Does environmental connotation affect coordination issues in an experimental stag hunt game?

Dubois, D.* Farolfi, S.† Tidball, M.‡ Désolé, M.§ Hofstetter, A.¶

March 13, 2015

Preliminary version

Abstract

We introduce illustration identifying environmental degradation or improvement into a 2x2 coordination game with two pareto-ranked equilibria. Our contribution focuses on the environmental character of the information provided through the illustrations, and its effects towards possible pro-environmental behaviour.
Our findings have important consequences in terms of public policies. Incentives based on sensitization campaigns for environmental issues can be an alternative to economic instruments when implementing environmental management.

1 Introduction

The social perception of environmental problems evolved crucially during the last half century. From an economic viewpoint, since the work by Boulding (1966) and Hardin (1968), the vision of natural resources moved from an anthropocentric one, considering the "homo oeconomicus" as a rational profit taker using natural resources to maximize utility, to an integrated one, where environmental equilibria are the basis for a sustainable growth. The latter vision, synthetized in the paradigm of Ecological economics (Daly 1977, Costanza 1991) puts on the same plan of relevance economic and ecological dynamics, underlying their respective interdependencies and interconnections. The respect of these interconnections is the basic condition to reach sustainable development (Brundtland 1987). In terms of economic analysis of the human behaviour related to environmental problems, the standard economic model evolved towards a Meta model (Lynne 1999) through the introduction of new elements such as ethical, sociological and psychological considerations. In this new model, the personal interest based on a selfish-hedonistic behaviour and the ethical/shared interest based on sympathy-empathy for the other members of the society are internalized into an integrated own-interest (Czap et al. 2012). This new representation of the human behaviour, for certain aspects in line with the concepts of limited or procedural rationality of behavioural economics (Simon 1982), embeds innovative ideas compared with mainstream neoclassic economics, such as social norms (Lewis 1969, Sugden 1986, Ostrom 2000),

*CNRS,UMR 5474 LAMETA, F-34000 Montpellier, France. Contact: dimitri.dubois@lameta.univ-montp1.fr
†CIRAD, UMR 183 G EAU, F-34000 Montpellier, France. Contact: stefano.farolfi@cirad.fr
‡INRA, UMR 1135 LAMETA, F-34000 Montpellier, France. Contact: tidball@supagro.inra.fr
§Montpellier SupAgro, UMR 1135 LAMETA, F-34000 Montpellier, France. Contact: desole@supagro.inra.fr
¶INRA, UMR 1135 LAMETA, F-34000 Montpellier, France. Contact: hofstett@supagro.inra.fr

"warm glow" (Andreoni 1989, 1990), altruism (Andreoni & Miller 2002) or reciprocity (Falk & Fischbacher 2006, Gätcher & Hermann 2009). According to Schwartz (1970, 1973, 1977) the activation of personally held norms influences pro-social behaviour when two pre-conditions co-exist: awareness of consequences and ascription to responsibility. Pro-environmental behaviour (i.e.: recycle of waste, green consumption, donations to environmental associations, etc.) is a form of pro-social behaviour that consists mainly in contributing to a public good, creating a positive externality or refraining from creating a negative one (Marciano & Roussel 2014).

Following these concepts, the economic behaviour in terms of natural resource management, pollution problems, natural resource use, public good contribution, can prove to be significantly different from the one prescribed by the standard economic theory. To explain this behaviour, Nyborg et al. (2006) propose a model of green consumer based on concepts such as moral motivation and individual responsibility. Consumer choses an environmental friendly behaviour not only on the basis of his own perception, but also in function of the share of the population around him that he believes chose a pro-environmental behavior. Laury & Taylor (2008) show the role of the components 'warm glow' and altruism for the contribution to a public good. Czap et al. (2012) use a contextualized experiment representing upstream and downstream farmers that can use more or less polluting cultural techniques to test subjects' empathy and sympathy. Michel-Guillou & Moser (2006) discuss in terms of social representations the dynamics of the adoption by French farmers of environmental friendly cultural practices. More precisely, the main motivation for the adoption of less polluting techniques seems to be the need for farmers to improve and defend the social image of their profession. On the other side, the adoption of less polluting techniques seems to be at the origin of an increased perception and a higher commitment towards environmental protection. Grolleau et al. (2012) show that when individuals exhibit positional, prosocial or conformist preferences which are endogenous, the outcomes in terms of private provision of public goods can differ significantly from traditional neo-classical predictions.

