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AN EXPERIMENT ON BANKRUPTCY*

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ABSTRACT

This paper reports an experimental study on three well known solutions for bankruptcy problems, that is, the constrained equal-awards, the proportional and the constrained equal-losses rule. To do this, we first let subjects play three games designed such that the unique equilibrium outcome coincides with one of these three rules. Moreover, we also let subjects play an additional game, that has the property that all (and only) strategy profiles in which players unanimously agree on the same rule constitute a strict Nash equilibrium. While in the first three games subjects' play easily converges to the unique equilibrium rule, in the last game the proportional rule overwhelmingly prevails as a coordination device.

1 Introduction

When a firm goes bankrupt, how should its liquidation value be divided among its creditors? Previous question is an example of the so called *bankruptcy problems,* which provide with a simple framework to study ways of distributing losses when agents' claims cannot be fully satisfied.

This is a major practical issue and, as such, it has a long history. From the way of solving some practical cases, researches moved in the direction of searching for well-behaved methods or *rules* to solve families of bankruptcy problems. The best-known rule is the *proportional rule,* which recommends awards to be proportional to claims. In the case of shareholders of a firm, the idea behind the proportional rule is natural: each share is awarded equally. The idea of equality underlies another well-known rule: the *constrained equal-awards rule.* It makes awards as equal as possible to all creditors, subject to the condition that no creditor receives more than her claim. A dual formulation of equality, focusing on the losses creditors incur, as opposed to what they receive, underlies the *constrained equal-losses rule.* It proposes losses as equal as possible for all creditors, subject to the condition that no creditor ends up with a negative award. The constrained equal awards rule gives priority to agents with small claims. They are reimbursed relatively more than agents with larger claims. It seems a natural procedure to apply when creditors claims are correlated with their incomes. On the contrary, the constrained equal-losses rule gives priority to agents with large claims. They start receiving money before agents with small claims, that are only reimbursed once the loss they experience is larger than the losses experienced by agents with larger claims. It is a natural procedure to be applied when claims are related to needs, as for example when we think of public support of health care expenses.

The behavior of the different rules comes from the properties those rules fulfill. The analysis and formulation of properties, and the search for combination of properties characterizing a single rule, is the object of an important branch of the bankruptcy literature: the so called *axiomatic approach.* The proportional, constrained equal-awards and constrained equal-losses rules satisfy many basic properties. Looking specially to those three solutions is by no means arbitrary. First because they are among the most common methods of solving practical problems. Second for their long tradition in history. And last but not least, because they are almost the only sensible ones within the family of solutions that treat equally equal claims.[1]

Another approach to bankruptcy is the *game theoretical,* in which bankruptcy problems are formulated either as TU coalitional games, or as bargaining problems, and rules are derived from solutions to coalitional games and from bargaining solutions, respectively.[2] The axiomatic, as well as the game-theoretic approach share a common view in the analysis of bankruptcy problems: they look at the fairness and cooperative aspect in order to support certain bankruptcy rules.

Bankruptcy problems have also been addressed from a *noncooperative* viewpoint in a limited number of papers.[3] These papers apply to bankruptcy the same methodology known as the *Nash program* for the theory of bargaining, that is, they construct specific procedures as noncooperative games which have the property that the unique equilibrium outcome corresponds to a specific bankruptcy rule.[4] In other words, this literature provides theoretical support to bankruptcy rules by constructing specific strategic situations for which these rules are self-enforcing.

There is another aspect which makes this noncooperative approach interesting for bankruptcy theory. As it happens for bargaining theory, research is far from unanimous in identifying a *unique* optimal solution to bankruptcy problems. In consequence, there are many situations in which a judge, or the outside authority in charge to design the procedure to solve a bankruptcy problem, may not have strict preferences, a priori, on which rule should be implemented for the problem at stake. Under these circumstances, the judge may resort to a (noncooperative) procedure which may lead to alternative rules as the outcome of strategic interaction among the claimants.

The aim of this paper is to bring these interesting matters for social choice theory into an experimental lab. To do so, we first investigate subjects' behavior playing the (noncooperative) procedures of Chun (1989), Herrero (2001) and Moreno-Ternero (2002). To keep things simple, subjects could only choose among the constrained equal awards, constrained equal losses and proportional rules. We focus on these three procedures because they share the same game-form (claimants are required, simultaneously, to

[1] See Moulin (2000) and Herrero and Villar (2001).

[2] Instances of this approach are the papers of O'Neill (1982), Aumann and Maschler (1985), Curiel, Maschler and Tijs (1988) and Dagan and Volij (1993).

[3] See Chun (1989), Dagan, Serrano and Volij (1997), Herrero (2001), and Moreno-Ternero (2002).

[4] See Nash (1953), Binmore *et al.* (1992), or Roemer (1996) among others.

propose a rule) and because they display very similar strategic properties (namely, there is always a player with a dominant strategy by which she can force the outcome of the game in her favor). These appear very mild (first-order) rationality conditions that may obscure non-cooperative flavor of this approach. If subjects recognize the strategic incentive structure induced by each game, then choosing a particular procedure may be equivalent to choose a particular rule to solve the problem. This is why we also consider an additional procedure (a coordination game) that has the property that all (and only) strategy profiles in which players unanimously agree on the same rule constitute a strict Nash equilibrium. This additional game has no selection incentives, but coordination incentives only. Thus, we can use this game to investigate, in a more compelling way, the rule selection problem.

Finally, we also want to investigate the matters above from a different perspective. As we mentioned earlier, different rules are to be considered more appropriate depending on the bankruptcy problem at stake. Therefore, it may be interesting to provide the "same" bankruptcy problem with alternative contexts to see whether different frames may induce subjects to behave differently. We also want to test a completely "unframed" scenario, where only monetary payoffs associated to strategy profiles are provided.

Our experimental study yields the following conclusions. While in the first three procedures subjects' play easily converges to the unique equilibrium rule even in the first repetitions, in the coordination procedure the proportional rule overwhelmingly prevails as a coordination device. As for the framing issue, we find that frames have some impact on subjects' behavior only in the first repetitions of the game. As time proceeds, strategic considerations appear more compelling in explaining subjects' behavior.

This is, to the best of our knowledge, the first experiment on bankruptcy games. The closest reference to our work is the paper of Cuadras-Morató *et al.* (2001). They investigate, by way of questionnaires, the equity properties of different bankruptcy rules in the context of health care problems.[5] In this respect, they find that, when asked to choose among six potential allocations (including the proportional and the constrained equal losses rule) using the perspective on an "impartial judge" in the context of health care problems, subjects display a slight preference for the constrained equal losses solution.

