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How does context influence players' behaviour?

Experimental assessment in a 3-player coordination problem

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Abstract

This paper uses a CGT TU game modified into a coordination experiment to explore the causal effect of context on players' behaviour. An analytical framework focusing on four attributes representative of the game's context is proposed and an experimental protocol based on this framework allows testing hypotheses regarding the influence of context on players' choices. Results show that attributes such as Repetition and Communication seem to have a higher influence than Illustration on players' behaviour. The peculiar nature of the experimental results in the control group, showing the emergence of a focal point other than the outcome prescribed by the theory, allows discussing the expected "noise" observed in the treatments from a new perspective.

Key words: Context, Experimental Economics, Coordination, Cooperative Game Theory, Schelling effect, Role Playing Games, Water.

JEL: C92 ; C71 ; D71 ; Q25

Introduction

A common issue in experimental economics (EE) is the trade-off between internal and external validity of the experiments. Campbell (1957) considered an experiment internally valid if the experimenter finds a significant difference between the treatment and the control conditions. This difference is only the result of the response of subjects to causal processes at play and excludes all extraneous mediating factors that influence such responses. On the other hand, external validity is a matter of generalization of experimental results outside the specific situation created in the laboratory (Druckman et al., 2012).

Experiments conducted by economists tend to give priority to internal validity, by creating the laboratory conditions of control and replicability necessary to "evaluate the causal impacts of potentially informative explanatory variables" (Druckman et al., 2012). These conditions imply a simplification of the experimental settings, making them very distant from the real life, and therefore creating a problem in terms of external validity of the experiments (i.e. generalization of the outcomes).

Conversely, in the field of "adaptive and participatory research" (Barreteau et al., 2011), role-playing games (RPGs) are an "extremely simplified representation of the problem, yet sufficient to reflect the complexity of the system by taking the main dynamics and interactions into account" (Bousquet et al., 2011). As a consequence, protocols are highly contextualised. Obviously, RPGs are weak in terms of internal validity, as their complexity makes it difficult to interpret the results and identify the factors influencing the behaviour observed during the game (Desolé et al., 2009). Another problem with RPGs used as participatory platforms resides in their specificity to the local situation where they have been constructed, making them unsuitable for other similar utilisations (out-scaling) and consequently hampering the accumulation of knowledge that could result from this generalization (Rouchier, 2007).

Field experiments offer an intermediate set-up, where internal validity is preserved through rigorous protocols and control of the explanatory variables, but in order to increase external validity, the experiments are conducted far from laboratories, in the presence of more real conditions and with real stakeholders.

According to Shadish et al. (2002), "external validity covers at least four aspects of experimental design: whether the participants resemble the actors who are ordinarily confronted with these stimuli; whether the context (including the time), within which actors operate, resembles the context (and time) of interest; whether the stimulus used in the study resembles the stimulus of interest in the world; and whether the outcome measures resemble the actual outcomes of theoretical and practical interest".

We concentrated our analysis on the context of the experiment, which was identified with the level of information given to players through instructions, exchanged by players during an experiment or accumulated by players before or during an experiment.

The trade-off between internal and external validity of experiments assumes a different weight in function of the social discipline where these experiments are conducted. "While psychologist pay primary attention to issues associated with internal validity, political scientists tend to focus, almost exclusively, on problems associated with external validity" (Mc Dermott, 2012).

Limiting our analysis to EE and RPGs for participatory research, we observe that on one hand experimental economists are looking for more external validity in order to generalize the results of their abstract and controlled protocols, while on the other hand, although primarily driven by social validation (Le Page et al., 2011), RPGs designers are in quest of improved internal validity and therefore a higher capacity to interpret the games' outcomes and the factors that affect players' behaviour.

If we identify then a positive relation between the quantity of context (i.e. more realistic and informed set-up of a protocol) and the external validity of an experiment, we observe a tendency to contextualize abstract experiments in EE. At the same time, some RPGs designers (Ferrand et al., 2009; Abrami et al., 2012) tend to simplify their platforms to face the problems of interpretation and accumulation of knowledge indicated by Desolé et al. (2009) and Rouchier (2007).

A crucial scientific issue is therefore the research of the quantity and quality of context that are "good" for both experimental protocols and RPGs in order to reach the acceptable compromise between internal and external validity in both disciplines and to allow simplification towards some accumulation of knowledge in RPGs.

A research programme that aims at answering this question consists for EE in finding out first how the context, as the previously defined array of variables, has a causal impact on player's behaviours, and then whether or not it is possible to isolate this impact and measure it quantitatively and objectively.

The experimental observations derived from such a research programme would provide useful suggestions and guidance for both economists and RPG designers in terms of the priorities to follow when choosing the contextual components constituting an experimental protocol or a game platform.

The idea developed in this paper is that experimentation makes it possible to analyse the question of the influence of context on players' behaviour.

More precisely, we are interested in characterising and quantifying the causal impact that introducing different dimensions of a predefined context in a completely decontextualized protocol has on the experiment's outcomes.

In other terms: do contextualized treatments, introducing more variables that influence players' behaviour, create a *noise* (Babcock et al., 1995) that increases the dispersion of players' responses if compared to the abstract control, or vice versa may the context rather be seen as a catalyst accelerating the learning processes without modifying the cognitive processes of reasoning (Cooper and Kagel, 2003)?

To answer our research question, we proceeded through the following steps.

First we proposed a new analytical framework for the definition and study of the contextual dimensions of an EE set-up. Then we designed an experimental protocol derived from the degradation of a role-playing game called "KatAware", created and used in South Africa to deal with decision-making about the allocation of water resources (Farolfi and Rowntree, 2007) in a catchment area. Our protocol consists of a coordination problem where three players must choose to allocate the grand-coalition payoff following the Cooperative Game Theory (CGT) theoretical reference. Finally, we used the analytical framework to build contextualized treatments in order to test our hypotheses about the impact of context on players' behaviour. The hypotheses that we test are therefore on the gap that the introduction of contextual elements creates between the outcomes of the untreated state (abstract) and the outcomes of the contextualized treatments.

The paper is structured as follows. Section 1 describes the new analytical framework to define and analyse the contextual dimensions of an experimental protocol; section 2 presents the coordination problem and section 3 illustrates how the coordination problem was converted into an experimental protocol aiming at testing hypotheses about the influence of context on players' behaviour. Section 4 presents and discusses the results of the experiments. Section 5 concludes, indicates the limits and caveats of the exercise and provides perspectives for future work.

1. A framework for the analysis of context in economic experiments

1.1 Context and players' behaviour

In endeavouring to obtain better control of the experiment parameters, investigators in EE agree that it is necessary to eliminate every element that might disrupt participants' behaviour. In light of the loss of control over behaviour caused by the different representations envisaged by the players, the introduction of context in experiments can be perceived as *noise* (Babcock et al., 1995). The underlying idea is that the participants have the same interpretation of a neutral and generic piece of information, hence the desire for maximum control to ensure the validity and robustness of the results.

Nevertheless, this idea of a homogenous perception of a neutral context by the players is called into question. According to certain authors, introducing references to reality has the effect of limiting players' confusion with regard to the decisions to be taken and the actions to be implemented. In other words, players can lose their ability to reason when they are placed in an environment which is too abstract and which, by definition, is unfamiliar to them as they do not encounter such abstract contexts in reality (Loewenstein, 1999; Loomes, 1999). If the subjects understand neither the question posed, by means of the instructions, nor the consequences of the decisions they are to take, no control over the players' motivations is guaranteed (Pillutla and Chen, 1999).

Faravelli (2007) compared the results obtained by conducting an experiment involving different samples of students enrolled in economics or sociology courses, either in the first year or subsequent years of their study course. He noted that the differences between the answers observed in abstract treatments disappear once context has been introduced, thereby corroborating the hypothesis made by Loewenstein (1999). The context provided players with indicators enabling them to behave in accordance with a common representation of this context. The players gave the same answer irrespective of their individual characteristics (level of studies and specialist subject), thereby contradicting – through the homogenisation of their behaviours – the idea that context acts as a *noise* which alters the interpretation of the economic question asked.

