^0\right)$, it is

$$\lambda_{212}\left(h_2^7\right) = 0 - \frac{1}{2} = -\frac{1}{2}.$$

From equation (4) it can directly be seen that player 2 perceives player 1's *procedural choice* $r\left(h_1^0\right)$ as kind or unkind depending on α_2. If $\alpha_2 > \frac{3}{4}$ then player 1's choice of $r\left(h_1^0\right)$ is perceived as kind. Therefore,

Remark 1 *If α_2 is such that*

$$1 > \alpha_2 > \frac{3}{4},$$

then player 2 perceives player 1's procedural choice $r\left(h_1^0\right)$ as kind.

Henceforth we assume that player 1's *procedure* $r\left(h_1^0\right)$ is associated with an explicit probability distribution $\alpha_2 > \frac{3}{4}$.

We said before that player 1's first order belief is $\left(c\left(h_2^4\right), c\left(h_2^5\right), c\left(h_2^6\right), d\left(h_2^7\right)\right)$. Furthermore, we said that in equilibrium this belief has to be correct. Hence, under what condition do we expect player 2 to choose $c\left(h_2^4\right)$ following player 1's choice of $c\left(h_1^0\right)$? By playing $c\left(h_2^4\right)$ player 2 receives the following utility

$$u_2\left(c\left(h_2^4\right)\right) = 1 + Y_2(1)\left(\frac{1}{2}\right),$$

where $\kappa_{21}\left(c\left(h_2^4\right)\right) = 1 - \frac{1}{2}((1) + (-1)) = 1$ is player 2's kindness to player 1 by playing $c\left(h_2^4\right)$. On the other hand, by playing $d\left(h_2^4\right)$ player 2's utility is

$$u_2\left(d\left(h_2^4\right)\right) = 2 + Y_2(-1)\left(\frac{1}{2}\right),$$

where $\kappa_{21}\left(d\left(h_2^4\right)\right)=-1-\frac{1}{2}\left((1)+(-1)\right)=-1$. Hence player 2 plays $c\left(h_2^4\right)$ in history h_2^4 if

$$1+Y_2\left(1\right)\left(\frac{1}{2}\right)\geq 2+Y_2\left(-1\right)\left(\frac{1}{2}\right).$$

This reduces to

$$Y_2\geq 1.$$

This shows that if player 1 plays $c\left(h_1^0\right)$, player 2 plays $c\left(h_2^4\right)$ if $Y_2\geq 1$.

Remark 2 *If player 1 plays $c\left(h_1^0\right)$, player 2 plays $c\left(h_2^4\right)$ if $Y_2\geq 1$.*

Going back to player 1's first order belief, under what conditions do we expect player 2 to choose $d\left(h_2^7\right)$ following player 1's choice of $d\left(h_1^0\right)$?

In history h_2^7 it is easy to see that player 2's monetary and reciprocity payoff induce him to chooses $d\left(h_2^7\right)$ for all $Y_2\geq 0$. Hence, if player 1 plays $d\left(h_1^0\right)$, player 2 plays $d\left(h_2^7\right)$ if $Y_2\geq 0$.

Remark 3 *If player 1 plays $d\left(h_1^0\right)$, player 2 plays $d\left(h_2^4\right)$ if $Y_2\geq 0$.*

Finally, under what conditions do we expect player 2 to choose $c\left(h_2^5\right)$ in h_2^5 and $c\left(h_2^6\right)$ in h_2^6 following player 1's choice of $r\left(h_1^0\right)$?

Assume that player 1 has chosen $r\left(h_1^0\right)$. Doing the analogous calculations as above for player 2's behaviour in history h_2^5 one can see that player 2 plays $c\left(h_2^5\right)$ in h_2^5 if

$$1+Y_2\left(1\right)\left(2\alpha_2-\frac{3}{2}\right)\geq 2+Y_2\left(-1\right)\left(2\alpha_2-\frac{3}{2}\right),$$

where the *lhs* is $u_2\left(c\left(h_2^5\right)\right)$ and the *rhs* is $u_2\left(d\left(h_2^5\right)\right)$. The above reduces to

$$Y_2\geq\frac{1}{4\alpha_2-3}.$$

Note, as $\alpha_2>\frac{3}{4}$ we know that $Y_2\geq\frac{1}{4\alpha_2-3}>1$. This shows that any player 2 with $Y_2\geq\frac{1}{4\alpha_2-3}$ would play $c\left(h_2^4\right)$ in history h_2^4 and $c\left(h_2^5\right)$ in history h_2^5. Finally, in history h_2^6 the analogous calculations as in h_2^5 and h_2^4 are

$$-1+Y_2\left(1\right)\left(2\alpha_2-\frac{3}{2}\right)\geq 0+Y_2\left(-1\right)\left(2\alpha_2-\frac{3}{2}\right),$$

where the *lhs* is $u_2\left(c\left(h_2^6\right)\right)$ and the *rhs* is $u_2\left(d\left(h_2^6\right)\right)$. The above also reduces to

$$Y_2\geq\frac{1}{4\alpha_2-3}.$$

Hence, also here it holds that if $Y_2\geq\frac{1}{4\alpha_2-3}$ player 2 plays $c\left(h_2^6\right)$ in history h_2^6.

Remark 4 *If player 1 plays $r\left(h_1^0\right)$, player 2 plays $c\left(h_2^5\right)$ in h_2^5 and $c\left(h_2^6\right)$ in h_2^6 if $Y_2\geq\frac{1}{4\alpha_2-3}$.*

Concluding, as we have seen above, if $Y_2 \geq \frac{1}{4\alpha_2 - 3}$, it holds that player 2' equilibrium behaviour is characterized by $c(h_2^4), c(h_2^5), c(h_2^6)$ and $d(h_2^7)$ in histories h_2^4, h_2^5, h_2^6 and h_2^7 respectively.

Let us now turn to player 1. Player 1's perceived kindness of player 2's equilibrium *procedural profile* is

$$\begin{aligned}\lambda_{121}\left(h_1^0\right) &= (q + 2q' - q'\alpha_2) - (1 - q'\alpha_2 - q) \\ &= 2q + 2q' - 1,\end{aligned}$$

where q and q' are player 1's second order beliefs associated with his *procedures* $c(h_1^0)$ and $r(h_1^0)$. His kindness to player 2, on the other hand, is

$$\kappa_{12}\left(c\left(h_1^0\right)\right) = 1 - \frac{1}{2} = \frac{1}{2},$$

by playing $c(h_1^0)$,

$$\begin{aligned}\kappa_{12}\left(r\left(h_1^0\right)\right) &= \alpha_2 - (1 - \alpha) - \frac{1}{2} \\ &= 2\alpha_2 - \frac{3}{2},\end{aligned}$$

by playing $r(h_1^0)$ and

$$\kappa_{12}\left(c\left(h_1^0\right)\right) = 0 - \frac{1}{2} = -\frac{1}{2},$$

by playing $d(h_1^0)$.