Experimental economics (EE) plays a fundamental role in terms of exploration of these behaviours and in particular in the test of standard theories when confronted to real life. The largely accepted 'mantra' in EE is represented by the absence of context (or abstraction) of laboratory conditions (Czap et al. 2012) in order to allow as much control as possible of the studied parameters. Conversely, several authors (Laury & Taylor 2008, Farolfi et al. 2014) recently claim an introduction of contextual elements in EE protocols in order to improve their external validity, but also to allow subjects to make visible in their behaviour those variables of the above-mentioned meta-economic model. According to Michel-Guillou & Moser (2006) those variables depend upon the awareness of the context and cannot be made explicit in an abstract situation. Laury & Taylor (2008) demonstrate experimentally that an abstract protocol has a lower capacity than a contextualized one to predict subjects' contributions to a naturally occurring public good. Farolfi et al. (2014) propose an analytical framework to study the influence of context on players' behaviour composed of four elements: repetition (R), illustration (I), communication (C) and experience (E). The authors confirmed through the RICE framework 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 that context. According to Cooper & Kagel (2003), when learning processes are allowed, a "weak" contextual effect would also allow behaviors to converge more quickly toward theoretical predictions.

In this paper, we aim at focusing on illustration. We introduce basic illustration identifying environmental degradation or improvement into a 2x2 coordination game with two pareto-ranked equilibria, one risk dominant and the other payoff dominant. This class of coordination game is called "stag hunt game". Our hypothese is that environmental connotation may affect issues in situations with strategical interactions, either by moving away from the Nash equilibrium or by

selecting a particular equilibrium in case of multiplicity. The structure of the stag hunt game is of particular interest for this purpose. This game admits several Nash equilibria and theoretical as well as experimental investigations don't give a clear cut on which equilibrium players should coordinate. Moreover some papers deal with the effect of labels placed on strategies in this class of games (Dugar & Shahriar 2012). We could also use a prisoner's dilemma game or a public good game, but these games have a different structure, they introduce a social dilemma; a conflict between the unique Nash equilibrium and a Pareto optimal issue. The study of prisoner's dilemma game is a possible extension of this work.

We show that this kind of basic environmental illustration significantly influence subjects' behavior, however, that influence is constrained by the nature of the stag-hunt game. In particular, our analysis shows that environmental negative signals impact more players' behavior over a repeated session than positive signals. This result is consistent with the findings of previous works dealing with subjects' appraisal of environmental values and with experimental tests of the influence of rewards and punishments on subjects' behavior. From a policy implication point of view, this outcome is relevant as it suggests the use of warning campaigns for the protection of the environment as effective tools to sensitize the society. In terms of dynamics observed, the main result is the fact that the choices of strategies are made basically during the first repetitions of the interactions. This fact has policy implications, as it shows that players coordinate themselves relatively soon and then maintain the equilibrium reached until the end of the game with few exceptions. Policies based on sensitization of the consumers through information and awareness-raising campaigns would again find in these outcomes interesting suggestions, as they would show that these campaigns modify quickly and in a steady way consumers' behavior.

The paper is composed of the following sections. Section 2 describes the experimental design and our conjectures. Section 3 presents the results of our investigation while section 4 discusses them and indicates policy implications.

2 Experimental design and conjectures

Experimental design

We experiment a symmetric stag hunt game. Under its normal form, this game can be represented as in table 1. With the condition that $a > c \geq d > b$ this game admits two pure-strategy Nash equilibria, XX and YY and one mixed-strategy equilibrium where strategy X is chosen with probability $p = \frac{d-b}{a-b+d-c}$. Furthermore, XX is payoff dominant and YY is risk dominant (Harsanyi & Selten 1988). Payoff-dominance notion is obvious, since $a > d$. Risk-dominance is more complicated. YY is said risk-dominant because adopting this strategy is less risky than adopting X. Indeed X has to be chosen by the opponent with a high probability (p>0.5) to have an expected payoff equal to Y's one.

		Player B	
		X	Y
Player A	X	a, a	b, c
	Y	c, b	d, d

Table 1: A symmetric stag hung game, with $a > c \geq d > b$

The parameters used for the experiment are $a = 10$, $b = 5$, $c = 9.25$ and $d = 8$, as reported in table 2. The game is based on game 2 of Dubois et al. (2012), with payoffs divided by 4[1].