Cooper and Kagel (2003) identified two levels of contextual influence on behaviour. They adopted the hypothesis of a first "weak" level where context may be seen as a catalyst, accelerating the learning processes (established as the periods are repeated) without modifying the cognitive processes of reasoning. This "weak" level differs from the second "strong" level where context influences both the learning processes and the cognitive processes of decision-making, altering behaviours and encouraging much more sophisticated reasoning than that observed in abstract situations. Cooper and Kagel (2003) concluded that introducing contextual elements into protocols by means of a "weak" contextual effect is likely to allow behaviours to converge more quickly on the equilibrium observed in the protocols where these contextual elements do not exist.

1.2 Breaking context down into four attributes

The literature presented above highlights the importance to experiments of the effect of context on participants' behaviour. The decisions taken by the players are based on social and ethical representations of the problems submitted to them. These representations depend on the context in which the agents are placed, i.e. the information available to them. Certain authors, such as Loewenstein (1999), recommend not attempting to eliminate every contextual reference in the protocols, instead endeavouring to understand the influence of context on behaviour. To this end, investigators should go beyond the usual methodological standards in constructing their protocol in order to reflect reality more accurately, either by giving the players the ability to communicate (Cooper et al., 1989), or by selecting samples of players which are more representative of society

(Harrison and List, 2004), or by introducing a less abstract informational content in the instructions given to the players (Wang, 1996).

The assessment of the influence of each of these different elements on the players' representations is likely offer a better understanding of the decision-making processes in an experimental situation. An improved knowledge of the effects produced by the introduction of contextual elements helps to target the construction of contextualised protocols more effectively and thus to improve the quality of experimental results, particularly their external validity, i.e. the capacity to extrapolate the observations made in the experimental conditions with regard to reality (Loewenstein, 1999).

In EE, the context is more often than not reduced to the information provided in the instructions and its effect is limited to the "framing effect", the definition of which resulting from the works of Tversky and Kahneman (1981) is that a minimal change in the description of the same decision-making problem can lead to a reversal of the players' preferences.

To answer our research question about the influence of context on players' behaviour, we argue that it is relevant not to limit the definition of a game context to this single aspect, but rather to consider it more broadly in terms of information conveyed in the protocol and characterised by:

- ***the information that players accumulate during the game session*** referring to the repetition of periods in a session and the subsequent *learning effect* that this can produce on players;
- ***the information provided to the players*** through the game instructions, or information flows from the scientist to the players;
- ***the information exchanged among the players*** by means of communication, or shared information;
- ***the information already in possession of the players*** referring to the players' experience.

Scientists exercise considerable control over the information given to the players, and by limiting the periods of a session to one (one-shot games) or few they can reduce to the minimum the *learning effect*. The information in possession of the players can be partially controlled by the selection of homogeneous groups of participants (e.g. students) to a game session, while the information exchanged among players can be observed through methods that constrain communication (cf. below).

Breaking down the context of a game, interpreted as a level of information, enables us to identify four elementary dimensions or attributes:

1. The first attribute – **"REPETITION"** – takes into account the progression of the periods which contributes to the *learning process*, i.e. the accumulation of information during the game leading to increased knowledge. By accumulating information, a player can change his behaviour in order to adapt to the characteristics of the game and the decisions taken by his partners (Roth and Erev, 1995; Hertwig and Ortmann, 2001). One shot games do not allow for learning. By repeating the same identical period or by playing a dynamic game (i.e. the situation of the game in period *n* depends on the decisions taken during the *n-1* previous periods), the players can accumulate information and thus increase their experience.
2. The second attribute – "**ILLUSTRATION"** – is the level of information provided in the instructions. Its influence is examined in the literature via the "framing effect" mentioned previously (Tversky and Kahnemann, 1981; Kuhberger and Tanner, 2010).
3. The third attribute – **"COMMUNICATION"** – considers the fact that when they are assembled in groups in which individual decisions affect the collective results, players can share information.

This exchange can take place in person or using IT media (audio, video or messenger) and causes a change in the way the players understand the game, irrespective of whether it is improved or disturbed (Cardenas, 2003; Carpenter et al., 2004; Ostrom, 2006). This attribute can be controlled: the minimum level is obtained in the laboratory by isolating the players in compartments (no visual contact) and preventing them from speaking to each other. In these conditions, the only exchange is a signal sent (at the end of each period) by each player summarising the decisions taken by him.

4. Finally, the fourth attribute – **"EXPERIENCE"** – considers the level of information acquired by the player before he joins the game. Experience influences the player's interpretation of the information provided in the instructions, exchanged with his partners and acquired during the repetitions (Gilboa and Schmeidler, 1997; Harrison and List, 2004).

This analytical framework composed of four dimensions of the context (Figure 1), which we call RICE from the initials of each attribute, can be used to test in the laboratory the causal impact that each dimension has on players' behaviour.

In fact, each attribute of the context contributes to the complexity of the protocol. The experimental methodology allows isolating each of these attributes and assessing their influence on the players' behaviours. Based on the fact that an experimental protocol can have different levels of contextualisation (Wang, 1996; Harrison and List, 2004), the impact of each of these attributes can be tested separately using the same protocol. Comparing the results obtained in this way enables assessing the impact of the four dimensions of context on players' behaviour.

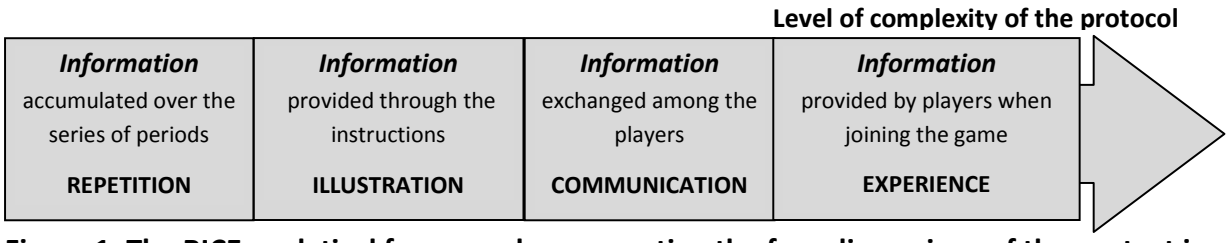

Figure 1. The RICE analytical framework representing the four dimensions of the context in a protocol

2. Coordination in a cooperative game theory set-up

2.1 Origins of our experiment

According to Colman (2006), "A coordination game is an interactive decision in which two or more players have a common interest in coordinating their actions and their expectations of one another's actions". Following this definition, a coordination game can be something different from the class of competitive games with multiple pure strategy Nash equilibria in which players choose the same or corresponding strategies.

Our experimental protocol is based on a coordination game derived from the degradation[1] of a RPG called "KatAware" (Farolfi and Rowntree, 2007), designed and used within a Companion Modelling (Bousquet et al., 2011) project in South Africa to deal with the allocation of water resources in a catchment area. Based on some regularities observed during the RPG sessions and referring players' behaviour to Cooperative Game Theory (CGT), a Transferable Utility (TU) CGT model (Dinar et al., 2008) was implemented. The resulting 3-player coordination game where players can choose among

[1] For more information on this approach, cf. Désolé (2011).

a discrete number of options for payoff allocation in a super additive framework is based on the model by Dinar et al. (2008) and allows verifying whether players behave following the CGT theoretical reference, i.e. on the basis of the common advantage, coordinate their actions and reallocate among them the payoff obtained together in an efficient and equitable way.

The solutions of such a game can be presented in the form of a set of allocations complying with certain conditions. Among these solution sets, the *core* (Gillies, 1953) consists of several elements satisfying both the conditions of coalitional rationality and of efficiency, which guarantee the superadditivity[2] of the game and satisfy the conditions of rationality (individual and coalitional). If the *core* consists of several allocations, the players are asked to choose the one which seems the most equitable. Several single solution concepts are proposed by CGT to identify a solution from the set proposed: the nucleolus, the kernel, the "T-value" and the Shapley value. The Shapley value (1953) is calculated for each player according to his participation in the grand coalition, evaluated by means of the average of his marginal contributions to each of the coalitions of which he is a member. The unit to be taken into consideration for the calculation, therefore, corresponds to what a player contributes to a coalition by joining it. According to the Shapley value, the amount that player *i* gets given a coalitional game (v,N) is:

$$\Phi_i(v) = \sum_{S \subseteq N \setminus \{i\}} \frac{|S|!(n-|S|-1)!}{n!}(v(S \cup \{i\}) - v(S))$$

Where *n* is the total number of players and the sum extends over all subsets *S* and *N* not containing player *i.* All other terms refer to note 2.