Putting the pieces together one can see that player 1 chooses $r(h_1^0)$ in equilibrium if for $q' = 1$ and $q = 0$ two conditions hold: *i)* $u_1(r(h_1^0)) \geq u_1(c(h_1^0))$ and *ii)* $u_1(r(h_1^0)) \geq u_1(d(h_1^0))$. The first condition boils down to

$$(2 - \alpha_2) + Y_1\left(2\alpha_2 - \frac{3}{2}\right) \geq (1) + Y_1\left(\frac{1}{2}\right),$$

which reduces to

$$Y_1 \leq \frac{1}{2}.$$

The second condition furthermore boils down to

$$(2 - \alpha_2) + Y_1\left(2\alpha_2 - \frac{3}{2}\right) \geq (0) + Y_1\left(-\frac{1}{2}\right),$$

which holds for all $Y_1 \geq 0$. Hence, given player 2's behaviour, the equilibrium behaviour of player 1 is characterized by $r(h_1^0)$ if $0 < Y_1 \leq \frac{1}{2}$.

Remark 5 *Given player 2's equilibrium behaviour* $(c(h_2^4), c(h_2^5), c(h_2^6), d(h_2^7))$, *player 1 plays* $r(h_1^0)$ *if* $0 < Y_1 \leq \frac{1}{2}$.

In other words, if player 2's sensitivity to reciprocity is high and player 1's is not too strong, the equilibrium behaviour for both players is player 1 choosing the *procedure* $r(h_1^0)$ and player 2 choosing $(c(h_2^5), c(h_2^6))$ in response. This concludes the proof of the result (1).■

Proof to result (2):

In analogy to the aforementioned proof, we first show under what conditions $(\omega_2'(h_2^4), \omega_2(h_2^5))$ and $(\omega_3'(h_3^6), \omega_2(h_3^7))$ simultaneously represent the equilibrium behaviour of players 2 and 3. Then, secondly, we show the conditions for which it is best for player 1 to choose $\omega_1'(h_1^0)$, given the behaviour of players 2 and 3.

If $(\omega_2'(h_2^4), \omega_2(h_2^5))$ and $(\omega_3'(h_3^6), \omega_2(h_3^7))$ are player 2's and 3's *procedural profiles*, then the most and least that player 1 can give to player 2 and 3 is either 1 or $-\varepsilon$. Hence, it can easily be seen that the perceived kindness of player 2 and 3 in either of the four histories h_2^4, h_2^5, h_3^6, h_2^7 is:

$$\begin{aligned}\lambda_{212}\left(h_2^4\right) &= \lambda_{313}\left(h_3^7\right)\\ &= -\varepsilon - \frac{1}{2}(1-\varepsilon)\\ &= -\frac{1}{2}(1+\varepsilon),\end{aligned}$$

$$\begin{aligned}\lambda_{212}\left(h_2^5\right) &= \lambda_{212}\left(h_3^6\right) = \lambda_{313}\left(h_2^5\right) = \lambda_{313}\left(h_3^6\right)\\ &= \frac{1}{2} - \frac{1}{2}(1-\varepsilon)\\ &= \frac{1}{2}\varepsilon,\end{aligned}$$

and

$$\begin{aligned}\lambda_{212}\left(h_3^7\right) &= \lambda_{313}\left(h_2^4\right)\\ &= 1 - \frac{1}{2}(1-\varepsilon)\\ &= \frac{1}{2}(1+\varepsilon),\end{aligned}$$

where $\pi_2^{e_1} = \pi_3^{e_1} = \frac{1}{2}(1-\varepsilon)$. In other words, if player 1 chooses $\omega_1(h_1^0)$ player 2 perceives this as unkind and player 3 as kind. On the other hand, if player 1 chooses $\omega_1''(h_1^0)$, player 2 perceives this as kind and player 3 as unkind. Furthermore, if player 1 takes his decision by flipping a coin, i.e. $\omega_1'(h_1^0)$, then both players do not perceive this as unkind as $\varepsilon \geq 0$.

Remark 6 *Player 2 perceives player 1's procedural choice of $\omega_1(h_1^0)$ as unkind. Likewise, player 3 perceives player 1's procedural choice $\omega_1''(h_1^0)$ as unkind. On the other hand, both player do not perceive player 1's choice $\omega_1'(h_1^0)$ as unkind.*

Consider now all histories in turn. Looking at history h_2^4 after which player 2 has to choose one can see that player 2 can either show a kindness of

$$\begin{aligned}\kappa_{12}\left(\omega_2\left(h_2^4\right)\right) &= 3 - \frac{1}{2}(3+1)\\ &= 1\end{aligned}$$

by playing $\omega_2(h_2^4)$ or he can show a kindness of

$$\begin{aligned}\kappa_{12}\left(\omega_2'\left(h_2^4\right)\right) &= 1-\frac{1}{2}(3+1)\\ &= -1\end{aligned}$$

by playing $\omega_2'(h_2^4)$. Obviously, player 2's behaviour in history h_2^4 in general also creates some (un)kindness towards player 3. In our case, however, 3's monetary payoff is invariant to player 2's choice in h_2^4. Hence, player 2's kindness towards player 3 is 0 in h_2^4. Given this, the utilities from either of player 2's choices are

$$u_2\left(\omega_2\left(h_2^4\right)\right) = (0) + Y_{21}(1)\left(-\frac{1}{2}(1+\varepsilon)\right),$$

and

$$u_2\left(\omega_2'\left(h_2^4\right)\right) = (-\varepsilon) + Y_{21}(-1)\left(-\frac{1}{2}(1+\varepsilon)\right).$$

Again in equilibrium player 2 chooses the later if $u_2(\omega_2'(h_2^4)) \geq u_2(\omega_2(h_2^4))$. This can be written as

$$(-\varepsilon) + Y_{21}(-1)\left(-\frac{1}{2}(1+\varepsilon)\right) \geq (0) + Y_{21}(1)\left(-\frac{1}{2}(1+\varepsilon)\right),$$

which reduces to

$$Y_{21} \geq \frac{\varepsilon}{\varepsilon+1}.$$

This means if $Y_{21} \geq \frac{\varepsilon}{\varepsilon+1}$ then player 2 takes revenge on player 1 by choosing $\omega_2'(h_2^4)$ in history h_2^4. From the symmetry of the game it necessarily also follows that everything which holds for player 2 in history h_2^4 also holds for player 3 in history h_3^7. In other words if

$$Y_{31} \geq \frac{\varepsilon}{\varepsilon+1},$$

then player 3 takes revenge on player 1 in history h_3^7 by playing $\omega_3'(h_3^7)$.