The remainder of this paper is organized as follows. In Section 2 we formally introduce bankruptcy problems, the three rules, and the noncoop-

[5] See also Yaari and Bar-Hilel (1984).

erative procedures object of our experiment. Section 3 is devoted to the experimental design. In Section 4, we report the experimental results. Conclusions, comments and further proposals are presented in Section 5. An Appendix contains the experimental instructions.

2 Bankruptcy problems, rules and procedures

Let $N = \{1, 2, \ldots, n\}$ be a set of agents with generic elements i and j. A *bankruptcy problem* [O'Neill (1982)] is a pair (c, E), where $c \equiv \{c_i\} \in \mathbb{R}^n_+$ and $\sum_{i \in N} c_i > E > 0$. In words, c_i is the claim of agent i over an estate E. Let $\mathbb{B}$ denote the class of such problems.

A *rule* is a mapping $r : \mathbb{B} \to \mathbb{R}^n$ that associates to every problem (c, E) a unique allocation $r(c, E) \in \mathbb{R}^n$ such that:

(i) $0 \leq r(c, E) \leq c$.

(ii) $\sum_{i \in N} r_i(c, E) = E$.

(iii) For all $i, j \in N$, if $c_i \geq c_j$ then $r_i(c, E) \geq r_j(c, E)$ and $c_i - c_j \geq r_i(c, E) - r_j(c, E)$.

The allocation $r(c, E)$ is interpreted as a desirable way of dividing E among the agents in N. Requirement *(i)* is that each agent receives an award that is non-negative and bounded above by her claim. Requirement *(ii)* is that the entire estate must be allocated. Finally, requirement *(iii)* is that agents with higher claims receive higher awards and face higher losses. Let $\mathcal{R}$ denote the set of all such rules.

Next, we introduce three well-known rules focus of our experiment.

- **RULE "*cea*": Constrained equal-awards**. For all $(c, E) \in \mathbb{B}$ and all $i \in N$, $cea_i(c, E) = \min\{c_i, \lambda\}$, where λ solves $\sum_{i \in N} \min\{c_i, \lambda\} = E$.

- **RULE "*p*": Proportional**. For all $(c, E) \in \mathbb{B}$ and all $i \in N$, $p_i(c, E) = \lambda c_i$, where λ solves $\sum_{i \in N} \lambda c_i = E$.

- **RULE "*cel*": Constrained equal-losses.** For all $(c, E) \in \mathbb{B}$ and all $i \in N$, $cel_i(c, E) = \max\{0, c_i - \lambda\}$, where λ solves $\sum_{i \in N} \max\{0, c_i - \lambda\} = E$.

The *constrained equal-awards rule* makes awards as equal as possible, subject to no agent receiving more than her claim. The *proportional rule* distributes awards proportionally to claims. The *constrained equal-losses rule* makes losses as equal as possible, subject to the condition that no agent ends up with a negative award.

Remark 1 *Note that for all $(c, E) \in \mathbb{B}$ and all $r \in \mathcal{R}$, if $c_i = \max_N c_k$ and $c_j = \min_N c_k$, then $cel_i(c, E) \geq r_i(c, E)$ and $cea_j(c, E) \geq r_j(c, E)$. In other words, cel (cea) is the most preferred rule by the highest (lowest) claimant among all rules belonging to $\mathcal{R}$.*

There has been a wide research about bankruptcy rules under an axiomatic perspective. The three rules presented above satisfy many appealing properties, have a long history of use, and share many common sense equity principles. Thus, it is agreed that they somehow constitute the *central group* of bankruptcy rules. This may induce a social planner to prefer these rules to other alternatives. On the other hand, like for bargaining problems, the literature seems far from unanimous in proposing *a unique* optimal solution to bankruptcy problems relying on axiomatic properties only. This opens the possibility of approaching bankruptcy problems using alternative techniques.

2.1 Noncooperative solutions to bankruptcy problems

As we mentioned earlier, our experiment is concerned with some noncooperative *procedures* proposed to solve bankruptcy problems. All these procedures have the same game-form. Agents simultaneously propose a rule belonging to the set $\mathcal{R}$, and the procedure selects a particular division of the estate accordingly.

Diminishing claims procedure (P_1) [Chun (1989)]**.** Let $(c, E) \in \mathbb{B}$ be given. Each agent chooses a *rule* $r^j \in \mathcal{R}$. Let $r = (r^j)_{j=1}^n$ be the profile of rules reported. The division proposed by the diminishing claims procedure, $dc[r, (c, E)]$ is obtained as follows:

Step 1. Let $c^1 = c$. For all $j \in N$, calculate $r^j(c^1, E) \in R(c^1, E)$. If all coincide, then, $dc[r, (c, E)] = r^j(c^1, E)$. Otherwise, go to the next step.

Step 2. For all $i \in N$, let $c_i^2 = \max_{j \in N} r_i^j(c^1, E)$. For all $j \in N$, calculate $r^j(c^2, E)$. If all coincide, then $dc[r, (c, E)] = r^j(c^2, E)$. Otherwise, go to the next step.

Step k+1. For all $i \in N$, let $c_i^{k+1} = \max_{j\in N} r_i^j(c^k, E)$. For all $j \in N$, calculate $r^j(c^{k+1}, E)$. If all coincide, then $dc[r,(c,E)] = r^j(c^{k+1}, E)$. Otherwise, go to the next step.

If previous process does not terminate in a finite number of steps, then:

Limit case. Compute $\lim_{t\to\infty} c^t$. If it converges to an allocation x such that $\sum_{i\in N} x_i \leq E$, then $x = dc[r,(c,E)]$. Otherwise, $dc[r,(c,E)] = 0$.

In the *diminishing claims procedure,* once agents have selected a rule, agents' claims are sequentially reduced by substituting them with the highest amount assigned to every agent by the chosen rules. If the process converges to a feasible allocation, then this limit is chosen as solution to the problem. Otherwise, nobody gets anything.

Proportional concessions procedure (P_2) [Moreno-Ternero (2002)]**.** Let $(c,E) \in \mathbb{B}$ be given. Each agent chooses a rule $r^j \in \mathcal{R}$. Let $r = (r^j)_{j=1}^n$ be the profile of rules reported. The division proposed by the proportional concessions procedure, $pc[r,(c,E)]$, is obtained as follows:

Step 1. Let $c^1 = c$ and $E^1 = E$. For all $j \in N$, calculate $r^j(c^1, E^1)$. If all of them coincide, then, $pc[r,(c,E)] = r^j(c^1, E^1)$. Otherwise, go to the next step.

Step 2. For all $i \in N$, let $m_i^1 = p_i(c^1, \frac{E^1}{2})$, $c^2 = c^1 - m^1$, and $E^2 = E^1 - \sum m_i^1 = \frac{E}{2}$. For all $j \in N$, calculate $r^j(c^2, E^2)$. If all of them coincide, then $pc[r(c,E)] = m^1 + r^j(c^2, E^2)$. Otherwise, go to the next step.