2.2 The coordination set-up

Our objective was not to observe the coordination process itself but rather to test hypotheses that relate to the impact of introducing the contextual elements presented in the RICE framework on the decisions taken by players. As one of those contextual dimensions is represented by the information that players accumulate over a game session (Repetition), we needed to repeat easily a certain number of periods in a controlled environment using the same players. For this reason we adopted a 3-player game like Rapoport and Kahan (1976) did, but with a different game structure.

Games in which it is possible to create partial coalitions, such as that of Rapoport and Kahan (1976), require very long time frames. In our protocol, the 3 players automatically play together at the start of each period (i.e. the grand coalition was assumed as a given[3]). Partial coalitions[4] are not played and the information concerning them is provided to players for the purpose of mutual information only.

The structure of our cooperative game is presented in table 1.

[2] Where *N* is a finite set of n players (or "grand coalition") in a game with transferable utility, *S* and *T* are subsets of *N* (or sub-coalitions with $S \cap T = \emptyset$) and $v(S)$ is the payoff obtained by the coalition *S*. A game is superadditive if for all coalitions *S* and *T* included in *N*, $v(S \cup T) \geq v(S) + v(T)$.

[3] As the game is superadditive, it is a necessary consequence of the hypothesis of player rationality.

[4] The instructions avoid the term "coalition", which is referred to as an "association" or "group". Cf. the detailed instructions in the annex.

Each member of the group remains independent	Player ***A*** earns **75,000** ecus Player ***B*** earns **100,00**0 ecus Player ***C*** earns **200,000** ecus
Players *A* and *B* work together	The association ***A-B*** earns **175,000** ecus Player *C* earns 200,000 ecus
Players *A* and *C* work together	The association ***A-C*** earns **275,000** ecus Player *B* earns 100,000 ecus
Players *B* and *C* work together	The association ***B-C*** earns **350,000** ecus Player *A* earns 75,000 ecus
The 3 members of the group work together	The association ***A-B-C*** earns **500,000** ecus

Table 1. Structure of the cooperative game

As this CGT TU 3-player game structure is superadditive following the definition provided above, the players have a real incentive to cooperate within the grand coalition.

The terminology of CGT defines the payoffs allocation as a function $x = (x_1, \ldots, x_n) \in R^N$. The allocation choices therefore belong to the continuous space R^N. In order to ensure that our protocol is more playable (in particular to overcome the absence of communication between the players), different choices for the grand coalition's payoff allocations are proposed using cards, among which at each period the players must choose the allocation they prefer. The use of cards represents a discretisation of the choices, breaking the condition of continuity of cooperative games and therefore making our protocol rather a coordination game. The agreement among players is underpinned by the unanimity rule: if three players all coordinate together on the same card, the corresponding amounts are allocated; if not, each one receives the gain associated with the players playing as singletons (status quo).

The seven proposals (cards) of payoff allocation are as follows:

	Card 1	Card 2	Card 3	Card 4	Card 5	Card 6	Card 7
Player *A*	498,000	117,000	1,000	100,000	166,666	1,000	75,000
Player *B*	1,000	142,000	1,000	150,000	166,666	498,000	100,000
Player *C*	1,000	241,000	498,000	250,000	166,666	1,000	200,000

Table 2. Cards available to the players: amounts in ecus

The numbering on the cards, randomly chosen, is set to be identical for each treatment of the protocol described in the following section. Card 7 does not propose a distribution of the grand coalition's payoff, instead offering the *status quo* that leaves the players with the payoff that they get remaining singletons. Choosing card 7 means choosing non-cooperation, being it explicit or non-intentional following the failure of the group members to coordinate. Cards 1 to 6 are based on different criteria of the distribution of the 500,000 ecus of the grand coalition [5]. These criteria are explained below.

[5] Players must coordinate themselves (i.e. choose the same card) to reach a consensus for the allocation of the grand coalition payoff. However, players can be willing to stay in the grand coalition, but they can have different ideas in

- "Selfish" criterion: **cards 1, 3 and 6**

A player proposes to leave only the minimum (1,000 ecus) to his partners in the grand coalition and to keep the rest, i.e.:

$$v(ABC) - 2 * 1{,}000 = 500{,}000 - 2{,}000 = 498{,}000 \text{ ecus}$$

This selfish choice is independent of the role and values received as a singleton. Each player can therefore choose to be selfish, hence the fact that three symmetrical cards are proposed, each one favourable to one of the three players. These cards propose a very unfair allocation of the grand coalition payoff to the advantage of the proponent. It could be interpreted as a provocative choice, not really aiming at preserving the coalition.

- "Strict egalitarian" criterion: **card 5**

The egalitarian criterion often appears in the results of economic experiments, although it is not provided for by the theory for which the hypotheses are tested. Gamson (1964) proposes an egalitarian (or anti-competitive) theory which hypothesises that, rather than attempting to maximise their utility function, the players within a coalition attempt to minimise conflicts to maintain the social link within the group. In the case of super-additive games, egalitarian sharing of the grand coalition's payoff is the ultimate form of anti-competitive sharing. Card 5 is designed as follows:

$$1/3 * v(ABC) = 500{,}000 / 3 = 166{,}666.67 \text{ ecus}$$

Each player in the grand coalition receives exactly the same amount rounding down to the nearest ecu, where x_i = 166,666 ecus[6]. The condition of individual rationality is not respected. Player *C* receives an allocation of x_C = 166,666 ecus, less than $v(C)$ = 250,000 ecus. This allocation is not in the *core* and therefore is not expected as an outcome by the CGT.

- "Intermediate egalitarian" criterion: **card 2**

Gamson (1964) considers that strict egalitarian sharing is excluded from superadditive games in which the initial endowments are unequal, because the potential appearance of conflicts of interest is high. Supposing that coalitions form "along the lines of least resistance" (Gamson, 1964), we can consider that the line of resistance for each player, corresponds to the payoff received when that player operates as a singleton. An intermediate form of the anti-competitive theory may demonstrate the criterion of egalitarian sharing beyond these lines of resistance, i.e. an equal division of the surplus of the grand coalition (in relation to the situation where players are singletons). Card 2 is designed as follows:

The sum of the payoffs received when the players operate as singletons is:

$$v(A) + v(B) + v(C) = 375{,}000 \text{ ecus}$$

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terms of payoff allocation. In particular, some cards (i.e. 1,3 and 6) propose an allocation plan that is clearly representative of a willingness to break the grand coalition. The choice of these cards would then show that, despite the superadditivity of the game, a player has either not understood the interest of cooperation or is not prepared to coordinate his efforts with the others.

[6] The sum of the shares of the grand coalition distributed to the players is thus equal to 3 * 166,666, i.e. 499,998 ecus. We consider that the difference of 2 ecus between the sum of the shares actually allocated by card 5 and the payoff of the grand coalition is negligible: the difference of 2 ecus represents 0.0004% of the 500,000 ecus of the grand coalition.

The surplus of the grand coalition in relation to the singletons situation is the difference between the two situations:

$$\Delta = v(ABC) - 375{,}000 = 125{,}000 \text{ ecus}$$

The surplus is shared equally between the 3 players, i.e. Δ / 3 = 125,000 / 3 = 41,666 ecus each, in addition to the payoff obtained in the singletons situation.

Player *A* will receive $v(A)$ + 41,666 = 116,666 ecus rounded up to x_A = 117,000 ecus.

Player *B* will receive $v(B)$ + 41,666 = 141,666 ecus rounded up to x_B = 142,000 ecus.

Player *C* will receive $v(C)$ + 41,666 = 241,666 ecus rounded down to x_C = 241,000 ecus.