[1] We divided values by 4 in order to avoid the use of a conversion rate. The payoffs in the matrix are euros.

In order to test for the effects of environmental illustration on strategy choices and coordination issues, we ran five treatments (table 3): a baseline without illustration, two treatments where one option has a "positive" environmental connotation (treatments XEP and YEP) and two treatments where one option has a "negative" environmental connotation (XEN and YEN).

		Player B	
Player A		10, 10	5, 9.25
		9.25, 5	8, 8

Table 2: The game we experimented

The environmental illustrations are very simple and generic in order to be easily understandable and to induce a minimum of personal interpretation. Indeed our objective is to analyse the effects of a "pro" or "anti" environmental connotation in coordination problems, not to lead the subject to rely on its own experience or imagination, which would result in a lost of control in the experiment. What we call illustration in our protocol is a short sentence added at the end of the instructions. The sentence with a positive environmental connotation on option X (Y in treatment YEP) is the following: "X preserves the environment". The negative one is "X degrades the environment".

		Illustrated option	
		X	Y
Environmental illustration	$\emptyset$	Baseline	
	$-$	XEN	YEN
	$+$	XEP	YEP

Table 3: The treatments

The experiment took place in the experimental lab of Montpellier (LAMETA-LEEM) in July and September 2014. A total of 178 subjects participated to the computerized[2] experiment, some students from various disciplines of the University of Montpellier[3]. The experiment was divided into four parts: a one-shot stag hunt game, a repeated stag hunt game, a simple portfolio choice and a questionnaire to capture subject's sensitivity to environmental concerns (the New Environmental Paradigm – NEP – scale).

In the general instructions[4] subjects were informed that: i) the experiment is composed of three independent parts and a questionnaire; ii) the instructions of each part are given only when the previous part is finished and iii) payments are based on only one of the three parts randomly drawn.

Let us now detail the content of each part. In the first part pairs of players, randomly formed, play the stag hunt game reported in table 2 in one-shot. In the instructions of part 2 subjects are informed they stay with the same partner as in part 1. In the second part subjects participate to the same game repeated 20 periods. In part 3 subjects participate to a simple real-money

[2]The computer program was based on LE2M, the software dedicated to experimental economics developped in Montpellier by Dubois, D. and Rousselle, J.M.

[3]The organization of the experimental sessions as well as the subjects' database is managed by ORSEE (Greiner 2004).

[4]Instructions are available upon request to the authors.

portfolio choice aiming at capturing their sensitivity to risky decisions (Gneezy & Potters 1997, Beaud & Willinger 2014). Subjects then answer to the NEP scale (Dunlap & Van Liere 1978) questionnaire. The NEP scale attempts to measure public pro-environmental orientation. The NEP focuses on beliefs about humanity's ability to upset the balance of nature, the existence of limits to growth for human societies, and humanity's right to rule over the rest of nature. The questionnaire was slightly completed and classified by Dunlap et al. (2000) trying to capture the ideas of "ecological consciousness" and "anthropocentrism versus ecocentrism".

Conjectures

The experiment is designed to test the following conjectures about the expected effect on players' decisions of an environmentally connoted strategy.

Conjecture 1 *An environmental connotation attached to a strategy affects players' choices of that strategy*

This is our main conjecture. Several papers show there exists a "pro-environmental" behavior, that leads people to take decisions inconsistents with pure maximizing concerns, like recycle of waste, green consumption or donations to environmental associations (Marciano & Roussel 2014). For Schwartz (1970, 1973, 1977) and Stern et al. (1993, 1999) the pro-environmental behavior belongs to the class of pro-social behaviors with the specificity that it also concerns nonhuman species.

Conjecture 2 *A positive (resp. negative) environmental connotation attached to a strategy increases (resp. decreases) the frequency of choice of that strategy compared to the baseline*

We suppose that in general players have a pro-environmental behavior or at least they are neutral.

Conjecture 3 *A negative environmental connotation has a stronger effect than a positive one*

Some experimental results show that people are more sensitive to loss than to gains with respect to climate and environmental issues (Newman et al. 2012) and to punishments than to rewards (Bravo & Squazzoni 2013). Applied to our context, theses findings may imply that a negative connotation has a stronger impact than a positive one.