Step k+1. For all $i \in N$, let $m_i^k = p_i(c^k, \frac{E^k}{2})$, $c^{k+1} = c^k - m^k$, and $E^{k+1} = E^k - \sum m_i^k = \frac{E}{2^k}$. For all $j \in N$, calculate $r^j(c^{k+1}, E^{k+1})$. If all of them coincide, then $pc[r,(c,E)] = m^1 + \cdots + m^k + r^j(c^{k+1}, E^{k+1})$. Otherwise, go to the next step.

If previous process does not terminate in a finite number of steps, then:

Limit case. Compute $\lim_{k\to\infty}(m^1 + \cdots + m^k)$. If it converges to an allocation x such that $\sum x_i \leq E$, then $x = pc[r,(c,E)]$. Otherwise, $pc[r,(c,E)] = 0$.

In the *proportional concessions procedure,* once agents have selected a rule, they sequentially receive the share proposed by the proportional rule to the resulting bankruptcy problem after reducing the estate to half of it. If the process converges to a feasible allocation, then this limit is chosen as solution to the problem. Otherwise, nobody gets anything.

Unanimous concessions procedure (P_3) [Herrero (2001)]**.** Let $(c,E) \in \mathbb{B}$ be given. Each agent chooses a rule $r^j \in \mathcal{R}$. Let $r = (r^j)_{j=1}^n$ be the profile of rules reported. The division proposed by the unanimous concessions procedure, $u[r,(c,E)]$ is obtained as follows:

Step 1. Let $c^1 = c$ and $E^1 = E$. For all $j \in N$, calculate $r^j(c^1, E^1)$. If all of them coincide, then, $u[r,(c,E)] = r^j(c^1, E^1)$. Otherwise, go to the next step.

Step 2. For all $i \in N$, let $m_i^1 = \min_{j \in N} r_i^j(c^1, E^1)$, $E^2 = E^1 - \sum_{i \in N} m_i^1$, and $c^2 = c^1 - m^1$, where $m^1 = (m_i^1)_{i \in N}$ For all $j \in N$, calculate $r^j(c^2, E^2)$. If all of them coincide, then $u[r,(c,E)] = m^1 + r^j(c^2, E^2)$. Otherwise, go to the next step.

Step k+1. For all $i \in N$, let $m_i^k = \min_{j \in N} r_i^j(c^k, E^k)$, $E^{k+1} = E^k - \sum_{i \in N} m_i^k$, and $c^{k+1} = c^k - m^k$. For all $j \in N$, calculate $r^j(c^{k+1}, E^{k+1})$. If all of them coincide, then $u[r,(c,E)] = m^1 + \cdots + m^k + r^j(c^{k+1}, E^{k+1})$. Otherwise, go to the next step.

If previous process does not terminate in a finite number of steps, then

Limit case. Compute $\lim_{k \to \infty}(m^1 + \cdots + m^k)$. If it converges to an allocation x such that $\sum_{i \in N} x_i \leq E$, then $x = u[r,(c,E)]$. Otherwise, $u[r,(c,E)] = 0$.

In the *unanimous concessions procedure,* once agents have selected a rule, agents' claim are sequentially reduced by the minimum amount assigned by the chosen rules. If the process converges, then this allocation is chosen as the solution to the conflict. Otherwise, nobody gets anything.

The strategic properties of these procedures have already been explored by the literature, as the following lemmas show.

Lemma 1 *If, for some $i \in N$, $r^i = cea$, then $dc[r,(c,E)] = cea(c,E)$. Furthermore, in game P_1, cea is a weakly dominant strategy for the smallest claimant. All Nash equilibria of P_1 are outcome equivalent to cea.*

Proof. See Chun (1989). ■

Lemma 2 *If, for some $i \in N$, $r^i = p$, then $pc[r,(c,E)] = p(c,E)$. Furthermore, in game P_2, if there exists an agent whose preferred allocation is p, then p is a weakly dominant strategy for her. All Nash equilibria of P_2 are outcome equivalent to p.*

Proof. See Moreno-Ternero (2002). ■

Lemma 3 *If, for some* $i \in N$*,* $r^i = cel$*, then* $u[r,(c,E)] = cel(c,E)$*. Furthermore, in game* P_3*, cel is a weakly dominant strategy for the highest claimant. All Nash equilibria of* P_3 *are outcome equivalent to cel.*

Proof. See Herrero (2001). ■

As shown in the lemmas, these procedures do not seem to provide the agents with any freedom of choice, at least under very mild (first-order) rationality conditions. This is because, there is always some player (the identity of which depends on the procedure) who can force the outcome in her favor by selecting her weakly dominant strategy. This may render these procedures inadequate, if we were genuinely interested in the rule selection problem, that is, in collecting experimental evidence on how subject reach an agreement on bankruptcy problems in the lab. This is why we also consider an additional procedure by way of the following coordination game.

Majority procedure (P_0)**.** Let $(c,E) \in \mathbb{B}$ be given. Each agent $i \in N$, simultaneously, chooses a rule $r^i \in \mathcal{R}$. The payoff function is as follows.

$$\pi_i\left(r^i, r^{-i}\right) = \begin{cases} r_i^i\,(c,E) \text{ if } r^i \text{ is the (single) majority rule.} \\ -\varepsilon \text{ otherwise.} \end{cases}$$

In the *majority procedure,* a claimant obtains the share of the estate proposed by her chosen rule only if it has been selected by the majority. Otherwise, she is fined by $\varepsilon > 0$. The strategic properties of this procedure are contained in the following lemma, the (trivial) proof of which is here omitted.

Lemma 4 *The set of strict Nash equilibria of* P_0 *is* $\{(r,r,...,r) : r \in \mathcal{R}\}$*.*

3 Experimental design

In what follows, we describe the features of the experiments in detail.

Subjects. The experiment was conducted in eight subsequent sessions in July, 2001. A total of 84 students (12 per session) were recruited among the undergraduate population of the University of Alicante.[6] Each session lasted for approximately one hour.

[6] Mainly, undergraduate Economics students with no (or very limited) prior exposure to game theory.

Treatment. The eight experimental sessions were run in a computer lab.[7] In the first six sessions, subjects were assigned to a group of 3 individuals and played twenty rounds of a *framed* procedure,[8] P_1, P_2 or P_3, followed by twenty rounds of P_0, presented under the same frame. In the last two sessions, subjects played twenty rounds of each of the four procedures, P_1, P_2, P_3 and P_0, without any framework.[9] As a consequence, these last two sessions were longer and subjects received higher monetary rewards. In all sessions, subjects played anonymously with varying opponents. Subjects were informed that their *player position* (i.e., their individual claims in the bankruptcy problem) would remain the same throughout the experiment, while the composition of their group would change at every round.