The allocation of card 2 complies with the conditions of efficiency, individual rationality and coalitional rationality; it is located in the *core* and therefore is an expected outcome in terms of CGT.

- "Equitable and efficient" criterion according to the Shapley value: **card 4**

We have already seen that the Shapley value is calculated for each player on the basis of his participation in the cooperation, evaluated by means of the average of his marginal contributions to each of the coalitions of which he is a member.

The allocation $x = (x_A, x_B, x_C)$ of card 4, calculated according to the Shapley criterion $\phi = (\phi_A, \phi_B, \phi_C)$, takes into account all the levels of cooperation (singletons, partial coalitions and grand coalition) and complies with the conditions of efficiency, individual rationality and coalitional rationality; it is located in the *core* and therefore is an expected outcome in terms of CGT.

3. The experimental protocol

3.1 Treatments

The protocol is designed on the basis of the coordination game presented in the previous section to a) capture the different dimensions of the context defined in the RICE analytical framework: repetition (facilitating the learning process), illustration, communication, and experience, and b) measure the causal impact of each dimension (explanatory variables) on participants' behaviour.

As the causal stimulus of our experiment is represented by the introduction into an abstract[7] protocol (control, coded here as 0.0) of the four dimensions of context presented in section 1, we built different treatments containing these dimensions and contrasted the outcomes of the treatment groups with those of the control group.

The possible emergence of a *learning effect* due to the accumulation of information during the session was tested through the *repetition* within each treatment (including the control) of 15 periods, each player retaining his role in the same group of 3 subjects during the whole treatment ("partner" mode). The effect of *illustration* was tested by contrasting the outcome of the control (0.0) first with the results of treatments illustrated in an elementary manner by means of a single phrase ("the experiment focuses on a problem of water resource management") (treatment 0.1), then by a narrative explaining the sources of heterogeneity of the individual gains in the water sector (different productivity of water – treatment 0.2), and finally by a narrative explaining the sources of heterogeneity in the industrial sector (different seniority of employees – treatment 0.3). The effect of

[7] We call the control "abstract" in contrast with the "contextualized" treatments, which are characterized by the introduction of various attributes of context.

communication was tested allowing the players to exchange information[8] before periods 1, 6 and 11 in a non-illustrated treatment (1.0) and in the most illustrated treatment in the water sector (1.2).

Two important aspects are worthwhile noticing at this stage: first, as we deal with university students and not with expert subjects, the "E" dimension of our RICE framework is not explored so far, and consequently we can rename RIC the framework used for this specific experiment. Second, the R dimension is present in all treatments including the control starting from period 2. The treatment 0.0 is therefore the control only at period 1, as only at this stage all the RIC dimensions are absent.

3.2 Hypotheses

Following CGT, players facing a superadditive situation coordinate their choices, stay in the grand coalition and choose to share the resulting payoff following the Shapley value (most efficient and equitable solution). In the control (0.0) at period 1, without illustration, communication and prior to any repetition, we might expect a certain consensus around this theoretical solution. Our experiment then tests first whether theoretical expectations are confirmed in the control (0.0 at period 1).

All the following hypotheses to be tested in the experiment concern the progressive introduction of context dimensions (RIC) through treatments.

Repetition should allow a *learning effect* in players (Cooper and Kagel, 2003). This effect changes player's behaviour in the direction of an improved respect of the theoretical expectations (Andreoni, 1995; Laury et al., 1999) (**H0**). Introducing an illustration is likely to cause greater uncertainty concerning the choices made (Babcock et al., 1995; Binmore, 1999). Adding this contextual dimension in the experiment creates *noise* that increases the dispersion of players' responses in selecting a payoff allocation mechanism if compared to the control (**H1**). This *noise* increases as the illustration of context becomes richer (**H2**). The *noise* does not depend on the specific content of the illustration (**H3**). As communication should facilitate coordination (Brosig et al., 2003; Bochet et al., 2006), we can make the hypothesis that communication does operate a contrary effect to refocus the choices on a preferred payoff allocation configuration (**H4**).

3.3 Experimental conditions

The participants in the sessions were chosen from a database of subjects containing the third-year students enrolled at the universities in Montpellier and provided by the Laboratory of Experimental Economics in Montpellier (L.E.E.M.). We consider that the samples are homogenous and consist of subjects with the same experience concerning the context studied. Each treatment brings together 12 groups of 3 players whose role within the group remains the same throughout the game session ("partner" procedure). These players only participate in one treatment to ensure the independence of the results ("between subjects" procedure).

At the start of the session, the instructions (cf. Annex) are provided in printed format. The participants read the instructions individually then the experimenter reads them aloud. The players are given a comprehension test on the computer to check that they have understood the instructions. The rest of the session is managed by computer.

The session takes place over 15 identical periods. For each period, the individual choices and the cards which establish the payoff allocation to the players are displayed on the screen for the members of the group (but not the results of the other groups) before starting the subsequent

[8] Information was exchanged by players through "constrained communication", inspired by the "Numerical Cheap Talk (NCT) communication" used by Bochet et al. (2006). Details on the adoption of this method can be found in Désolé (2011).

period. The learning process during the successive sessions therefore relates to the preferences of the other players in the group and can be conducive to attempting to coordinate with regard to an allocation (one card, one behaviour in accordance with the expectations of the other members who form these small societies of 3 players).

The players are paid at the end of the 15 periods in accordance with their performance, which depends on the choices they will have made throughout the game, at a rate of €0.6 for 100,000 ecus. For instance, the sum of €3 is distributed to each group of players every time the group succeeds in agreeing on the same means of sharing the 500,000 ecus of the grand coalition.

3.4 Theoretical predictions

Following CGT predictions, in the proposed superadditive set-up participants should coordinate around cards representing payoff allocations situated in the *core*, such as card 4 (Shapley) preferentially, or even card 2 (intermediate egalitarian).

Using the Gately index of "propensity to disrupt the grand coalition"[9], we can predict the interest of the three players in a grand coalition to coordinate around cards 2 and 4 (Tab. 3):

	Card 2	**Card 4**
Player *A*	0.79	2
Player *B*	1.98	1.5
Player *C*	2.05	1.5

Table 3. Gately indices (propensity of players to disrupt the coalition) for the allocations of the grand coalition's payoff in the *core*

In table 3, we observe that the propensity of player *A* (G_A = 2) to disrupt the coalition of card 4 (Shapley allocation) is higher than for players *B* and *C* (G_B = G_C = 1.5). Players *B* and *C* have a high propensity (G_B and $G_C \approx 2$) to disrupt the coalition of card 2 ("intermediate egalitarian" allocation) when that of player *A* is lower (G_A = 0.79). Players *B* and *C* have similar preferences, oriented towards card 4 rather than card 2. The analysis of the Gately indices (in which the payoffs v(N-{i}) of the

[9] Gately (1974) introduced the concept of "propensity to disrupt the grand coalition". He defined this concept as the relationship between: (a) what the other players lose if player *i* chooses not to cooperate and (b) what player *i* loses in this case (i.e. if he refuses to cooperate). If *N* is the grand coalition comprising *n* players, for all $i \in N$, the propensity G_i to disrupt the coalition ($x_1,\ldots,x_n$) can be expressed as follows:

$$G_i = \frac{\sum_{j \neq i} x_j - v(N - \{i\})}{x_i - v(\{i\})}$$

where x_i is the allocation received by player *i* once the payoff *v(N)* of the grand coalition has been shared, *v({i})* is the payoff received by i when it plays as a singleton and *v(N-{i})* is the payoff of the coalition comprising all the players except *i*.

partial coalitions are taken into account) therefore highlights the symmetry of preferences of *B* and *C*, reflecting the fact that the payoff *v*(*BC*) is more advantageous for these two players than the payoffs of the partial coalitions that each one forms separately with player *A* – *v*(*AB*) and *v*(*AC*) respectively.

While player *A* has considerable "power of disruption" in the stability of the choice of card 4, he has less power in the tacit bargaining with players *B* and *C* within the grand coalition due to his weak position in the partial coalitions. Although he prefers card 2, card 4 is not the worst solution for him and this should therefore be the resulting point of coordination, confirming the prediction of cooperative game theory which considers the Shapley allocation (represented by card 4) as the players' preferred allocation.