Conjecture 4 *Repetition has no additional effect with respect to environmental connotation*

The repeated game is built such that players are not incitivized to influence their partner decision (partner matching and only one randomly selected period is paid). Additionally, we think that players have a some kind of myopic behavior with respect to information. Therefore, strategic considerations might quickly replace the environmental considerations. In other words we do not expect environmental connotation to affect the dynamic of the repeated game.

3 Results

3.1 One-shot game

[Insert figure 1 here]

Figure 1 reports the distribution of the average frequency of X in each treatment. The frequency of X choice in the baseline treatment is 67.00%. This frequency is very close to the 68.75% observed by Dubois et al. (2012) in the first period of their game 2 which differs only in that payoffs are multiplied by four[5].

The average frequencies of X in treatments XEP and YEN, respectively 71.00% and 64.00%, are not statistically different compared to the baseline treatment (Mann Whitney two-sided test[6], p-value=0.884 and 0.806). Between those two treatments averages don't differ either (MW p-value=0.663). However there is a strong effect toward a less frequent choice of X when the environmental connotation incites to move away from it: the X strategy frequency falls down to 36% in treatment XEN and to 31% in YEP, a significant difference compared to the baseline[7] (MW p-value=0.024 and 0.008 respectively).

The observations in the one-shot game show that the environmental connotation has an influence in terms of strategy choice. However, this choice is constrained by the nature of the stag-hunt game. A statistically significant reduction of X choice with respect to the baseline treatment is observable when this strategy is described as degrading the environment. On the other hand, no statistically significant increase of X choice is observed when this strategy is presented as able to preserve the environment. Actually, that connotation "fights" with the game's structure in terms of orienting player's choices. When the connotation pushes players to a choice that goes in the same direction of the strategies' basin of attraction, then the players follow it. Conversely, when the connotation pushes players in the direction contrary to the basin of attraction, then its influence is statistically not significant. The analysis of the data therefore confirms partially conjectures 1 and 2 while conjecture 3 is not verified.

3.2 Repeated game

[Insert figure 2 here]

Figure 2 reports the distribution of the average frequency of X in each treatment. X choice is significantly lower in XEN and YEP compared to the baseline (MW, XEN vs Baseline p-value=0.010, YEP vs Baseline p-value=0.012). Introducing a positive connotation for X is not sufficient to increase the choice of this strategy compared to the baseline (XEP vs Baseline p-value=0.986). Conversely, a negative connotation for Y strongly affects the decisions, as the frequency of X choice approaches 100%, which is significantly higher than in the baseline and XEP treatments (MW p-value=0.062 and 0.042 respectively)[8].
In the baseline treatment and in both treatments with the positively oriented environmental connotation (XEP and YEP) the average frequency of X stays nearly around the same level as in the one-shot game: 68.00% in the baseline, 70.00% in XEP and 28.00% in YEP. Conversely in both treatments with the negative environmental connotation the frequencies of the payoff dominant strategy X are more extreme: a choice of X that reaches 92.00% in YEN and falls down to 21.00% in XEN. These two values are significantly different from those observed in

[5] In particular the two games share the same mixed strategy equilibrium (p=0.8) and the same "relative riskiness" ratio ($RR = 0.25$). Relative riskiness of the safe strategy relative to the risky one is defined by the ratio of their expected payoff ranges: $RR = \frac{|c-d|}{a-b}$. A Mann Whitney two-sided test confirms there is no significant difference between the observed frequency of X in both games (p-value=0.751).

[6] Thereafter MW. Since the independent data in our experiment is the group, all the statistical tests are based on this unit of observation.

[7] As well as to treatments XEP and YEN.

[8] More precisely, the frequency is 97% if we exclude the group which clearly distinguishes from the other with a very low frequency of X choice (2%). With this group the p-values are respectively 0.117 and 0.090.

the one-shot decision (Wilcoxon two-sided test: p-value=0.033 for XEN and p-value=0.006 for YEN).

[Insert figure 3 here]

Figure 3 reports the average frequency of X in the one-shot game and the evolution of X in the repeated game for each treatment. As the pairs remain unchanged between the one-shot and the repeated game and through the latter the first periods of play are the most important part of the coordination game. For three treatments out of five (Baseline, XEP and YEP) there is almost no difference between the one-shot decision and the decision at the beginning of the repeated game. Conversely for the two treatments with the negative environmental connotation (XEN and YEN), a strong dynamic occurs in the very first repetitions. In XEN the frequency of X in the one-shot, 36%, falls to 22% in period 3. The change in the YEN treatment is even more pronounced, from 64% in the one-shot to 86% in period 2 and 94% in period 6. After period 6, in every game the dynamic is quite stable. As mentioned above this is a consequence of the partner matching we chose in the experiment.