Remark 7 *Players 2 and 3 take revenge on player 1 by playing $\omega_2'(h_2^4)$ in h_2^4 and $\omega_3'(h_3^7)$ in h_3^7 respectively, if $Y_{21}, Y_{31} \geq \frac{\varepsilon}{\varepsilon+1}$.*

Turning now to histories h_2^5 and h_2^6 one can see that due to the symmetry of the situation both players, 2 and 3, perceive player 1's kindness identically. Therefore, in history h_2^5 player 2's utilities from choosing either of his *procedures* is

$$u_2\left(\omega_2\left(h_2^5\right)\right) = (0) + Y_{21}(1)\left(\frac{1}{2}\varepsilon\right)$$

and

$$u_2\left(\omega_2'\left(h_2^5\right)\right) = (-\varepsilon) + Y_{21}(-1)\left(\frac{1}{2}\varepsilon\right).$$

He chooses $\omega_2(h_2^5)$ rather than $\omega_2'(h_2^5)$ if $u_2(\omega_2(h_2^5)) \geq u_2(\omega_2'(h_2^5))$, i.e.

$$(0) + Y_{21}(1)\left(\frac{1}{2}\varepsilon\right) \geq (-\varepsilon) + Y_{21}(-1)\left(\frac{1}{2}\varepsilon\right),$$

which reduces to

$$Y_{21} \geq -1.$$

Note, this holds for all $Y_{21} \geq 0$. Again, for equal reasons also player 3 chooses $\omega_3\left(h_3^6\right)$ rather than $\omega_2'\left(h_3^6\right)$ in history h_3^6 if $Y_{21} \geq 0$.

Remark 8 *If player 2's and 3's sensitivity to reciprocity is*

$$Y_{21} \geq 0,$$

and

$$Y_{31} \geq 0,$$

then they respectively choose $\omega_2\left(h_2^5\right)$ and $\omega_3\left(h_3^6\right)$ in histories h_2^5 and h_3^6 following player 1's choice of $\omega_1'\left(h_1^0\right)$.

Concluding, if $Y_{21} \geq \frac{\varepsilon}{\varepsilon+1}$ and $Y_{31} \geq \frac{\varepsilon}{\varepsilon+1}$ then players 2 and 3 play $\left(\omega_2'\left(h_2^4\right), \omega_2\left(h_2^5\right)\right)$ and $\left(\omega_3'\left(h_3^6\right), \omega_2\left(h_3^7\right)\right)$ in their histories h_2^4, h_2^5 and h_3^6, h_3^7 respectively.

Given this under what conditions is it best for player 1 to choose $\omega_1'\left(h_1^0\right)$? Assume for simplicity that player 1's sensitivity to reciprocity is equal towards both, player 2 and 3. In other words, assume that $Y_{12} = Y_{13} = Y$. Denote player 1's second order beliefs about player 2's and 3's beliefs p_2, p_2' and $(1 - p_2 - p_2')$ as well as p_3, p_3' and $(1 - p_3 - p_3')$. More precisely, let p_i and p_i' be player 1's belief about the probabilities that any player $i \in \{2, 3\}$ attaches to player 1's *procedures* $\omega_1\left(h_1^0\right)$ and $\omega_1'\left(h_1^0\right)$ respectively. Therefore, player 1's perceived kindness from player 2's and 3's procedural strategies is

$$\begin{aligned}
\lambda_{121} &= p_2(-1) + p_2'\left(\frac{1}{2}(1) + \frac{1}{2}(0)\right) + (1 - p_2 - p_2')(0) \\
&= p_2'\left(\frac{1}{2}\right) - p_2,
\end{aligned}$$

and

$$\begin{aligned}
\lambda_{131} &= p_3(0) + p_3'\left(\frac{1}{2}(0) + \frac{1}{2}(1)\right) + (1 - p_3 - p_3')(-1) \\
&= p_3'\left(\frac{1}{2}\right) - (1 - p_3 - p_3')
\end{aligned}$$

Player 1's kindness, on the other hand, towards player 2 and 3 is given by $\kappa_{12}\left(\omega_1\left(h_1^0\right)\right) = \kappa_{13}\left(\omega_1''\left(h_1^0\right)\right) = -\frac{1}{2}(1+\varepsilon)$, $\kappa_{13}\left(\omega_1\left(h_1^0\right)\right) = \kappa_{12}\left(\omega_1''\left(h_1^0\right)\right) = \frac{1}{2}(1+\varepsilon)$ and $\kappa_{12}\left(\omega_1'\left(h_1^0\right)\right) = \kappa_{13}\left(\omega_1'\left(h_1^0\right)\right) = \frac{1}{2}\varepsilon$.

Hence, given that players 2 and 3 choose $\left(\omega_2'\left(h_2^4\right), \omega_2\left(h_2^5\right)\right)$ and $\left(\omega_3'\left(h_3^6\right), \omega_2\left(h_3^7\right)\right)$ the utilities from all of player 1's *procedural choices* can be written as

$$\begin{aligned}
u_1\left(\omega_1\left(h_1^0\right)\right) &= 1 + Y\left(-\frac{1}{2}(1+\varepsilon)\right)\left(p_2'\left(\frac{1}{2}\right) - p_2\right) \\
&\quad + Y\left(\frac{1}{2}(1+\varepsilon)\right)\left(p_3'\left(\frac{1}{2}\right) - (1 - p_3 - p_3')\right)
\end{aligned}$$

by playing $\omega_1(h_1^0)$,

$$u_1\left(\omega_1'\left(h_1^0\right)\right) = 3+Y\left(\frac{1}{2}\varepsilon\right)\left(p_2'\left(\frac{1}{2}\right)-p_2\right) +Y\left(\frac{1}{2}\varepsilon\right)\left(p_3'\left(\frac{1}{2}\right)-(1-p_3-p_3')\right)$$

by playing $\omega_1'(h_1^0)$ and

$$u_1\left(\omega_1''\left(h_1^0\right)\right) = 1+Y\left(\frac{1}{2}(1+\varepsilon)\right)\left(p_2'\left(\frac{1}{2}\right)-p_2\right) +Y\left(-\frac{1}{2}(1+\varepsilon)\right)\left(p_3'\left(\frac{1}{2}\right)-(1-p_3-p_3')\right)$$

by playing $\omega_1''(h_1^0)$.

Obviously, player 1 plays $\omega_1'(h_1^0)$ if $u_1(\omega_1'(h_1^0)) \geq u_1(\omega_1(h_1^0))$ and $u_1(\omega_1'(h_1^0)) \geq u_1(\omega_1''(h_1^0))$ with $p_2 = p_3 = 0$, $p_2' = p_3' = 1$ and $p_2'' = p_3'' = 0$. The first of the two conditions can be written as

$$3+Y\left(\frac{1}{2}\varepsilon\right)\left(\frac{1}{2}\right)+Y\left(\frac{1}{2}\varepsilon\right)\left(\frac{1}{2}\right) \geq 1-Y\left(\frac{1}{2}(1+\varepsilon)\right)\left(\frac{1}{2}\right)+Y\left(\frac{1}{2}(1+\varepsilon)\right)\left(\frac{1}{2}\right),$$

which holds for all $Y>0$. Secondly, it has to hold that

$$3+Y\left(\frac{1}{2}\varepsilon\right)\left(\frac{1}{2}\right)+Y\left(\frac{1}{2}\varepsilon\right)\left(\frac{1}{2}\right) \geq 1+Y\left(\frac{1}{2}(1+\varepsilon)\right)\left(\frac{1}{2}\right)-Y\left(\frac{1}{2}(1+\varepsilon)\right)\left(\frac{1}{2}\right),$$

which is identical to the above. Hence, whenever $Y = Y_{12} = Y_{13} > 0$ it holds that player 1's best response to player 2's and 3's *procedural strategy* $(\omega_2'(h_2^4), \omega_2(h_2^5))$ and $(\omega_3'(h_3^6), \omega_2(h_3^7))$ is to play $\omega_1'(h_1^0)$.