4. Results

4.1 Measure of the dispersion of players' choices between treatments

The factual effects of the introduction of a variable (attribute of the context) on players' behaviour are measured through the difference between the outcomes (i.e. players' choices of cards proposing different payoff allocations) of the treatment characterized by that variable and the outcomes of the control[10].

The experiment outcomes from the control group (0.0) at period 1 are contrasted first with the results from treatments (0.1, 0.2, 0.3), which introduce progressively *illustration*, and then with the results from treatments (1.0, 1.2), which allow *communication*. The *repetition* of periods in all treatments tests the emergence of a *learning effect*, and therefore outcomes between and within all treatments at periods 1 and 15 are contrasted as well.

As we are examining the distribution of choices and not the individual components thereof, in order to assess the difference between the results of the various treatments (e.g. the causal effects of the studied variables), we favour a Chi-squared test.

If m_1 and m_0 are two distributions of the *n* individuals of a population split into *k* classes *(j=1,2,..k)* in two distinct circumstances (treatments), then:

$$\chi^2(\mathrm{k}\text{-}1) = \sum_{j=1}^{k} \frac{(m_{1j} - m_{0j})^2}{m_{0j}}$$

Where m_{ij} represents the number of individuals in class *j* in the *i* treatment *(i=0, 1). DF=(k-1)* [11].

In our analysis, we only examine the distribution of the choices without distinguishing either the roles allocated to the players (*A*, *B* or *C*) or the failure or success in coordinating within the grand coalitions. In other terms, we observe the players' proposals to coordinate (or not) in order to allocate the grand coalition payoff, we do not analyse the actual coordination that follows. Twelve groups of 3 players took part in each treatment, i.e. 36 players (n). For each treatment, we will therefore analyse the distribution of the 36 choices expressed between the 4 classes of cards (*k*): class 1 (cards 7,1,3,6) corresponding to the refusal to cooperate; class 2 (card 5) corresponding to the allocation strictly egalitarian of the payoff of the grand coalition; class 3 (card 2) corresponding to the

[10] The session conducted with the control group (i.e. in the absence of context attributes) in the text below is called control.

[11] We grouped cards 1, 3, 6 and 7 together because they are based on a similar criterion (refusal to cooperate). Card 7 means in fact a direct and explicit refusal to stay in the grand coalition, while cards 1, 3, and 6 propose a *outrageously* unfair allocation of the grand coalition payoff to the advantage of the proponent, and have therefore no chance to be accepted by the two other players . We therefore have *K* = 4 and thus *K*-1 = 3 degrees of freedom.

intermediate egalitarian allocation of the payoff of the grand coalition (in the *core*); and class 4 (card 4) corresponding to the allocation of the payoff of the grand coalition that follows the Shapley value (in the *core*).

It is worthwhile noticing that the choice to coordinate between players in this protocol takes place at three progressive levels: i) staying in the grand coalition allocating the consequent payoff in a "reasonable", i.e. not selfish, way (cards 2, 4 and 5); ii) choosing a payoff allocation within the *core* (cards 2 and 4); iii) choosing the Shapley value as a payoff allocation criterion (card 4).

4.2 Respect of theoretical predictions in the control group

Before moving into the test of our hypotheses about the influence of context on players' behaviour, we needed to verify whether the theoretical predictions are respected within the control group (0.0).

We therefore checked the distribution of players' choices at period 1, which is the only situation where all dimensions of context following the RICE framework are absent.

Period	Cards / Treat-ment	7,1,3,6	5	2	4
1	0.0	6	22	4	4

Table 4. Control group's choices at period 1[12]

Table 4 shows that 30 players out of 36 choose to coordinate and stay in the grand coalition, but 22, the large majority, choose card 5 (strictly egalitarian) rather than the payoff allocation solutions which reside in the *core* according to CGT.

This result can be interpreted as a *Schelling effect* (Schelling, 1960). The *Schelling effect* consists of the emergence of a *focal point* for the coordinating players far from the theoretical predictions. "A combination of actions may function as a *focal point* if it stands out from others because of some property of prominence or salience that it possesses, even if its distinguishing feature is a psychological or cultural attribute that is filtered out of its abstract representation in orthodox game theory" (Colman, 2006).

In the absence of communication and at the beginning of the sessions, a certain consensus around a sharing mechanism (*focal point*) other than the Shapley value, or even other than a mechanism residing in the *core*, characterised the choices of players.

This important result puts our protocol into a situation where the control does not produce a full convergence of results towards the theoretical predictions (card 4 or even card 2 in the *core*). Subsequently, a dispersion of results in the treatments due to the *noise* provoked by the introduction of contextual dimensions does not necessarily mean an increased distance from the theoretical predictions. It is then possible to find out that the introduction of contextual dimensions influences players' behaviour positively, increasing the convergence of choices towards the theoretical equilibrium rather than decreasing it.

[12] The cards are presented in tables 4 to 11 following the same order as in section 2.2, where they are explained.

4.3 Repetition of periods and *learning effect*

At period 15, players of the control group (0.0) shift their choices from card 5 to cards 4 and 2, while the refusals to cooperate are divided by two (Table 5). This result indicates the existence of a *learning effect* between period 1 and period 15 (confirmed by the high Chi-squared calculated between the two distributions). That learning, in the absence of all other contextual dimensions, increases players' willingness to coordinate their choices around an acceptable allocation of the grand coalition payoff (sum of choices of cards 5, 2, and 4) and facilitates the reach of the theoretical predictions (sum of choices of cards 2 and 4).

We checked whether the same *learning effect* is observable in the other treatments as well. The Chi-squared test shows clearly that the probability that the two distributions of choices at periods 1 and 15 are different is 100% or close in all treatments, confirming the existence of a *learning effect* also when illustration and communication are introduced. **This result would confirm H0**[13]**.**

Period	Cards / Treat-ments	7,1,3,6	5	2	4	χ^2	Prob
1	**0.0**	6	22	4	4	51.29	**1.000**
15	**0.0**	3	10	6	17		
1	**0.1**	8	22	1	5	76.68	**1.000**
15	**0.1**	8	9	9	10		
1	**0.2**	3	23	6	4	18.42	**0.999**
15	**0.2**	3	12	11	10		
1	**0.3**	3	23	7	3	14.59	**0.997**
15	**0.3**	1	15	15	5		
1	**1.0**	4	19	1	12	37.89	**1.000**
15	**1.0**	6	6	6	18		
1	**1.2**	7	16	7	6	35.15	**1.000**
15	**1.2**	1	5	17	13		

Table 5. $\chi^2(3)$ test and players' choices at periods 1 and 15 of all treatments

The fact that the university students share an industrial culture rather than the culture of the irrigators, might be at the origin of the very marked *Schelling effect* at period 15 in treatment 0.3, with choices focusing on the "egalitarian" proposals (i.e. card 5 and card 2, together representing 83% of the choices) to the detriment of card 4 (Shapley).

[13] Notice that in an experiment where 0.0 at period 1 produces results in line with the theoretical predictions, H0 is expected to be rejected.

4.4 Illustration

To evaluate the "pure" illustration effect (without learning, without communication), we compared the distributions at period 1 between the control (0.0) and the illustrated treatments without communication (0.1, 0.2 and 0.3).

Period	Cards / Treat-ments	7,1,3,6	5	2	4	χ^2	Prob
1	0.0	6	22	4	4	3.16	0.633
	0.1	8	22	1	5		
1	0.0	6	22	4	4	2.54	0.532
	0.2	3	23	6	4		
1	0.0	6	22	4	4	4.04	0.743
	0.3	3	23	7	3		

Table 6. $\chi^2(3)$ test at period 1 between treatments (0.0) and (0.1), (0.2), (0.3)

The low Chi-squared statistics (Tab. 6) show that there is very little difference in the distribution of players' choices between the control and the illustrated treatments. The "pure" illustration effect is therefore very weak. The players focus their decisions on card 5 irrespectively of the illustration provided (or not) in the instructions. "Pure" illustration does not have a sufficiently strong effect on the decisions to correct the *Schelling effect* observed in the abstract treatment (0.0) in favour of card 5 (egalitarian). **This result would reject H1**[14] as no *noise* provoked by the illustration seems to influence the outcomes of treatments 0.1, 0.2 and 0.3 at period 1.