To summarize, there are two main differences observed in the repeated game with respect to the one-shot. In YEN the choice of strategy X is significantly higher than in the baseline. In XEN the frequency of X, already significantly lower in the one-shot compared to the baseline, becomes even lower. As a consequence, conjectures 1 and 2 are confirmed in XEN, YEP and YEN but not in XEP, conjecture 3 is confirmed and conjecture 4 is rejected.

[Insert figure 4 here]

Figure 4 reports the evolution of the coordination rate, corresponding to the frequency with which the two players choose the same strategy. We observe first that there is no difference between treatments neither in the one-shot (67%, 61%, 53%, 61% and 61%) nor in the repeated game (95%, 91%, 95%, 96% and 92%). Environmental connotation therefore affects the equilibrium towards which pairs converge but not their success in coordinating. Second, that the coordination rate strongly increases in the beginning of the repeated game (five first periods) and then remains quite stable until the end of the repetitions, whatever the treatment. The environmental connotation doesn't affect the dynamic of the coordination either.

3.3 The New Environmental Paradigm (NEP) scale and the investment in the portfolio choice

The (revisited) NEP scale (Dunlap et al. 2000) is a test that captures the sensitivity of the subject to environmental concerns. The questionnaire contains a set of 15 items. The eight odd-numbered items refer to a pro-ecological behavior and the seven even-numbered ones to a disagreement with pro-ecological world-view. Moreover, the items were classified according to the following five central ideas: (i) the reality of limits to growth (questions 1, 6, and 11), (ii) antianthropocentrism (questions 2, 7, and 12), (iii) the fragility of nature's balance (questions 3, 8, and 13), (iv) rejection of exemptionalism (questions 4, 9, and 14), and (v) the possibility of an ecocrisis (questions 5, 10, and 15). Participants to the experiment answered the 15 questions that we carefully translated into french. Figure 5 reports the distribution of the NEP coefficients.

[Insert figure 5 here]

Observed coefficients are in accordance with literature in this field (Dunlap et al. 2000, Kotchen & Reiling 2000). The average value for the NEP coefficient is 55.4 compared to 54.8

and 54.1 for the NEP coefficients estimated during the contingent valuation of two different endangered species (Kotchen & Reiling 2000).

[Insert figure 6 here]

In order to capture the sensitivity of subjects to risky decisions they also participated to a portfolio choice game. More precisely participants have an initial endowment of 10 euros and must decide its allocation between a safe asset (return rate equal to 1) and a risky one where the rate of return is $\tilde{k} = (0, 1/2; 3, 1/2)$, i.e. with probability 1/2 they lose the amount invested and with probability 1/2 they get back three times their investment. Figure 6 reports the distribution of the amount invested in the risky option. On average subjects invested 4.24 euros in the risky option, and the third quartile corresponds to an investment of 6 euros, which means than most of subjects are rather risk averse, as usually observed in economic experiments (Holt & Laury 2002).

[Insert figure 7 here]

As depicted in figure 7 and confirmed by a Person's correlation test, there is no link between subjects' environmental concern and their sensitivity to risk ($\rho = -0.065$, p-value=0.386). In order to test for the existence of a relationship between subjects' profile in these two dimensions and their choice in the coordination game we group subjects according to their coefficient in the NEP scale and to the amount they invested in the portfolio choice. In the former dimension we split subjects depending on whether their NEP coefficient is strictly lower than the median of the observed coefficients (N_L) or not (N_H). We applied the same rule for the risk dimension, i.e. I_L if the subject invested strictly less than the median of the observations and I_H otherwise. Subjects are therefore classified according to four profiles: $N_L I_L$, $N_L I_H$, $N_H I_L$ and $N_H I_H$. We make the following conjectures.