Instructions were provided by a self-paced, interactive computer program that introduced and described the experiment. Subjects were also given a written copy of the experimental instructions.[10] At the end of each round, each player knew about the game outcome and the monetary payoff associated with it.

The bankruptcy problem. All experimental games were constructed upon *the same* bankruptcy problem, where $c^* = (49,\ 46,\ 5)$ (i.e., $\sum c_i = 100$) and $E = 20$.[11] The resulting allocations associated with each rule for this specific bankruptcy problem are the following:

$$\begin{aligned} cel(E, c^*) &= (11.5, 8.5, 0), \\ p(E, c^*) &= (9.8, 9.2, 1), \\ cea(E, c^*) &= (7.5, 7.5, 5). \end{aligned}$$

We decided to focus on this particular problem for the following reasons. Ideally, we were looking for a problem satisfying the following three conditions.

1. Since *cel* is strictly preferred by player 1 (i.e., the highest claimant)

[7] The experiment was programmed and conducted with the software z-Tree (Fischbacher, 1999).

[8] See subsection *Framework* below.

[9] More precisely, the first and the fourth session involved P_1, followed by P_0. The second, and the fifth session involved P_2, followed by P_0. The third and the sixth session involved P_3, followed by P_0. Finally, the seventh session involved P_1, followed by P_2, followed by P_3, and followed by P_0, without any framework. The eighth session, involved P_3, followed by P_2, followed by P_1, and followed by P_0, without any framework.

[10] The complete set of instructions can be found in Appendix.

[11] All monetary payoff are expressed in Spanish pesetas (1 euro=166 pesetas approximately).

and cea is strictly preferred by player 3 (the lowest claimant), our first requirement was to impose that player 2 would strictly prefer p. In other words,

$$p_2 > \max\{cel_2,\ cea_2\}.$$

2. We were also looking for a bankruptcy problem for which the three rules would always give positive quantities to all claimants. This is always true for cea and p but not for cel. Thus, we required

$$cel(c, E) > 0.$$

3. Finally, we tried to ensure that each claimant would get different quantities. Combined with condition 2, this implies

$$cea_j \neq cea_i \text{ for all } i \neq j.$$

As it turns out, the three conditions above are incompatible. Therefore, we relaxed condition 3 to allow for at most two players receiving the same amount, and condition 2 to allow the third claimant to get a null amount. As a result, we have the bankruptcy problem presented above.

The games. All experimental treatments had the same game-form. In each session, each player was assigned to a player position, corresponding to a particular claim in the bankruptcy problem above, with c_i^* denoting player i's claim. In each round, each player was required to choose simultaneously a rule among cea, p and cel. Round payoffs were determined by the ruling procedure.

Payoffs. To frame the situation as closest as possible to a bankruptcy problem, in each round, subjects were loosing the difference between their claim and the share of the estate's division assigned to them, given the ruling procedure and the group's strategy profile. These amounts were subtracted to subjects' endowments. All subjects selected as players 1 and 2 received 500 pesetas to show up, in the framed sessions, and 1000 pesetas in the unframed sessions. Subjects selected as players 3 did not receive an initial show-up fee, due to the fact that their losses were considerably lower than the others'. Moreover, in each of the two procedures that constitutes a framed session, each player received an initial endowment of 1000 pesetas from which it was subtracted the associated loss to each bankruptcy situation. In procedure P_0, the penalty ε was equal to 1 peseta in all payoff treatments. Average earnings were around 1800 pesetas for players 1 and 2 (including the participation fee) and around 3600 pesetas for player 3.

Group size. Our decision to focus on a bankruptcy problem with three players was dictated by several reasons. The procedures presented in Section 2 (as opposite with some bargaining procedures of a related nature), work for any number of agents. Furthermore, the situation is radically different when more than two agents are involved than in the two-agent case. That is, the reason of choosing three agents, as a way of moving away from the two-person case, but keeping the population size at a minimum. Second, on the fact that in our case, each one of the proposed solutions provides with the best outcome to one of the players. It is always true that the smallest claimant will prefer the *cea* rule, and the largest claimant will prefer the *cel* rule. Nonetheless, it is not always the case that any intermediate claimant will prefer p over the other two rules. In any case, we choose this type of situation in order to keep any of the rules attached to any of the agents, and to avoid obvious solutions to the coordination game. Third, on the fact that we made agents to play a single bankruptcy problem. We think that this example is enough to give us the flavor of the way agents will play at any other circumstances, and keeping a single example facilitates learning and comprehension by the players.

Framework. In the first six sessions the bankruptcy problem were framed in three different ways, depending on the procedure being employed. The idea is to provide a frame consistent with the rule induced by the procedure.[12]

All frames had in common that the bankruptcy problem was framed in terms of *a bank which goes bankrupt.*

- **Frame 1: Depositors** (P_1). In this first frame claimants are all *bank depositors.* In our interpretation, this is a situation where the priority should go to smaller claims (i.e., smaller deposits), as it happens with procedure P_1.
- **Frame 2 : Shareholders** (P_2). Under this frame claimants are all bank *shareholders.* In this case, it seems to be commonly agreed that claims should be treated proportionally, as P_2 does.
- **Frame 3 : Non-governmental organizations** (P_3). Our last frame is concerned with *non-governmental organizations which are supported*

[12] A precise description of the hypothetical situations used as frames can be found in the Appendix.

by the bank. In this case, we assumed that each organization had signed a contract with the bank, previously to the bankruptcy situation, to receive a contribution according with its social relevance (the higher the social relevance, the higher the contribution). Under this framework, it would seem appropriate to use the *constrained equal-losses rule,* as P_3 does.

- **Frame 0: No frame**. We also run two unframed sessions. In this case, individuals played the four games without any story behind.

4 Results

In analyzing the experimental data, we first look at the rule distributions and subjects' aggregate behavior in the six framed sessions. Later, we also compare the experimental evidence between framed and unframed sessions.

4.1 Outcomes and behaviors in the framed sessions

Relative frequencies with which the three bankruptcy rules were implemented in the six framed sessions of P_1, P_2 and P_3 are summarized in Table 1.[13]

RULES / PROCEDURES	*cea*	*p*	*cel*	Others
P_1	.98	0	0	.02
P_2	0	1	0	0
P_3	0	0	.98	.02

(1)

Table 1: Rule distributions of P_1, P_2 and P_3 in the framed sessions.

We begin by noting that, in the framed sessions, virtually all matches yielded the corresponding equilibrium rule.[14] This striking evidence has to be compared with the rule distribution in the framed versions of the coordination

[13] In all tables, frequencies were rounded to the nearest .01.