Period	Cards / Treat-ments	7,1,3,6	5	2	4	χ^2	Prob
1	0.1	8	22	1	5	28.37	1.000
	0.2	3	23	6	4		
1	0.2	3	23	6	4	0.41	0.063
	0.3	3	23	7	3		

Table 7. $\chi^2(3)$ test at period 1 between treatments (0.1)-(0.2) and between treatments (0.2)-(0.3)

Comparing the results of treatments (0.1) and (0.2) allows **confirming H2**, as the significant Chi-squared between the outcomes demonstrates that *noise* increases as the illustration of the same context becomes richer. On the other side, there is no significant difference between the outcomes of treatments (0.2) and (0.3), showing that the increase in *noise* does not depend on the specific

[14] Notice that in an experiment where 0.0 at period 1 produces results in line with the theoretical predictions, the confirmation of H1 would correspond to a dispersion of treatments' outcomes far from the allocations in the *core*.

content of the illustration, which moves in the experiment from a water-related problem (0.2) into an industry-related problem (0.3). This would **confirm H3**.

The result is different when the illustration effect is combined with the *learning effect* resulting from repetition of periods. Showing this combined effect is possible through the comparison of the distribution of choices in period 15 for (0.0) and (0.1).

Period	Cards / Treat-ments	7,1,3,6	5	2	4	χ^2	Prob
15	0.0	3	10	6	17	12.81	0.994
	0.1	8	9	9	10		

Table 8. $\chi^2(3)$ test at period 15 between treatments (0.0)-(0.1)

At the end of the session even a very light introduction of context in the protocol (the phrase "the experiment focuses on a problem of water resource management") creates a *noise* and a consequent significant change in the behaviour of players captured by a relatively high Chi-squared at period 15.

4.5 Communication

To measure the "pure" communication effect (without illustration, without learning), we compare the distribution of choices at period 1 of the control with the treatment non illustrated but allowing communication (1.0) (Tab. 9).

Period	Cards / Treat-ments	7,1,3,6	5	2	4	χ^2	Prob
1	0.0	6	22	4	4	19.32	0.999
	1.0	4	19	1	12		

Table 9. $\chi^2(3)$ test at period 1 between treatments (0.0)-(1.0)

If we allow the subjects to exchange ideas, we observe a significant communication effect as early as at period 1. The choice of an egalitarian allocation (card 5) remains high, but there is an increased preference for the Shapley allocation (card 4) from the very first round. The refusals to cooperate also reduce from 6 to 4.

Period	Cards / Treat-ments	7,1,3,6	5	2	4	χ^2	Prob
15	0.0	3	10	6	17	4.65	0.801
	1.0	6	6	6	18		

Table 10. $\chi^2(3)$ test at period 15 between treatments (0.0)-(1.0)

At period 15 of a non illustrated treatment, communication seems to have exhausted its effect (Tab. 10). The distribution of players' choices does not differ whether it is in the presence of communication or not. It is like if communication just speeds-up the reach of the theoretical prediction.

Let us now consider the effect of introducing communication in an illustrated treatment. This is possible by comparing treatments (0.2) and (1.2) (Tab. 11).

Period	Cards / Treat-ments	7,1,3,6	5	2	4	χ^2	Prob
1	0.2	3	23	6	4	8.63	0.965
	1.2	7	16	7	6		
15	0.2	3	12	11	10	9.58	0.977
	1.2	1	5	17	13		

Table 11. $\chi^2(3)$ test at periods 1 and 15 between treatments (0.2)-(1.2)

We observe that distinct distributions of players' choices exist both at periods 1 and 15, showing the effect of communication. The probability that distributions follow the same law is rejected at the 5% level.

The results presented in Tab. 11 show that communication has an effect when introduced in illustrated treatments. But does this effect represent a *noise* as defined by Babcock et al. (1995), i.e. a disruption of the participants' behaviour observed in the absence of all context attributes? Figures presented in table 9 answer positively for period 1, while if we compare the distribution of players' choices at period 15 in treatment (1.2) and in the control we get a Chi-squared of 24.2, which is higher than the Chi-squared (7.4) resulting from the comparison at period 15 between treatment (0.2) and the control. Communication therefore amplifies and does not reduce the *noise* produced by the pure illustration on the control. **This conclusion would reject H4**[15].

4.6 Combined effects of contextual attributes

In an experiment where the control at period 1 produces results in line with the theoretical predictions, the study of the combined effects of contextual attributes is relatively straightforward, as repetition does not need to produce a *learning effect* to make the players converge towards theoretical predictions, while the *noise* increases the distance between the treatments' results and the theoretical predictions.

In our experiment the control did not produce results in line with the theoretical predictions, and as a consequence the *learning effect* produced by repetition was important in changing the behaviour of players in the direction of the theoretical predictions. At the same time, the *noise* could have both effects of increasing or reducing the distance between the treatments' outcomes and the theoretical predictions.

[15] Notice that in an experiment where (0.0) at period 1 produces results in line with the theoretical predictions, the rejection of H4 would correspond to a dispersion of results in (1.0) and (1.2) if compared to the theoretical predictions. In the presented case, vice versa, the rejection of H4 corresponds to a convergence of results in (1.0) and (1.2) towards the theoretical predictions.

The combined effect of the contextual attributes was therefore more articulated. At period 1, for instance, the combination of illustration and communication (Tab. 11, first two rows) produced a *noise* and at the same time allowed a slight convergence of results towards the theoretical predictions (choice of cards 4 and 2 in the *core*).

When repetition was introduced (at period 15), the *learning effect* was clear in all treatments (Tab. 5). However, the combination of the *learning effect* with the effects of illustration (Tab. 8) and communication (Tab. 10) showed that communication had a lower influence than illustration in terms of *noise* creation (low Chi-squared) and a higher influence in terms of convergence towards theoretical predictions (less refusals to stay in the grand coalition, more choices of cards in the *core*).

These results were confirmed by the outcomes presented in Tab. 5, where the strongest *learning effect* (highest Chi-squared) was observed either in the abstract treatment (0.0) or when minimum illustration was provided (0.1), while the weakest *learning effect* (lowest Chi-squared) corresponded to the illustrated treatments without communication (0.2 and 0.3). Conversely, the best convergence towards theoretical predictions (highest choice of cards in the core) corresponded to the treatments where communication was allowed (1.0 and especially 1.2, where the combined effect of repetition, illustration and communication coexists), while the worst convergence was in presence of illustration alone (0.1, 0.2, and 0.3).

Our experiment, while confirming the production of *noise* (Babcock et al., 1995) through the introduction of contextual attributes in treatments, seems therefore to corroborate the hypotheses made by Faravelli (2007) and Loewenstein (1999) that context provides players with indicators enabling them to behave in accordance with a common representation of this context. According to Cooper and Kagel (2003), when learning processes are allowed, a "weak" contextual effect would also allow behaviours to converge more quickly towards theoretical predictions. In our experiment, however, illustration (which often in EE is the only context considered) proved to have lower effect than communication in terms of accelerating learning processes.

5. Conclusion

The objective of this paper was twofold. We aimed first to provide a framework for the analysis of contextual components in an economic experiment. Then, based on the mentioned framework, we wanted to find out quantitatively and objectively whether and how the context has a causal impact on players' behaviours.

To do so, an experimental protocol based on a 3-player CGT TU game modified into a coordination game to improve its playability was constructed. The game is about the grand coalition payoff allocation among players in two different situations: one about water and another about an industrial context. Several treatments referring to the first three contextual attributes of the four (Repetition, Illustration, Communication, and Experience) included in the proposed analytical framework were designed and implemented in the laboratory to isolate the causal effect of each attribute on players' behaviour.