Remark 9 *Given player 2's and 3's equilibrium play, player 1 chooses procedure $\omega_1'(h_1^0)$, if $Y = Y_{12} = Y_{13} > 0$.*

This concludes the proof of result (2).■

Proof to result (3):

Consider first the agents' behaviour if the principal takes his decision '*behind closed doors*'. Looking at period 2 first, under what conditions are '*court*' and '*high*' the best alternatives for the agents? To answer this question let the agents' second order beliefs be (c) and (h) for the second period and assume, for example, that agent A_2 was laid off and agent A_1 is kept.

Notice, even though the agents initially believe that the principal mimics the '*tournament*' '*behind closed doors*', they update their first order belief after learning his decision. Hence, given the agents' (updated) beliefs and the agents' and principal's first period behaviour, agent A_2's perceived kindness of the principal is

$$\begin{aligned}\lambda_{A_2P} &= (\omega-\varepsilon)-\frac{1}{2}\left((\omega-\varepsilon)+(2\omega-\xi)\right)\\ &= \frac{1}{2}\left(\xi-\omega-\varepsilon\right)<0,\end{aligned}$$

where $\pi_{A_2}^{e_P}=\frac{1}{2}\left((\omega-\varepsilon)+(2\omega-\xi)\right)$. On the other hand, agent A_2's kindness towards the principal is

$$\begin{aligned}\kappa_{A_2P}\left(c\right) &= \left(\varphi\left(l,l\right)-2\omega+\varphi\left(h\right)-\omega-\varepsilon\right)\\ &\quad -\frac{1}{2}\left(\left(\varphi\left(l,l\right)-2\omega+\varphi\left(h\right)-\omega-\varepsilon\right)+\left(\varphi\left(l,l\right)-2\omega+\varphi\left(h\right)-\omega\right)\right)\\ &= -\frac{1}{2}\varepsilon,\end{aligned}$$

if he chooses to go to *court* and

$$\begin{aligned}\kappa_{A_2P}\left(nc\right) &= \left(\varphi\left(l,l\right)-2\omega+\varphi\left(h\right)-\omega\right)\\ &\quad -\frac{1}{2}\left(\left(\varphi\left(l,l\right)-2\omega+\varphi\left(h\right)-\omega-\varepsilon\right)+\left(\varphi\left(l,l\right)-2\omega+\varphi\left(h\right)-\varepsilon\right)\right)\\ &= \frac{1}{2}\varepsilon,\end{aligned}$$

if he chooses (nc). Given all this, agent A_2 chooses to go to *court* in the second period under (bcd) if $u_{A_2}\left(c\right)\geq u_{A_2}\left(nc\right)$ which means

$$\begin{aligned}&(\omega-\varepsilon)+Y_{A_2}\left(-\frac{1}{2}\varepsilon\right)\left(\frac{1}{2}\left(\xi-\omega-\varepsilon\right)\right)\\ \geq\ &\omega+Y_{A_2}\left(\frac{1}{2}\varepsilon\right)\left(\frac{1}{2}\left(\xi-\omega-\varepsilon\right)\right).\end{aligned}$$

This reduces to

$$Y_{A_2}\geq\frac{2}{\omega+\varepsilon-\xi}. \tag{5}$$

Hence, if $Y_{A_2}>\frac{2}{\omega+\varepsilon-\xi}$ then agent A_2 that is laid off after the first period will go to *court* in case the principal takes his decision *behind closed doors*.

Remark 10 *If the principal's lay off procedure is* (bcd)*, then the laid-off agent goes to court in the second period if* $Y_A\geq\frac{2}{\omega+\varepsilon-\xi}$.

The survivor's, i.e. A_2's perceived kindness in the second period, on the other hand, is

$$\begin{aligned}\lambda_{A_1P} &= (2\omega-\xi)-\frac{1}{2}\left((\omega-\varepsilon)+(2\omega-\xi)\right)\\ &= \frac{1}{2}\left(\omega+\varepsilon-\xi\right)>0,\end{aligned}$$

where $\pi_{A_1}^{e_P} = \frac{1}{2}((\omega - \varepsilon) + (2\omega - \xi))$. His kindness towards the principal is

$$\begin{aligned}
\kappa_{A_1 P}(h) &= (\varphi(l,l) - 2\omega + \varphi(h) - \omega - \varepsilon) \\
&\quad -\frac{1}{2}((\varphi(l,l) - 2\omega + \varphi(h) - \omega - \varepsilon) + (\varphi(h,l) - 2\omega + \varphi(l) - \omega - \varepsilon)) \\
&= \frac{1}{2}(\varphi(h) - \varphi(l)) \\
&= \frac{1}{2},
\end{aligned}$$

if he chooses *high* in the second period and

$$\begin{aligned}
\kappa_{A_1 P}(l) &= (\varphi(l,l) - 2\omega + \varphi(l) - \omega - \varepsilon) \\
&\quad -\frac{1}{2}((\varphi(l,l) - 2\omega + \varphi(h) - \omega - \varepsilon) + (\varphi(h,l) - 2\omega + \varphi(l) - \omega - \varepsilon)) \\
&= \frac{1}{2}(\varphi(l) - \varphi(h)) \\
&= -\frac{1}{2},
\end{aligned}$$

if he chooses *low*. Hence, the surviving agent A_1 chooses *high* in the second period if $u_{A_1}(h) \geq u_{A_1}(l)$. This means

$$\begin{aligned}
& (2\omega - \xi) + Y_{A_1}\left(\frac{1}{2}\right)\left(\frac{1}{2}(\omega + \varepsilon - \xi)\right) \\
\geq\ & (2\omega) + Y_{A_1}\left(-\frac{1}{2}\right)\left(\frac{1}{2}(\omega + \varepsilon - \xi)\right),
\end{aligned}$$

which reduces to

$$Y_{A_1} \geq \frac{2\xi}{\omega + \varepsilon - \xi}. \tag{6}$$

The surviving agent A_1 chooses *high* in the second period after the principal has taken the decision *behind closed doors* if $Y_{A_1} \geq \frac{2\xi}{\omega+\varepsilon-\xi}$.

Remark 11 *If the principal's lay off procedure is 'behind closed doors', then the surviving agent chooses high effort in the second period if* $Y_A \geq \frac{2\xi}{\omega+\varepsilon-\xi}$.

Notice, $\frac{2\xi}{\omega+\varepsilon-\xi} < \frac{2}{\omega+\varepsilon-\xi}$ which means that if both agents have a sensitivity to reciprocity $Y_A > \frac{2}{\omega+\varepsilon-\xi}$, then they both choose *court* in case they are laid off and *high* in case they are kept in the second period under (bcd).