Conjecture 5 *I_L (resp. I_H) subjects choose more frequently the risk-dominant (resp. payoff-dominant) strategy*

We wanted to test the relationship between the subject's risk-aversion and his/her choice in a game with a risky strategy. This has been tested by Eckel and Wilson () in the trust game where the usual conjecture is that greater risk aversion leads to less trusting. Authors on the contrary find that trustfullness is not correlated with sensitivy to risk. We are aware of the paper by Büyükboyaci (2014), which observe that in the stag hunt game subject's propensity to choose the risky action does not depend on his/her own risk attitude but rather on his/her opponent's one. However due to the specific protocol used by the author in her experiment we still believe that our conjecture is testable in our case.

Conjecture 6 *N_H subjects are more sensitive to the environmental connotation*

We restrict the conjecture to the N_H type since it would be false to consider that N_L type is anti-environment.

[Insert figure 8 here]

Figure 8 reports for each treatment the average frequency of the X choice depending on the profiles, in the one-shot game and in the repeated game. Some observations are in line with the conjectures but some are not. Let us start with thoses who are.
In treatment XEP data are very consistent with our conjectures. On average subjects with the

higher coefficient in the NEP scale, N_H type, choose more frequently X than N_L. Moreover in both classes subjects who invested more in the portfolio choice (type I_H), choose X more frequently than the others (type I_L). More precisely average frequencies of X in the repeated game are the following: $N_L I_L$: 55.00%, $N_L I_H$: 66.67%, $N_H I_L$: 72.27% and $N_H I_H$: 73.46%. In treatment YEN, type $N_H I_H$ chooses X at a frequency of 97.86%, followed by type $N_L I_H$ with a frequency of 95.71%. As for the two other types of subject, $N_L I_L$ and $N_H I_L$, the latter chooses X with a higher frequency (92.50%) than the former (83.13%).

In the one-shot game of treatment YEP the choices are consistents with the conjectures. In the repeated game $N_L I_H$ type chooses X with a higher frequency than other types almost all the time, while the frequency with which type $N_L I_L$ selects X is below the one of the other types in most periods. N_H types, I_L and I_H, behave the same way. In other words, in this treatment it seems that the risk-aversion dimension matters for subjects with a low environmental concern but not for subjects with a higher ones.

Conversely, in treatment XEN the $N_H I_L$ type clearly chooses more frequently X than the other types, contrarily to our conjectures. However, for more than half of the repetitions, type $N_L I_H$ chooses X with a frequency above types $N_L I_L$ and $N_H I_H$. In the baseline treatment the environmental concern dimension should not matter since no context is introduced in the game. According to conjecture 5 I_H types should select X more frequently than I_L's. This is not observed in our data.

To summarize, in both treatments where the environmental illustration is in favor of the "riskier" payoff-dominant strategy, subjects' choice are in accordance with conjectures 5 and 6. This is less evident in the other connoted treatments as well as in the baseline. In terms of conjecture 5, an avenue for further investigation could be to relate streategy choices with ambiguity-aversion instead of risk-aversion as we did so far. Ambiguity would refer to the belief dimension about the opponent choice while the risk-aversion is purely linked to the game structure.

4 Discussion

This article aimed at finding out whether basic environmental illustration influences players' economic behaviour. We tested hypotheses about this research question through an experiment based on a symmetric stag-hunt game. Both one-shot and repeated game were implemented. The one-shot game shows clearly that the environmental connotation has an influence in terms of strategy choice, and the positive or negative nature of the environmental connotation affects positively or negatively the frequency of players' choices. However, that modification is constrained by the nature of the stag-hunt game. The environmental connotation is therefore influent on players' behaviour, but it "fights" with the game's structure in terms of orienting player's choices. Conjectures 1 and 2 are therefore partially confirmed in one-shot games, while conjecture 3 is rejected. A further analysis in this direction could consist in testing the same connotations on games with a different structure and a smaller riskiness of X, and compare the results with those observed in the current set-up.