We wanted to test the following hypotheses: Repetition determines a *learning effect* (H0); Introducing an illustration increases the *noise* in terms of experiments' outcomes, i.e. the dispersion of these outcomes in the treatments w.r.t. the control (H1); This *noise* grows as the illustration of the same context becomes richer (H2); The increase in *noise* does not depend on the specific content of the illustration (H3); Communication does operate a contrary effect to refocus the choices on a preferred payoff allocation configuration (H4).

Results from the experiment confirmed H0, rejected H1, showing that illustration alone does not produce a significant *noise* in terms of treatment's outcomes. H2 and H3 were confirmed, as more illustration was positively correlated with higher dispersion of outcomes w.r.t. the control, while the

specific topic of the illustration did not seem to influence that dispersion. H4 was also rejected as communication did not seem to be able to reduce the *noise* produced by illustration, but rather increased it.

In our experiment the control did not produce results in line with the theoretical expectations (Shapley value, or even a payoff allocation residing in the *core* of the efficient and rational allocations), but rather a convergence to a *focal point* (*Schelling effect*) represented by the coordination towards an egalitarian allocation of the grand coalition payoff (card 5). This fact allowed interpreting the results of the treatments from two different perspectives, otherwise merged into the same criterion: 1) the production of *noise* (i.e. the increased dispersion of results in the treatments w.r.t. those of the control), and 2) the convergence of outcomes towards theoretical predictions.

In the absence of repetition, the combination of illustration and communication produced *noise* and allowed at the same time a slight convergence of results towards the theoretical predictions. When repetition was introduced, the *learning effect* was clear in all treatments. However, communication had a lower influence than illustration in terms of *noise* creation and a higher influence in terms of convergence of outcomes towards theoretical predictions.

These results contribute shedding some light, although partially, on the general problem of the quantity and quality of context that are "good" for both experimental protocols and RPGs in order to reach the acceptable compromise between internal and external validity in both disciplines.

It is clear that the results of the present work cannot be generalized, but they represent an initial step in the direction of the interpretation of the causal impacts that selected attributes of the so-called context have on players' behaviour, both in EE and in RPGs.

Among the substantial caveats still remaining and that should be approached in future works in this field, it can be mentioned the relative limited number of observations in the laboratory, which might affect negatively the statistical representativeness of the results obtained. This is also due to the relatively complex and long protocol (repetition of 15 periods for every treatment), which could be reduced to a "one shot" experiment in the future. The number of cards from which to choose the allocation of payoff could also be limited in order to speed and facilitate the interpretation of results.

It is important to notice, finally, that the RICE framework was only partially implemented so far, as the experiments were conducted in the laboratory with university students and not in the field with expert subjects. The "E" for Experience will therefore be approached only when field experiments involving real stakeholders (e.g. farmers for the water problem) will take place.

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Annex

Instructions to players

Control (0.0)

The experiment you will participate is part of a study on decision-making. The instructions are simple. If you follow them and if you take good decisions, you will earn a non-negligible amount of money. All your answers are anonymous and are collected by a computer. You will indicate your choices through a computer in front of you and your earnings will be displayed on the screen. The amount of money you will earn will be provided to you in cash at the end of the experiment.

1) General framework of the experiment

There are 18 participants in the room. At the beginning of the experiment the central computer will randomly gather you in 6 three-person groups. The setting-up of the groups will remain identical along the experiment. You cannot identify the other members of your three-person group and the two others cannot identify you. The experiment will last 15 identical periods.

Your earnings will depend on your own decisions and at the same time on the decisions the two other members of your group will make. Each decision will allow you to earn *ecus*. All the *ecus* you will earn will be changed in *euros* and you will receive them in cash at the end of the experiment. The *ecus-euros* exchange rate is detailed at the end of these instructions.

2) Situations

At the beginning of the experiment, the central computer will assign a role to each member of the group. Then, one member will play role A, another role B and the last role C. In the instructions below, “player A” will designate the participant to whom role A is allocated, “player B” the person to whom role B is assigned and “player C” the one who assumes role C. Each member will know his role at the beginning of the experiment. Everyone keeps the same role along the experiment.

Within each group, three situations are possible:

(i) Each member remains independent,
(ii) One member associates with another while the third member remains independent,
(iii) The three members are associated.

The earnings of the members or the earnings of the association change following the situation as stated in table 1.

Situation	Earnings
Each member remains independent	Player A earns 75 000 ecus Player B earns 100 000 ecus Player C earns 200 000 ecus
Players A and B are associated	The association A-B earns 175 000 ecus Player C earns 200 000 ecus
Players A and C are associated	The association A-C earns 275 000 ecus Player C earns 100 000 ecus
Players B and C are associated	The association B-C earns 350 000 ecus Player C earns 75 000 ecus
The three members are associated	The association A-B-C earns 500 000 ecus

Table 1 – The earnings according to the different situations

In the experiment, only situations (i) and (iii) are considered.

3) Decisions

At each period you must choose one card among the 7 presented in table 2. Each card displays the earnings of each member of the group depending on his role (A, B or C).

Note that cards 1 to 6 refer to situation (iii) while card 7 refers to situation (i).

	Card 1	Card 2	Card 3	Card 4	Card 5	Card 6	Card 7
Player A	498 000	117 000	1 000	100 000	166 666	1 000	75 000
Player B	1 000	142 000	1 000	150 000	166 666	498 000	100 000
Player C	1 000	241 000	498 000	250 000	166 666	1 000	200 000

Table 2 – The seven cards

If the three players choose the same card, they earn the corresponding amounts; otherwise, it is like card 7 was chosen by all.

Example 1:

Player A chooses card 7, player B chooses card 5 and player C chooses card 5. The three members of the group do not choose the same card, therefore card 7 is implemented in the group. Player A earns 75 000 ecus, player B earns 100 000 ecus and player C earns 200 000 ecus.

Example 2:

Player A chooses card 1, player B chooses card 1 and player C chooses card 1. The three members of the group choose card 1, therefore this card is implemented. Player A earns 498 000 ecus while players B and C earn 1 000 ecus.

4) The sequence of a period

All the periods are identical. At the beginning of a period, the decision page is displayed on the screen in front of you. You must choose one card among the seven proposed. When all participants have made their decision, a new page appears in the screen which summarizes the following information:

- The card you have chosen and the card your two partners in the group have chosen,
- The card which is implemented for the group,
- Your earnings for the period.

The bottom part of the screen displays the history of the periods, i.e. the summary of the choices made during the previous periods and the cumulative earnings from the beginning of the session. The history of the periods is available from the decision page by clicking on the button “history”.

5) Last details

At the end of period 15, your complete earnings will be displayed on your screen and will be expressed in ecus and in euros, knowing that the exchange rate is 100 000 ecus = 0.6 euros. Then, if you earned 2 500 000 ecus through the experiment, you will leave the room with 15 euros in cash.

Treatment (0.1)

In treatment 0.1, only one sentence is added to the instructions at the beginning of section 2 to distinguish them from the instructions distributed to the players in treatment 0.0. Then, in treatment 0.1 section 2 starts as follows:

(…)

2) Situations

The experiment is articulated around a water management issue

(…)

Treatment (0.2)

In treatment 0.2, a story was added to the instructions to distinguish them from the instructions distributed to the players in treatment 0.1. The particular sentence added in treatment 0.1 is maintained. Moreover, players are identified as farmers; every word "player" is substituted by the word "farmer" in tables 1 and 2 and in the two examples.

In treatment 0.2, introduction and sections 1, 4 and 5 remain identical. Only sections 2 and 3 change and become as follows:

(…)

2) Situations

The experiment is articulated around a water management issue

You and the two other members of your group are irrigator farmers, meaning that you can irrigate your crop. Water is essential for your production. Water is naturally provided by rain, but irrigation allows you to provide additional water to your crop in order to improve the development of the plant and then to get better yields. Without additional water your production is weaker and therefore your income is lower.

The available water for irrigation is stored in a dam and you share it with the two other farmers of your group. The quantity of water stored in the dam is not sufficient to allow optimal irrigation for the three cultivated surfaces (your surface and the ones of the two other farmers).

An irrigation scheme is implemented. It allows you to build associations of farmers in order to optimize the use of irrigation water from the dam.