[14] The relative frequency of equilibrium outcomes converges to 1, for all procedures, if we look at the last ten repetitions only. We also know that every Nash equilibrium is outcome equivalent to the corresponding rule of that procedure. However there are strategy profiles which are outcome equivalent to the equilibrium rule but are not Nash equilibria. In this respect, our experiment shows that these strategy profiles occur only marginally. If a particular rule is selected, this is because it is a Nash equilibrium of the corresponding procedure.

procedure P_0, as shown in Table 2.

FRAMES \ OUTCOMES	*cea*	*p*	*cel*	Others
1	.01	.82	0	.17
2	0	.69	.01	.30
3	0	.75	.01	.24

(2)

Table 2: Rule distributions of P_0, in the framed sessions.

Table 2 displays a completely different scenario. Here the proportional rule is salient in describing the outcome allocation in all sessions, with an average frequency of .75 across all treatments. Not surprisingly, learning effects are much stronger in P_0 than in any other procedure. The average frequency of use of the proportional rule raises from .75 to .9 if we consider the last ten periods only.[15]

We now move to subjects' behavior, disaggregated for player position, in the six framed sessions. As we know from Lemmas 1-3, every procedure provides a player (the identity of which depends on the procedure) with a weakly dominant strategy by which she can force her favorite outcome. In each game, we will refer to this player as the *pivotal player* of that game. However, given the reduced form games used in the experiment (subjects could only choose among *cea*, *p* and *cel*), other players have weakly dominant strategies, as follows:

- P_1: *cea* is weakly dominant for the pivotal player 3; player 2 has no weakly dominant strategies in this game; *cel* is weakly dominant for player 1.
- P_2: *p* is weakly dominant for the pivotal player 2; *cea* is weakly dominant for player 3; *cel* is weakly dominant for player 1.
- P_3: *cel* is weakly dominant for the pivotal player 1; *cea* is weakly dominant for player 3; player 2 has no weakly dominant strategies in this game.

To summarize, *cea* (*cel*) always corresponds to a weakly dominant strategy for player 3 (1), while player 2 has a weakly dominant strategy (*p*) only in

[15] Tables data disaggregated for periods can be found in the Appendix.

P_2. This fact has clear consequences when we look at the aggregate behavior of P_1, P_2 and P_3 in the six framed sessions. This is shown in Table 3.

PLAYERS	P_1			P_2			P_3		
1	.08	.28	.64	.02	.22	.76	.02	.06	.92
2	.15	.66	.19	.07	.76	.17	.06	.45	.49
3	.97	.02	.01	.82	.14	.04	.54	.3	.16
RULES	*cea*	*p*	*cel*	*cea*	*p*	*cel*	*cea*	*p*	*cel*

(3)

Table 3: Aggregate behavior in the framed sessions of P_1, P_2 and P_3.

Here we notice that the pivotal player 3 selects her weakly dominant strategy (A) in P_1 with a relative frequency of .97 (this frequency raises to 1 if we only consider the last ten repetitions); in P_3 the pivotal player 1 selects her weakly dominant strategy (*cel*) 92% of the times (96.25% if we consider the last ten periods); in P_2 the relative frequency with which the pivotal player 2 selects her weakly dominant strategy p is somehow lower (75.62% and 77.5% resp.), but still significantly higher than any other available choice. As far as the weakly dominant strategy used by "non-pivotal" players, we also notice that, although not as frequently as pivotal players, the weakly dominant action is selected always more than 50% of the times.[16]

Again, things change significantly if we look at the aggregate behavior in the framed sessions of P_0, as shown in Table 4 .

PLAYERS	FRAME 1			FRAME 2			FRAME 3		
1	.01	.95	.04	0	.81	.19	.02	.88	.10
2	.04	.93	.03	.02	.86	.12	.04	.92	.04
3	.12	.88	0	.07	.87	.06	.08	.9	.02
RULES	*cea*	*p*	*cel*	*cea*	*p*	*cel*	*cea*	*p*	*cel*

(4)

Table 4: Aggregate behavior in the framed sessions of P_0.

As Table 4 shows, subjects selected the proportional rule at least 80% of the times. This probability raises to over 90% if we only consider the last ten repetitions.

[16] More precisely, Player 1 chooses *cel* 64% and 76% of the times in P_1 and P_2, respectively. These frequencies raise to 65% and 84% in the last ten periods. Player 3 chooses *cea*, 82% and 54% of the times in P_2 and P_3, respectively. These frequencies raise to 84% and 54% in the last ten periods.

4.2 Framed Vs. Unframed sessions

The rule distribution for the two unframed sessions, is summarized in Table 5.

RULES / PROCEDURES	*cea*	*p*	*cel*	Others
P_0	.01	.71	0	.28
P_1	.99	0	.01	0
P_2	0	1	0	0
P_3	0	0	.99	.01

(5)

Table 5: Rule distributions in the unframed sessions.

Not differently than what happens in the framed sessions, the three procedures implemented the corresponding equilibrium rule virtually in every match. About P_0, again the proportional rule is salient in describing the rule distribution in all sessions. The average frequency of use is 71% across all treatments, 97% if we consider the last ten periods only.

We can observe from Tables 1 and 5 that, for P_2, rule distributions are identical, insofar the proportional rule was implemented all the time. As for P_1 and P_3, the difference between framed and unframed treatment is statistically significant at a 10% confidence level.[17] However, if we focus on the last ten repetitions, difference in behavior is no longer significant.

As for P_0, remember that we have three different framed versions, since P_0 was played within each frame. In this case, we accept the null hypothesis of no difference in behavior across frames at a 10% confidence level.

PLAYERS	P_0			P_1			P_2			P_3		
1	.04	.87	.09	.06	.11	.83	.03	.09	.88	.01	.01	.98
2	.05	.92	.03	.09	.59	.32	0	1	0	.01	.11	.88
3	.15	.81	.04	.99	0	.01	.77	.13	.1	.77	.16	.01
RULES	*cea*	*p*	*cel*	*cea*	*p*	*cel*	*cea*	*p*	*cel*	*cea*	*p*	*cel*

(6)

Table 6: Aggregate behavior in the unframed sessions

We now move to subjects' behavior in the two unframed sessions, as reported in Table 6. Here we notice that the pivotal players choose their weakly dominant strategies with a frequency even higher than in the framed sessions.

[17] In the remainder of this section, we shall measure significance by way of standard χ^2 statistics.

In particular, in P_2, player 2 selects the proportional rule all the time, in clear contrast with the framed sessions. However, while for all procedures pivotal players' initial play in the unframed sessions is significantly different from that of the framed sessions, if we consider the last 10 periods only, this is true only for P_2 (that is, the procedures that displays a higher variability in behavior).

As far as the weakly dominant strategy used by non-pivotal players, we notice that, the weakly dominant action is selected always more than 75% of the times.[18] This frequency is higher than in the framed sessions. However, while in the framed sessions non-pivotal players increased these frequencies throughout each session, the opposite occurs in the unframed sessions.