Consider now the first period under (bcd). Remember, both agents initially believe that the principal will, given that he chooses (bcd), keep the one with the higher effort or implicitly randomize between them, if they have chosen the same effort. Given this first order belief and the aforementioned second order beliefs of the agents, the perceived kindness of any agent $A_i \in \{A_1, A_2\}$ in the first period under (bcd) is:

$$\begin{aligned}
\lambda_{A_i P} &= \left(\omega + \frac{1}{2}(\omega - \xi) + \frac{1}{2}(-\varepsilon)\right) \\
&\quad -\frac{1}{2}\left(\left(\omega + \frac{1}{2}(\omega - \xi) + \frac{1}{2}(-\varepsilon)\right) + \left((\omega - \xi) + \frac{1}{2}(\omega - \xi)\right)\right) \\
&= \frac{1}{2}\xi - \frac{1}{4}\varepsilon,
\end{aligned}$$

where $\pi_{A_i}^{e_P} = \frac{1}{2}\left(\left(\omega + \frac{1}{2}(\omega - \xi) + \frac{1}{2}(-\varepsilon)\right) + \left((\omega - \xi) + \frac{1}{2}(\omega - \xi)\right)\right)$ is the agents equitable payoff before updating. The kindness that agent $A_i \in \{A_1, A_2\}$ shows towards the principal in the first period is

$$\begin{aligned}
\kappa_{A_i P}(h) &= (\varphi(h,h) - 2\omega + \varphi(h) - \omega - \varepsilon) \\
&\quad -\frac{1}{2}((\varphi(h,h) - 2\omega + \varphi(h) - \omega - \varepsilon) + (\varphi(l,h) - 2\omega + \varphi(l) - \omega - \varepsilon)) \\
&= \frac{1}{2}(\varphi(h,h) - \varphi(l,h)) \\
&= \frac{1}{2},
\end{aligned}$$

if he chooses *high* effort in the first period and

$$\begin{aligned}
\kappa_{A_i P}(l) &= (\varphi(l,h) - 2\omega + \varphi(h) - \omega - \varepsilon) \\
&\quad -\frac{1}{2}((\varphi(h,h) - 2\omega + \varphi(h) - \omega - \varepsilon) + (\varphi(l,h) - 2\omega + \varphi(l) - \omega - \varepsilon)) \\
&= \frac{1}{2}(\varphi(l,h) - \varphi(h,h)) \\
&= -\frac{1}{2},
\end{aligned}$$

if he plays *low*. This means agent A_i chooses *low* effort in the first period under (bcd) if $u_{A_i}(l) \geq u_{A_i}(h)$, i.e. if

$$\begin{aligned}
&\left(\omega + \frac{1}{2}(\omega - \xi) + \frac{1}{2}(-\varepsilon)\right) + Y_{A_i}\left(-\frac{1}{2}\right)\left(\frac{1}{2}\xi - \frac{1}{4}\varepsilon\right) \\
\geq\; &(2(\omega - \xi)) + Y_{A_i}\left(\frac{1}{2}\right)\left(\frac{1}{2}\xi - \frac{1}{4}\varepsilon\right),
\end{aligned}$$

which reduces to

$$Y_{A_i} \geq \frac{2(\varepsilon + \omega) - 6\xi}{\varepsilon - 2\xi}. \tag{7}$$

Hence, if $Y_{A_i} > \frac{2(\varepsilon+\omega)-6\xi}{\varepsilon-2\xi}$ it holds that any agent $A_i \in \{A_1, A_2\}$ chooses *low* effort in the first period, if the principal decides to take the decision *behind closed doors*.

Remark 12 *If the principal's lay-off procedure is 'behind closed doors', then any agent A_i choose low effort in the first period, if $Y_{A_i} > \frac{2(\varepsilon+\omega)-6\xi}{\varepsilon-2\xi}$.*

As both agents belief that the other agent chooses (l), both agents also belief that, if they choose *high* effort, they will be kept in the second period, earning an expected payoff of $2(\omega-\xi)$. On the other hand, if they choose also *low* effort, they belief to earn an expected payoff of $\left(\omega+\frac{1}{2}(\omega-\xi)+\frac{1}{2}(-\varepsilon)\right)$ under (bcd). As the former is bigger then the later, i.e. agents give up some monetary payoff by choosing (l), it follows that $Y_{A_i} > \frac{2(\varepsilon+\omega)-6\xi}{\varepsilon-2\xi} > 0$.

Let us now turn to the agents' behaviour under the *tournament*. As we have seen above, the agents updated their first order beliefs after learning the principal's decision that he had taken *behind closed doors*. To the contrary of this, under the *tournament* there is no change of first order beliefs after the first period. There is no change of first order beliefs as the *tournament* constitutes an explicit and, hence, credible criterion which the principal uses to take his decision. Even in the second period the principal's kindness is calculated at the principal's initial *decision context*.

Hence, following the principal's procedural choice '*tournament*' the perceived kindness of any agent $A_i \in \{A_1, A_2\}$ in the first and second period is

$$\begin{aligned}\lambda_{A_iP} &= \left((\omega-\xi)+\frac{1}{2}(\omega-\xi)\right)\\ &\quad -\frac{1}{2}\left(\left(\omega+\frac{1}{2}(\omega-\xi)+\frac{1}{2}(-\varepsilon)\right)+\left((\omega-\xi)+\frac{1}{2}(\omega-\xi)\right)\right)\\ &= \frac{1}{4}\varepsilon-\frac{1}{2}\xi > 0.\end{aligned}$$

Notice, both agent's perceive the principal's *procedural choice* as kind, i.e. $\frac{1}{2}\xi+\frac{1}{4}\varepsilon > 0$ independent of wether they are kept or laid off in the second period. They perceive his decision as kind even after learning who is laid off, as, given his *decision context* at the time when he had to decide between (bcd) and (t), he chose the better of the two procedures. From this it directly follows that the laid off agent never goes to *court* in the second period under the *tournament*.

Remark 13 *If the principal chooses the tournament, then the laid-off agent never goes to court.*

The surviving agent A_i, on the other hand, chooses high effort in the second period under the *tournament* if $u_{A_i}(l) \geq u_{A_i}(h)$, i.e. if

$$\begin{aligned}&2(\omega-\xi)+Y_{A_i}\left(\frac{1}{2}\right)\left(\frac{1}{4}\varepsilon-\frac{1}{2}\xi\right)\\ \geq\ &2\omega-\xi+Y_{A_i}\left(-\frac{1}{2}\right)\left(\frac{1}{4}\varepsilon-\frac{1}{2}\xi\right)\end{aligned}$$

where $\kappa_{A_iP}(h) = \left(\frac{1}{2}\right)$ and $\kappa_{A_iP}(l) = \left(-\frac{1}{2}\right)$. This reduces to

$$Y_{A_i} \geq \frac{4\xi}{\varepsilon-2\xi}. \tag{8}$$

In other words if $Y_{A_i} \geq \frac{4\xi}{(\varepsilon-2\xi)}$, then the surviving agent A_i chooses to provide *high* effort in the second period under the *tournament*.