You and the two other farmers in your group get the same cultivated surface but with different yields. At the beginning of the experiment, the central computer will assign a **yield (A, B or C)** to each member of the group. Then, one member will **have the yield** A, another the **yield** B and the last the **yield** C. In the instructions below, **"farmer A"** will designate the participant to whom the **yield** A is allocated, **"farmer B"** the person to whom the **yield** B is assigned and **"farmer C"** the one who assume the **yield** C. Each member will know **whether he is farmer A, B or C** at the beginning of the experiment. Everyone keeps the same role along the experiment.

Within each group, three situations are possible:

(i) Each member remains independent,
(ii) One member associates with another while the third member remains independent,
(iii) The three members are associated.

The earnings of the members or the earnings of the association change following the situation as stated in table 1.

Situation	Earnings
Each member remains independent	***Farmer*** A earns 75 000 ecus ***Farmer*** B earns 100 000 ecus ***Farmer*** C earns 200 000 ecus
Farmers A and B are associated	The association A-B earns 175 000 ecus ***Farmer*** C earns 200 000 ecus

Farmers A and C are associated	The association A-C earns 275 000 ecus ***Farmer*** C earns 100 000 ecus
Farmers B and C are associated	The association B-C earns 350 000 ecus ***Farmer*** C earns 75 000 ecus
The three members are associated	The association A-B-C earns 500 000 ecus

Table 1 – The earnings according to the different situations

In the experiment, only situations (i) and (iii) are considered.

3) Decisions

At each period you must choose one card among the 7 presented in table 2. Each card displays the earnings of each member of the group depending on his role (A, B or C).

Note that cards 1 to 6 refer to situation (iii) while card 7 refers to situation (i).

	Card 1	Card 2	Card 3	Card 4	Card 5	Card 6	Card 7
Farmer A	498 000	117 000	1 000	100 000	166 666	1 000	75 000
Farmer B	1 000	142 000	1 000	150 000	166 666	498 000	100 000
Farmer C	1 000	241 000	498 000	250 000	166 666	1 000	200 000

Table 2 – The seven cards

If the three ***farmers*** choose the same card, they earn the corresponding amounts; otherwise, it is like card 7 was chosen by all.

Example 1:

Farmer A chooses card 7, ***Farmer*** B chooses card 5 and ***Farmer*** C chooses card 5. The three members of the group do not choose the same card, therefore card 7 is implemented in the group. ***Farmer*** A earns 75 000 ecus, ***Farmer*** B earns 100 000 ecus and ***Farmer*** C earns 200 000 ecus.

Example 2:

Farmer A chooses card 1, ***Farmer*** B chooses card 1 and ***Farmer*** C chooses card 1. The three members of the group choose card 1, therefore this card is implemented. ***Farmer*** A earns 498 000 ecus while ***Farmer*** B and C earn 1 000 ecus.

(…)

Treatment (0.3)

In treatment 0.3, the context of the story was changed from water to industry. Farmers become employees in a firm. The specific water related sentence of treatment 0.1 is removed.

In treatment 0.3, introduction and sections 1, 4 and 5 remain identical. Only sections 2 and 3 change and become as follows:

(…)

2) Situations

You and the two other members of your group are ***employees in a firm. Open markets and the intensification of competition conducted to a deterioration of the economic situation of your firm. Jobs are on the line and the top management decides to delegate responsibilities to the employees in order to improve efficiency in the firm.***

A new organization of work is implemented in your firm. It allows you to associate with your colleagues in order to optimize the firm's production.

You and two other ***employees of your firm*** get the same ***machinery,*** but with different ***productivity, due to workers' different skills and experience.*** At the beginning of the experiment, the central computer will assign ***productivity*** (A, B or C) to each member of the group. Then, one member will get ***productivity*** A, another ***productivity*** B and the last ***productivity*** C. In the instructions below, ***"employee A"*** will designate the participant to whom ***productivity*** A is allocated, ***"employee B"*** the person to whom ***productivity*** B is assigned

and ***"employee C"*** the one who assume ***productivity*** C. Each member will know whether he is ***employee A, B or C*** at the beginning of the experiment. Everyone keeps the same role along the experiment.

Within each group, three situations are possible:

(i) Each member remains independent,
(ii) One member associates with another while the third member remains independent,
(iii) The three members are associated.

The earnings of the members or the earnings of the association change following the situation as stated in table 1.

Situation	Earnings
Each member remains independent	***Employee*** A earns 75 000 ecus ***Employee*** B earns 100 000 ecus ***Employee*** C earns 200 000 ecus
Employees A and B are associated	The association A-B earns 175 000 ecus ***Employee*** C earns 200 000 ecus
Employees A and C are associated	The association A-C earns 275 000 ecus ***Employee*** C earns 100 000 ecus
Employees B and C are associated	The association B-C earns 350 000 ecus ***Employee*** C earns 75 000 ecus
The three members are associated	The association A-B-C earns 500 000 ecus

Table 1 – The earnings according to the different situations

In the experiment, only situations (i) and (iii) are considered.

3) Decisions

At each period you have to choose one card among the 7 presented in table 2. Each card displays the earnings of each member of the group depending on his role (A, B or C).

Observe that cards 1 to 6 refer to a situation (iii) while card 7 refers to the situation (i).

	Card 1	Card 2	Card 3	Card 4	Card 5	Card 6	Card 7
Employee A	498 000	117 000	1 000	100 000	166 666	1 000	75 000
Employee B	1 000	142 000	1 000	150 000	166 666	498 000	100 000
Employee C	1 000	241 000	498 000	250 000	166 666	1 000	200 000

Table 2 – The seven cards

If the three ***employees*** chose the same card, they earn the corresponding amounts; otherwise, it is like card 7 was chosen by all.

Example 1:

Employee A chooses card 7, ***employee*** B chooses card 5 and ***employee*** C chooses card 5. The three members of the group do not choose the same card, therefore card 7 is implemented in the group. ***Employee*** A earns 75 000 ecus, ***employee*** B earns 100 000 ecus and ***employee*** C earns 200 000 ecus.

Example 2

Employee A chooses card 1, ***employee*** B chooses card 1 and ***employee*** C chooses card 1. The three members of the group choose card 1, therefore this card is implemented. ***Employee*** A earns 498 000 ecus while ***employees*** B and C earn 1 000 ecus.

(…)

Communication: treatments (1.0) and (1.2)

When players got the possibility to exchange information (in treatments 1.0 and 1.2) this section was added to the instructions just before section 5 "last details".

The previous sections 1, 2, 3 and 4 are the same as in the instructions of treatments 0.0 and 0.2 for treatments 1.0 and 1.2 respectively. The previous section 5 becomes section 6. New section 5 is as follows.

5) Sending messages

You get the possibility to communicate, still anonymously, with the two other members of your group before the periods 1, 6 and 11. The communication page will be displayed automatically on your screen.

At the top of the screen, you can compose messages using 4 scroll-down menus.

- The first one to indicate the choice or the refusal of a card ("I choose" or "I do not choose").
- The second one to select the card number.
- The third one to choose, among 18 available sentences, the one that corresponds to the card you have chosen or refused.
- The fourth one (non-compulsory) to select another card you want to compare with the chosen one.

Once your message is composed, you click on the button "create the message". Then you have to confirm the creation of your message. All created messages are chronologically added to the list at the bottom of your screen. You can order the messages through the buttons "up" and "down" from the one you consider the most important (at the top of the list) to the least (at the bottom).

Once the list is completed and ordered, you click on the button "send messages" in order to communicate them to the two other members of your group. After having clicked on the button "send messages" you cannot get back to the previous step. When all the members of your group have finished their creation of messages, a new screen appears with all the messages created by the three members of the groups (yours included).

In period 1 you have 8 minutes to compose your messages and order them in the list while in periods 6 and 11 you have 5 minutes. Once the time is over, you cannot modify your list of messages. You must click on the button "send messages".

If you do not want to send messages, all you have to do is to click on the button "quit" (which appears on the screen as long as you do not have created any message). On the next screen it will be indicated at your place (A, B or C) that you have not sent messages.

As for the history of periods, you can consult the history of the exchanged messages during the previous periods by clicking on the button "history of the messages".

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