As for P_0, subjects choose the proportional rule with a relative frequency higher than .8, (.98 in the last ten rounds as Table 7 shows).[19]

PLAYERS	P_0		
1	0 .07	1 .74	0 .19
2	0 .1	1 .84	0 .06
3	.02 .29	.98 .64	0 .07
RULES	*cea*	*p*	*cel*

(7)

Table 7: Table 6 disaggregated for periods in P_0.

Again, we observe that behavior in the unframed sessions is significantly different from that of the framed sessions only in the beginning, not if we consider the last ten repetitions only.

To summarize, we could say that subjects behave differently, depending on the particular frame considered (this frame effect being stronger in P_2). Notwithstanding, these differences vanish in the last repetitions of the game and do not affect rule distributions.

[18] More precisely, Player 1 chooses rule C, 83.12% and 88.12% of the times in P_1 and P_2, respectively. Surprisingly, these percentages decreased to 78.75% and 85% in the last 10 periods. Player 3 chooses rule A, 76.87% and 77.5% of the times in P_2 and P_3, respectively. These percentages again decreased to 71.25% and 73.75% in the last 10 periods.

[19] The number in the bottom-left (top-right) corner corresponds to the first (last) ten periods.

5 Conclusion

Our experimental study provides clear-cut answers to the questions we posed in the introduction.

- "*In Game 3 everything was determined by my own choice.*"[20]

First, we found that subjects recognized, since the very first periods, the strategic features of procedures P_1, P_2 and P_3 and reacted accordingly. For these games, convergence takes place since the very beginning. This is far more evident for pivotal players, those who could force the outcome in their favor by selecting their weakly dominant strategies. In this respect, our evidence confirms that compliance with equilibrium is high (in our case, practically full) in normal-form games that are solvable with one round of deletion of weakly dominated strategies.[21]

- "*First, I was trying the way to maximize my payoff, then I realized that this was not possible, since everybody was acting the same way and we were all loosing money. So, we settled on an intermediate solution, which was not the best for me, but as not the worst either.*"[22]

In stark contrast with the evidence above, in the coordination procedure P_0, subjects unanimously agreed to solve the bankruptcy problem by way of the proportional rule. The reason why they behave this way could be twofold. First, because of the fact that the proportional outcome lies in between the *cea* and the *cel* outcomes. As a consequence, the proportional rule provides with the second best outcome for both the highest and the smallest claimants, and with the best outcome for the intermediate claimant, while both the constrained equal awards and the constrained equal losses are associated to the worst possible outcome for either the highest and the lowest claimants, respectively. It seems then natural that agents coordinate at the intermediate outcome. Clearly, this *median voter effect* is specific of our experimental deign, and we expect our result to be different varying the claim distribution (for example, considering a bankruptcy problem in which there is a single majority of small claimants). This consideration notwithstanding,

[20] Debriefing section of Session 7 (unframed). Subject # 4 (player 1).

[21] See Costa-Gomes et al. [5]

[22] Debriefing section of Session 1 (framed). Subject # 9 (player 3).

our experiment suggests that optimal bankruptcy rule may depend on claim distributions (an aspect completely neglected by the axiomatic literature), and that a key feature of an optimal rule to be its immunity to strategic manipulation. In this respect De Frutos [10] shows that the proportional rule is the unique rule that meets this condition.

- "*I took the most equitative choice for the three of us.*"[23]

Finally, we suspect that fairness considerations may also have enhanced the coordination power of the proportional rule. The reason why the proportional rule (as opposed to *cea* or *cel*) was clearly identified as the *fair* rule to be applied to the problem at stake is left for future research.

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6 Appendix. The Instructions

We only present here the instructions of Session 1 and Session 7. The remaining sessions go along the same lines, except for some differences that are introduced in footnotes.

Instructions of a Framed Session (Session 1)

SCREEN 1: WELCOME TO THE EXPERIMENT

This is an experiment to study how people interact in a bankrupt situation. We are only interested in what people do on average and keep no record at all of how our individual subjects behave. Please do not feel that any particular behavior is expected from you.

On the other hand, keep also in mind that your behavior will affect the sum of money you may win during the course of this experiment.

On the following pages you will find a series of instructions explaining how the experiment works and how to use the computer during the experiment.

HELP: When you are ready to continue, please click on the OK button

SCREEN 2: HOW YOU CAN MAKE MONEY

- You will be playing two sessions of 20 rounds each. In each round, for all sessions, you and other two persons in this room will be assigned to a GROUP. In each round, each person in the group will have to make a decision. Your decision (and the decision of the other two persons in your group) will determine how much money you (and the other) win for that round.

- At the beginning of each round, the computer will select at random the composition of your group.

- Remember that the composition of your group WILL CHANGE AT EVERY ROUND.

- To begin, you will receive 1000 pesetas just for participating in this experiment.[24] Moreover, at the beginning of each session, an initial endowment of 1000 pesetas will be given to you.

[24] This sentence did not appear in the case of Player 3.

- Note that the computer has assigned you a number of PLAYER (1, 2 or 3). This number appears at the right of your screen and will represent your type of player. There are three types of players: player 1, player 2 and player 3. Every group will be always composed by three players from different types. Remember that you will be the same type of player along the experiment.

- In each round, you will have to pay some of this money, depending on your action and those of the persons in your group. The sum of the amounts you pay in each round, will be subtracted to your initial endowment and will constitute your TOTAL payoff in this session. Remember that payoffs in this experiment are such that IN ALL CIRCUMSTANCES YOU WILL WIN MONEY.

- At the end of the experiment you will receive the TOTAL sum of money you obtained in each session, plus the show-up fee of 1000 pesetas[25]

HELP: When you are ready to continue, please click on the OK button.

SCREEN 3: THE FIRST GAME (I)

There is *a bank which goes bankrupt.* A judge must decide how its liquidation value should be allocated among the bank's creditors. In this experiment you (and all other persons participating to the experiment) are creditors who go to the court.

In this session, the bank's creditors are all *depositors*,[26] that is, people who have money saved in the bank. You have to come to an agreement with the other depositors in your group on how much of the estate should be given to each of you. Clearly (since the bank has gone bankrupt) the sum of all claims, i.e. the sum of your deposits, is greater than the available estate.

In each round, you need to guarantee as much as possible of your claim, which will determine your loss (the difference between your claim and the amount you receive) in each round. The sum of these losses will be subtracted to your initial endowment and will constitute your TOTAL payoff in this session.

[25]In the case of Player 3: *At the end of the experiment you will receive the TOTAL sum of money you obtained in each session.*

[26]This is the case of Frame 1, which corresponds to P_1. In the case of Frame 2 (3) it is said *shareholders* (*non-governmental organizations which are, at least, partially, supported by the bank*) instead of depositors.