In the first period, on the other hand, both agents $A_i \in \{A_1, A_2\}$ choose *high* effort if

$$\begin{aligned} &\left((\omega-\xi)+\frac{1}{2}(\omega-\xi)\right)+Y_i\left(\frac{1}{2}\right)\left(\frac{1}{4}\varepsilon-\frac{1}{2}\xi\right) \\ \geq\ & (\omega)+Y_i\left(-\frac{1}{2}\right)\left(\frac{1}{4}\varepsilon-\frac{1}{2}\xi\right), \end{aligned}$$

where $\kappa_{A_iP}(h) = \left(\frac{1}{2}\right)$ and $\kappa_{A_iP}(l) = \left(-\frac{1}{2}\right)$. Note, $\left((\omega-\xi)+\frac{1}{2}(\omega-\xi)\right)$ and (ω) constitute agent A_i's expected payoffs from choosing respectively (h) and (l) given that the other agent chooses *high* effort. The above reduces to

$$Y_{A_i} \geq \frac{6\xi - 2\omega}{\varepsilon - 2\xi}. \tag{9}$$

Hence, if $Y_{A_i} \geq \frac{6\xi-2\omega}{\varepsilon-2\xi}$ then any agent $A_i \in \{A_1, A_2\}$ provides high effort in the first period under the *tournament.*

Remark 14 *If the principal chooses the tournament, then the surviving agent chooses high effort in the second period if* $Y_{A_i} \geq \frac{6\xi-2\omega}{\varepsilon-2\xi}$.

Comparing now (5), (6), (7), (8) and (9) it can be seen that

$$\frac{2}{\omega+\varepsilon-\xi} > \frac{2\xi}{\omega+\varepsilon-\xi},$$

and

$$\frac{6\xi-2\omega}{\varepsilon-2\xi} > \frac{4\xi}{\varepsilon-2\xi}$$

Hence, if agent A_1's and A_2's sensitivity to reciprocity Y_{A_1} and Y_{A_2} is such that

$$Y_{A_i} > \max\left\{\frac{2}{\omega+\varepsilon-\xi}, \frac{2(\varepsilon+\omega)-6\xi}{\varepsilon-2\xi}, \frac{6\xi-2\omega}{\varepsilon-2\xi}\right\}$$

where $A_i \in \{A_1, A_2\}$, then A_1 and A_2 play (l) in the first period and (c), if laid off, and (h), if kept, in the second period under (bcd) and (h) in the first period and (nc), if laid off, and (h), if kept, in the second period under (t). Given this, any profit maximizing principal prefers to take the decision using the *tournament* as this ensures the maximum profit of $3-\omega$.

Remark 15 *Given the first and second period behaviour of the agents, the profit maximizing principal will choose 'tournament' if* $Y_{PA_1} = Y_{PA_2} \geq 0$.

This concludes the proof of result (3).■

Note: Dotted lines in Figures 3-7 refer to actions chosen with probability zero, e.g. (1-α_1) = 0 and α_2 = 0. They are only indicated for clarification and not continued for subsequent stages.

Figure 1:

Game Γ_1 :

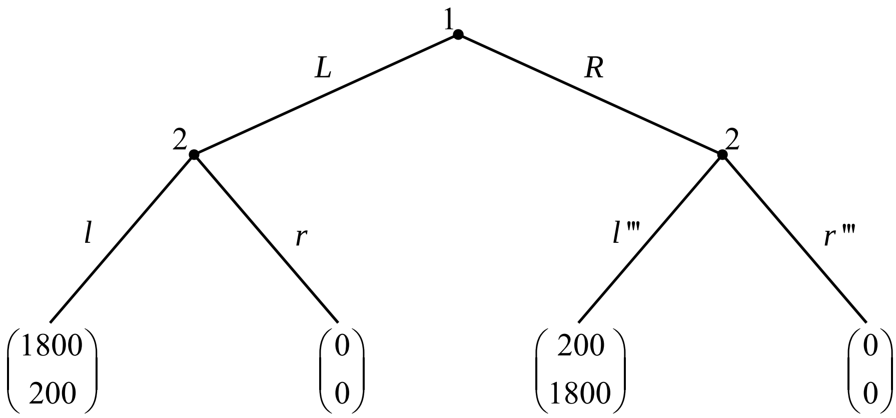

Figure 2:

Game Γ_2 :

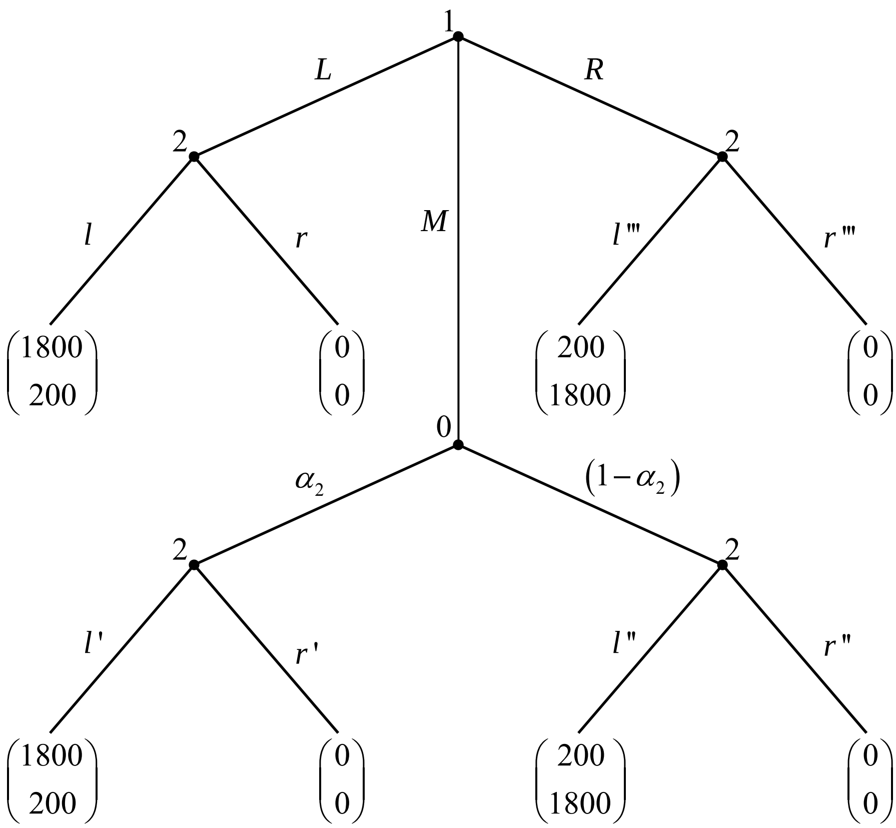

Figure 3: *Game* Γ_3

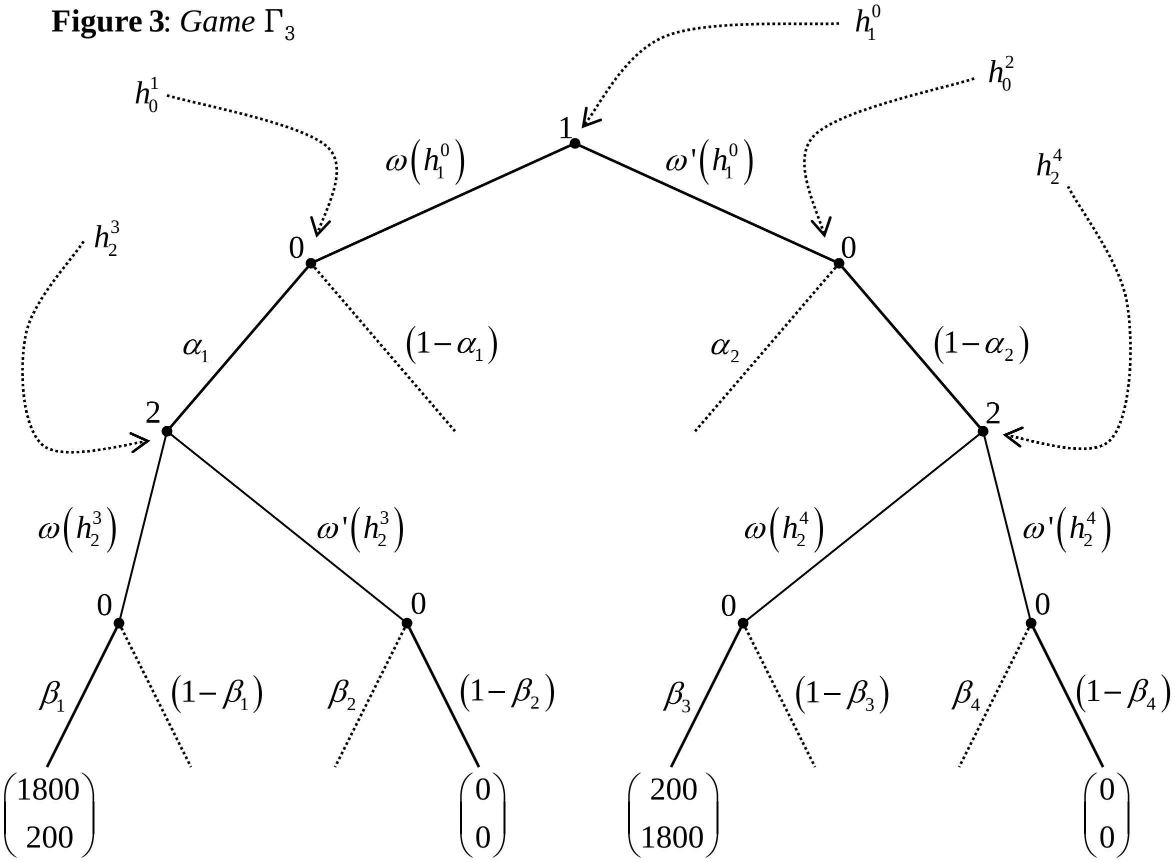

Figure 4: *Game* Γ_4

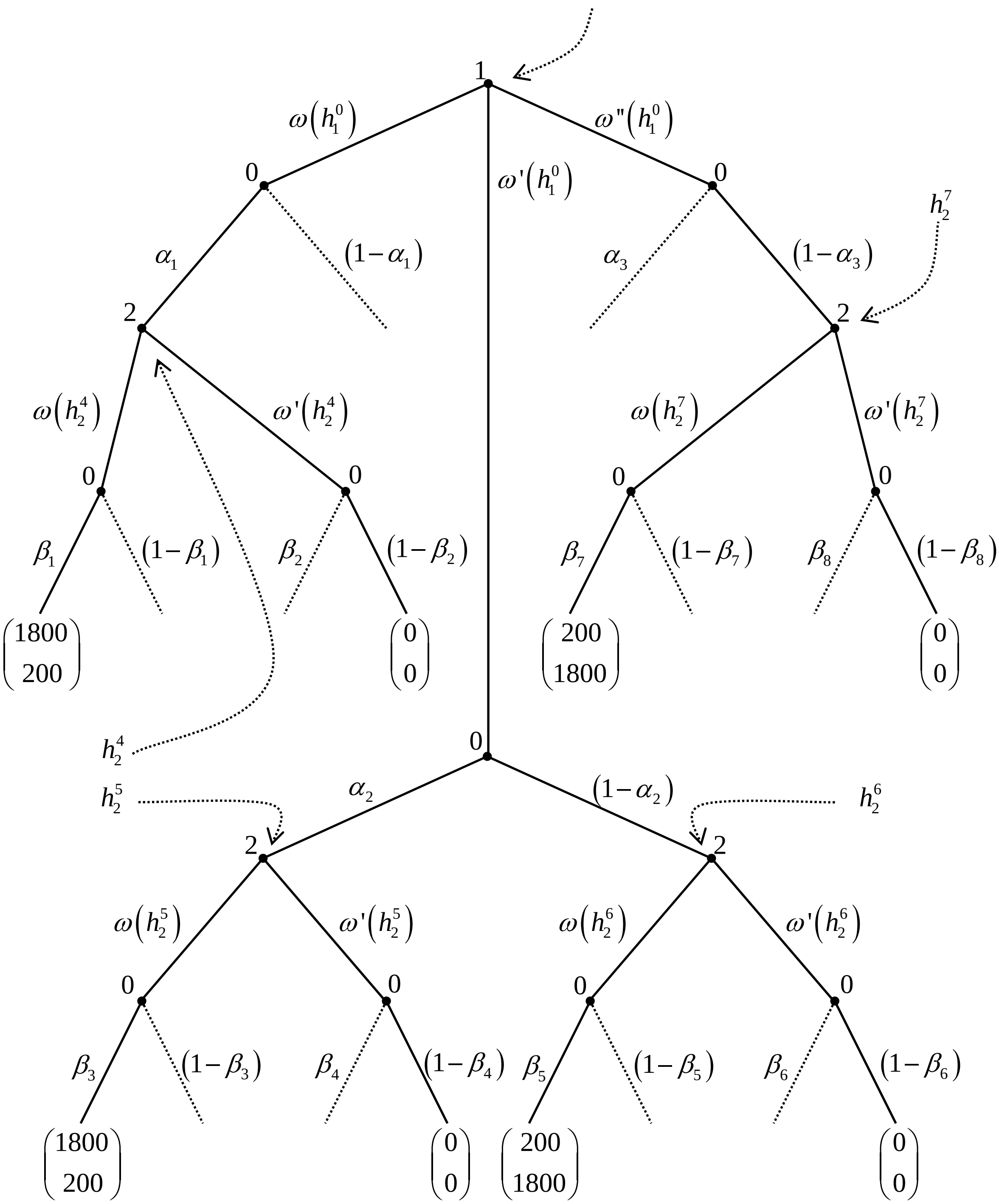