Concerning the problem involving you and the other two persons in your group, your claims and the available estate, are shown in the following table:

PLAYER	CLAIM
1	49
2	46
3	5

The estate is 20.

As you can observe, there is no enough liquidation value to satisfy all claims.

Remember that the player number assigned to you (1, 2 or 3) appears on the computer screen and remains fixed throughout the experiment.

Among the different options on how the liquidation value of the bank should be distributed, the judge has decided that you can only choose among the following *rules:*

1. RULE A*,* that divides the estate equally among the creditors under the condition in which no one gets more than her claim. In other words, this rule benefits the agent with the lowest claim.
2. RULE B*,* that divides the estate proportionally to claims.
3. RULE C*,* which makes losses as equal as possible, among creditors, subject to the condition that all agents receive something non-negative from the estate. In other words, this rule benefits the agent with the highest claim.

Concerning the problem involving you and the other two persons in your group, the allocations corresponding to each rule are the following:

$$A \equiv (7.5, 7.5, 5)\,; \;\; B \equiv (9.8, 9.2, 1)\,; \;\; C \equiv (11.5, 8.5, 0)\,.$$

For instance, rule B divides the estate in three parts, assigning 9.8 to player 1, 9.2 to player 2 and 1 to player 3.

SCREEN 4: THE FIRST GAME (II)

The structure of the game is as follows:

Your decision, and the decisions of the members of your group will determine the division of the estate, as it is shown in the payoff matrices. Note that if you all agree on the same rule, then the division of the estate is exactly the one you propose.

This is how to read the matrices. There are three tables with nine cells each: player 1 chooses the row, player 2 chooses the column and player 3 chooses the table. Each cell contains three numbers. The first number tells how much money player 1 looses if that cell is selected, the second number tells how much money player 2 looses and the third number tells how much money player 3 looses. For instance, consider the upper left cell. This cell is selected when every player chooses rule A. Therefore, the division of the estate is the one that rule A proposes, i.e. $(7.5, 7.5, 5)$. As a consequence of this, and taking into account the above claims, player 1 looses $7.5 - 49 = -41.5$, which is the first number of that particular cell. Similarly, player 2 looses $7.5 - 46 = -38.5$, and player 3 looses $5 - 5 = 0$.

To summarize,

- You will be playing 20 times with changing components.
- At the beginning of each round, the computer selects your group at random;
- In each round, you and the other two persons in your group must choose one among the three available rules A, B and C. Your choice (and the choices of the other two persons in your group) will determine how much money will be subtracted to your initial endowment, as it is shown in the corresponding table in front of you.

HELP: To choose an action, you simply have to click on the corresponding letter. Once you have done that, please confirm your choice by clicking the OK button.

Screen 5: The Second Game.

Now, you are going to play 20 additional rounds of the following game. As before, in this session, the bank's creditors are all *depositors*,[27] that is, people

[27] This is the case of Frame 1. In the case of Frame 2 (3) it is said *shareholders* (*non-governmental organizations which are, at least, partially, supported by the bank*) instead of depositors.

who have money saved in the bank. You can observe from your computer screen that the claims of each player and the estate do not change.

As before, you have to come to an agreement with the other depositors in your group on how much of the estate should be given to each of you. Remember, as before, that 1000 pesetas were assigned to you at the beginning of the session.

The instructions are the same as in the previous game with some slight modifications. In each round, as before, you have to choose among rules A, B and C. If you all agree on the same rule, in your group, then the division of the estate is exactly the one you propose. If only two of you agree on a rule then, those who agree get the share proposed by that rule and the creditor who does not agree in the division, not only looses her whole claim, but also pays a fixed penalty of 1 peseta Finally, if all of you disagree on the proposed shares, then all of you loose your claim and pay the fixed penalty of 1 peseta The corresponding allocations to each possible situation are shown in the payoff matrices below.

The matrices are read exactly as before. For instance, consider the lower left cell. This cell is selected when players 2 and 3 chooses A and player 1 chooses C. In this particular case, player 1 looses $-1 - 49 = -50$, which is the upper number of that particular cell. Similarly, player 2 looses $7.5 - 46 = -38.5$, and player 3 looses $5 - 5 = 0$.

HELP: To choose an action, you simply have to click on the corresponding letter. Once you have done that, please confirm your choice by clicking the OK button.

Instructions of an Unframed Session (Sessions 7 and 8)

Screen 1: Welcome to the Experiment

This is an experiment to study how people interact. We are only interested in what people do on average and keep no record at all of how our individual subjects behave. Please do not feel that any particular behavior is expected from you.

On the other hand, keep also in mind that your behavior will affect the sum of money you may win during the course of this experiment.

On the following pages you will find a series of instructions explaining how the experiment works and how to use the computer during the experiment.

HELP: When you are ready to continue, please click on the OK button

Screen 2: How you can make money

- You will be playing four sessions of 20 rounds each. In each round, for all sessions, you and other two persons in this room will be assigned to a GROUP. In each round, each person in the group will have to make a decision. Your decision (and the decision of the other two persons in your group) will determine how much money you (and the other) win for that round.
- At the beginning of each round, the computer will select at random the composition of your group.
- Remember that the composition of your group WILL CHANGE AT EVERY ROUND.
- To begin, you will receive 1000 pesetas just for participating in this experiment.[28] Moreover, at the beginning of each session, an initial endowment of 1000 pesetas will be given to you.
- Note that the computer has assigned you a number of PLAYER (1, 2 or 3). This number appears at the right of your screen and will represent your type of player. There are three types of players: player 1, player 2 and player 3. Every group will be always composed by three players from different types. Remember that you will be the same type of player along the experiment.

[28] This sentence was not included in the case of Player 3.

- In each round, you will have to pay some of this money, depending on your action and those of the persons in your group. The sum of the amounts you pay in each round, will be subtracted to your initial endowment and will constitute your TOTAL payoff in this session. Remember that payoffs in this experiment are such that IN ALL CIRCUMSTANCES YOU WILL WIN MONEY.

- At the end of the experiment you will receive the TOTAL sum of money you obtained in each session, plus the show-up fee of 1000 pesetas[29]

HELP: When you are ready to continue, please click on the OK button.

SCREEN 3: THE FIRST GAME.[30]

At the beginning of each round, the computer will select randomly the composition of your group.

In each round, you and the other two members of your group, must choose among three possible decisions: A, B and C.

Your decision, and the decisions of the members of your group will determine the how much money you will lose from your initial endowment in this session, as it is shown in the payoff matrices.

This is how to read the matrices. There are three tables with nine cells each: player 1 chooses the row, player 2 chooses the column and player 3 chooses the table. Each cell contains three numbers. The first number tells how much money player 1 looses if that cell is selected, the second number tells how much money player 2 looses and the third number tells how much money player 3 looses.

For instance, consider the lower left cell. This cell is selected when every player 1 chooses C and players 2 and 3 choose A. Therefore, player 1 loses -41.5, which is the first number of that particular cell. Similarly, player 2 loses -38.5, and player 3 loses $5-5=0$.

To summarize,

- You will be playing 20 times with changing components.

[29] In the case of Player 3: *At the end of the experiment you will receive the TOTAL sum of money you obtained in each session.*

[30] This was the third game in Session 8.

- At the beginning of each round, the computer selects your group at random;
- Remember that your player number (1, 2 or 3) will keep constant throughout the experiment.
- In each round, you and the other two persons in your group must choose one among the three available rules A, B and C. Your choice (and the choices of the other two persons in your group) will determine how much money will be subtracted to your initial endowment, as it is shown in the corresponding table in front of you.

HELP: To choose an action, you simply have to click on the corresponding letter. Once you have done that, please confirm your choice by clicking the OK button.

Procedure P_1

	A	B	C
A	−41.5 −38.5 0	−41.5 −38.5 0	−41.5 −38.5 0
B	−41.5 −38.5 0	−41.5 −38.5 0	−41.5 −38.5 0
C	−41.5 −38.5 0	−41.5 −38.5 0	−41.5 −38.5 0

A

	A	B	C
A	−41.5 −38.5 0	−41.5 −38.5 0	−41.5 −38.5 0
B	−41.5 −38.5 0	−39.2 −36.8 −4	−38.3 −37.6 −4.1
C	−41.5 −38.5 0	−38.3 −37.6 −4.1	−38.3 −37.6 −4.1

B

	A	B	C
A	−41.5 −38.5 0	−41.5 −38.5 0	−41.5 −38.5 0
B	−41.5 −38.5 0	−38.3 −37.6 −4.1	−38.3 −37.6 −4.1
C	−41.5 −38.5 0	−38.3 −37.6 −4.1	−37.5 −37.5 −5

C

Procedure P_2

	A	B	C
A	−41.5 −38.5 0	−39.2 −36.8 −4	−39.2 −36.8 −4
B	−39.2 −36.8 −4	−39.2 −36.8 −4	−39.2 −36.8 −4
C	−39.2 −36.8 −4	−39.2 −36.8 −4	−39.2 −36.8 −4

A

	A	B	C
A	−39.2 −36.8 −4	−39.2 −36.8 −4	−39.2 −36.8 −4
B	−39.2 −36.8 −4	−39.2 −36.8 −4	−39.2 −36.8 −4
C	−39.2 −36.8 −4	−39.2 −36.8 −4	−39.2 −36.8 −4

B

	A	B	C
A	−39.2 −36.8 −4	−39.2 −36.8 −4	−39.2 −36.8 −4
B	−39.2 −36.8 −4	−39.2 −36.8 −4	−39.2 −36.8 −4
C	−39.2 −36.8 −4	−39.2 −36.8 −4	−37.5 −37.5 −5

C

PROCEDURE P_3

	A	B	C
A	−41.5 −38.5 0	−39.6 −39.6 −3.7	−37.5 −37.5 −5
B	−39.6 −39.6 −3.7	−39.6 −39.6 −3.7	−37.5 −37.5 −5
C	−37.5 −37.5 −5	−37.5 −37.5 −5	−37.5 −37.5 −5

A

	A	B	C
A	−39.6 −39.6 −3.7	−39.6 −39.6 −3.7	−37.5 −37.5 −5
B	−39.6 −39.6 −3.7	−39.2 −36.8 −4	−37.5 −37.5 −5
C	−37.5 −37.5 −5	−37.5 −37.5 −5	−37.5 −37.5 −5

B

	A	B	C
A	−37.5 −37.5 −5	−37.5 −37.5 −5	−37.5 −37.5 −5
B	−37.5 −37.5 −5	−37.5 −37.5 −5	−37.5 −37.5 −5
C	−37.5 −37.5 −5	−37.5 −37.5 −5	−37.5 −37.5 −5

C

PROCEDURE P_0

	A	B	C
A	−41.5 −38.5 0	−41.5 −47 0	−41.5 −47 0
B	−50 −38.5 0	−39.2 −36.8 −6	−50 −47 −6
C	−50 −38.5 0	−50 −47 −6	−37.5 −37.5 −6

A

	A	B	C
A	−41.5 −38.5 −6	−50 −36.8 −4	−50 −47 −6
B	−39.2 −47 −4	−39.2 −36.8 −4	−39.2 −47 −4
C	−50 −47 −6	−50 −36.8 −4	−37.5 −37.5 −6

B

	A	B	C
A	−41.5 −38.5 −6	−50 −47 −6	−50 −37.5 −5
B	−50 −47 −6	−39.2 −36.8 −6	−50 −37.5 −5
C	−37.5 −47 −5	−37.5 −47 −5	−37.5 −37.5 −5

C

7 Tables

PLAYERS	P_1			P_2			P_3		
1	.07 .07	.28 .29	.65 .64	0 .04	.16 .27	.84 .69	.01 .04	.03 .09	.96 .87
2	.09 .22	.71 .60	.20 .18	.06 .07	.78 .74	.16 .19	.04 .08	.42 .47	.54 .45
3	1 .95	0 .04	0 .01	.84 .81	.14 .14	.02 .05	.54 .54	.27 .32	.19 .14
RULES	*cea*	*p*	*cel*	*cea*	*p*	*cel*	*cea*	*p*	*cel*

(8)

Table 8: Table 3 disaggregated for periods.

PLAYERS	FRAME 1			FRAME 2			FRAME 3		
1	0 .02	1 .89	0 .09	0 0	.93 .7	.07 .3	0 .05	.96 .79	.04 .16
2	.01 .07	.96 .9	.03 .03	.01 .03	.95 .76	.04 .21	.01 .06	.99 .85	0 .09
3	0 .24	1 .76	0 0	.01 .14	.94 .8	.05 .06	.04 .12	.96 .84	0 .04
RULES	*cea*	*p*	*cel*	*cea*	*p*	*cel*	*cea*	*p*	*cel*

(9)

Table 9: Table 4 disaggregated for periods

PLAYERS	P_1			P_2			P_3		
1	.09 .04	.12 .09	.79 .87	0.05 0	.1 .09	.85 .91	0 .01	0 .03	1 .96
2	.08 .1	.7 .49	.22 .41	0 0	1 1	0 0	0 .03	.1 .12	0.9 .85
3	1 .99	0 0	0 0.01	.71 .83	.14 .12	.15 .05	.74 .81	.19 .13	.07 .06
RULES	*cea*	*p*	*cel*	*cea*	*p*	*cel*	*cea*	*p*	*cel*

(10)

Table 10: Table 6 disaggregated for periods