Figure 5: *Game* Γ_5

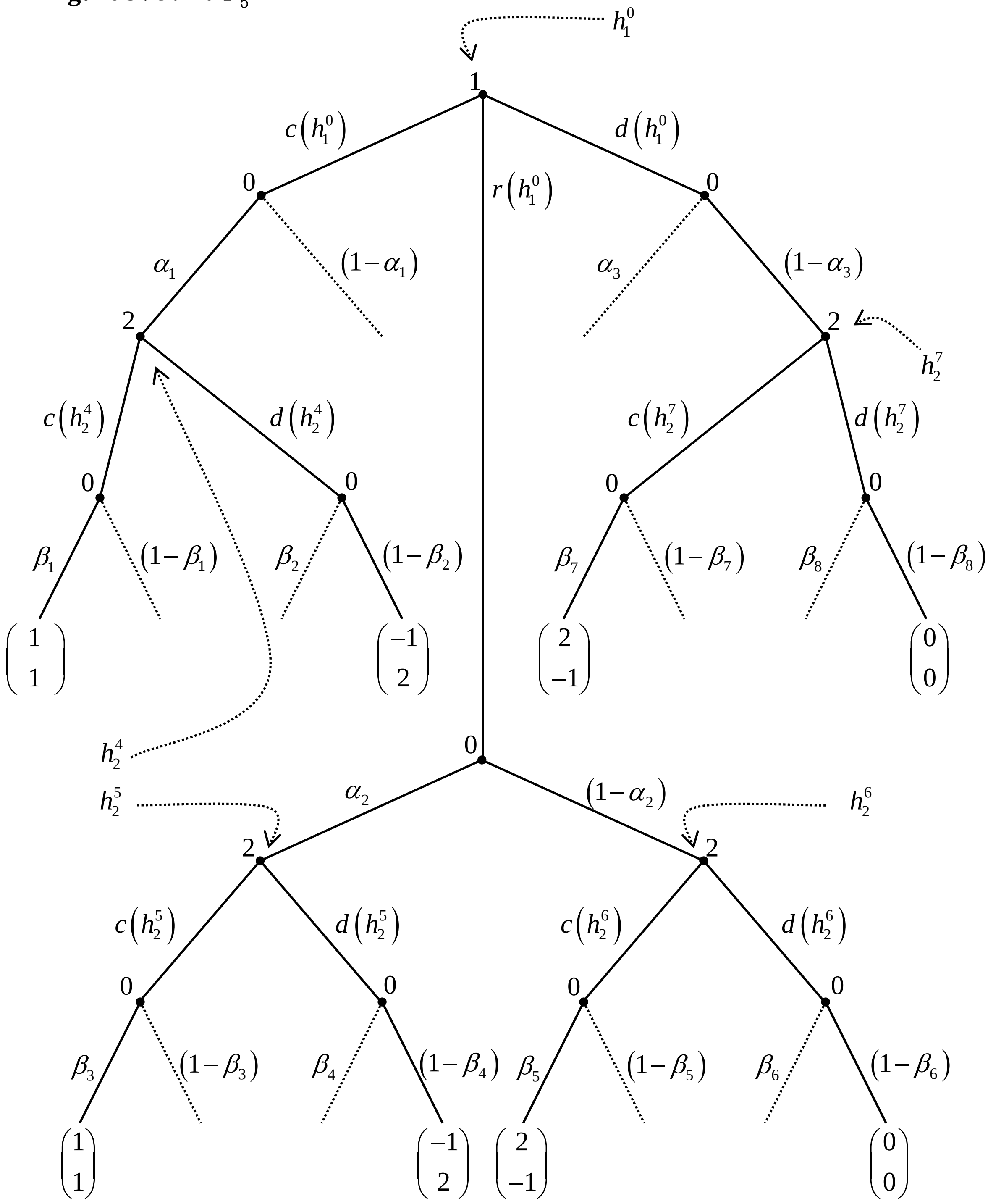

Figure 6 : *Game* Γ_6

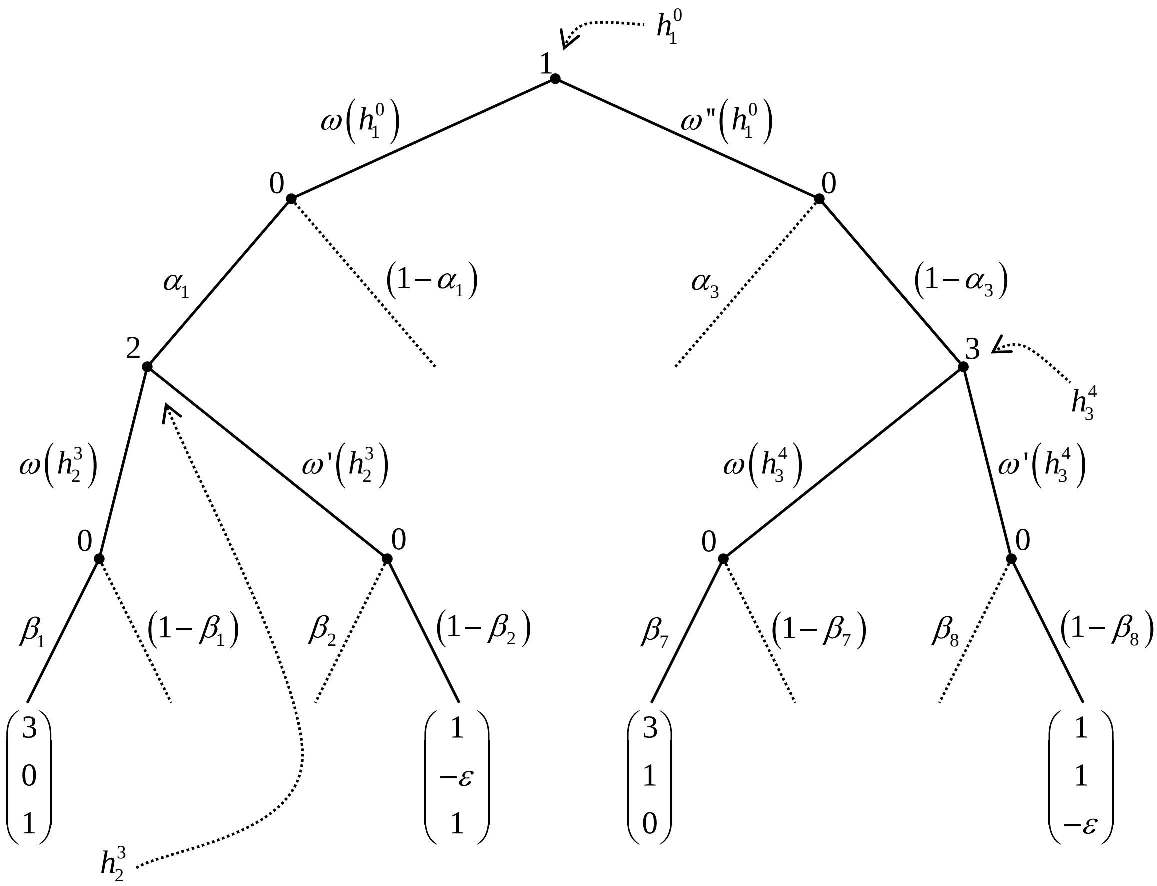

Figure 7 : *Game* Γ_7