In repeated games, we observe a similar result as in the one-shot for all treatments except YEN. In fact, while as in the one-shot game XEN and YEP reduce significantly X choice compared to the Baseline, and XEP is not significantly different from the Baseline, YEN increases significantly X choice. This finding provides more arguments to confirm conjectures 1 and 2 in the repeated games. This result is also important as it suggests that environmental negative signals impact more players' behavior than positive signals over a repeated session (conjecture 3 confirmed and conjecture 4 rejected). This outcome is consistent with the findings of previous works dealing with subjects' appraisal of environmental values (Newman et al. 2012) and with

experimental tests of the influence of rewards and punishments on subjects' behaviour (Bravo & Squazzoni 2013). According to Shogren et al. (2010), willingness to pay (WTP) is more accurate than willingness to accept (WTA) in terms of subjects' capacity to induce environmental values. Moreover, WTP for positive values are more consistent with theoretical expectations, while people tend to "overbid"' negative environmental values. Following Bravo & Squazzoni (2013), punishment has a stronger effect than rewards on cooperation. This is consistent with the idea that the "stick" (here the perspective of a negative impact on the environment) is more effective than the "carrot" (here the perspective of a positive impact on the environment) in changing subjects' behavior. From a policy implication point of view, this outcome is relevant as it suggests the use of warning campaigns for the protection of the environment as effective tools to sensitize the society and then induce a behavioral change in the direction of either a reduced negative practice or an increased positive one.

In terms of dynamics observed during the repeated games, the main result is the fact that the choices of strategies are made basically during the first periods of the game (1 to 6). In other terms, due also to the fixed pair nature of the groups, players coordinate and reach a Nash equilibrium in the first six periods of the game and in the majority of the cases select the same strategy until the end of the game. To check the influence of the environmental connotation overtime, a further test could be made by introducing it (either positive, i.e. the introduction of a treatment plant, or negative, i.e. a product that is now considered toxic thanks to a more sophisticated system to reveal its presence in the water) in the middle of a baseline session, and observe whether the equilibrium reached in the absence of context is modified by the introduction of the environmental connotation. Policies based on sensitization of the consumers through information and awareness-raising campaigns would again find in these outcomes interesting suggestions, as they would show the speed and stability of the consumers' behavior changes under the influence of environmental campaigns. Further extensions of these experiments will consist in analyzing larger groups to avoid the fixed-pair effect and in introducing environmental connotation in the two strategies at the same time as Dugar & Shahriar (2012) did in their experiment, to observe the possible facilitation of coordination through the introduction of illustration.

Results from the NEP scale test are in accordance with literature in this field (Dunlap et al. 2000, Kotchen & Reiling 2000) and the influence of environmental connotation on the strategy choice is partially in line with the NEP findings (conjecture 6 partially confirmed). Similarly, the investment portfolio test explains partially the attitude of players with regard to risk observed in the game (conjecture 5 partially confirmed). An avenue for further investigation in this field could be to relate strategy choices to ambiguity-aversion rather than to risk-aversion, with ambiguity referring to the belief dimension about the opponent choice while the risk-aversion is purely linked to the game structure.

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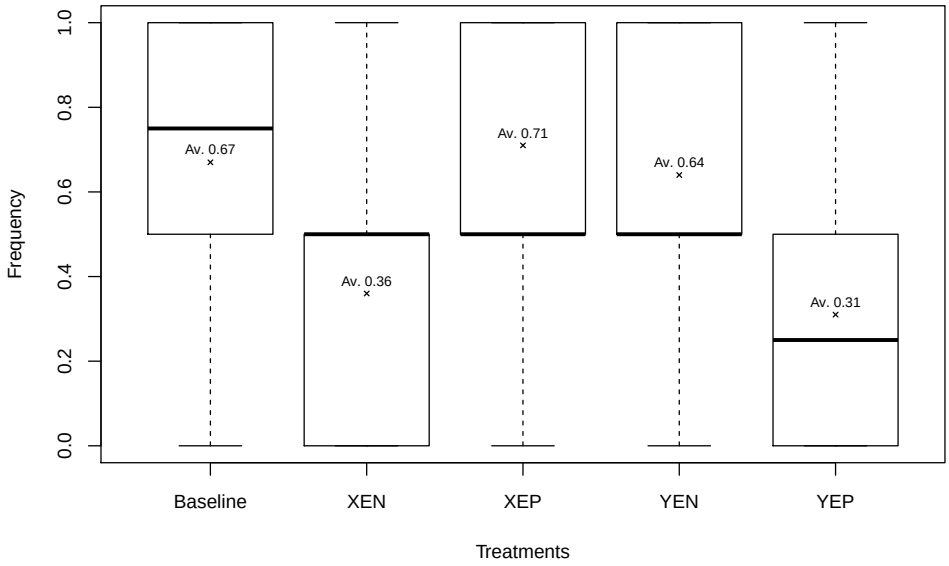

Figure 1: Distribution of the average frequency of X in the one-shot game

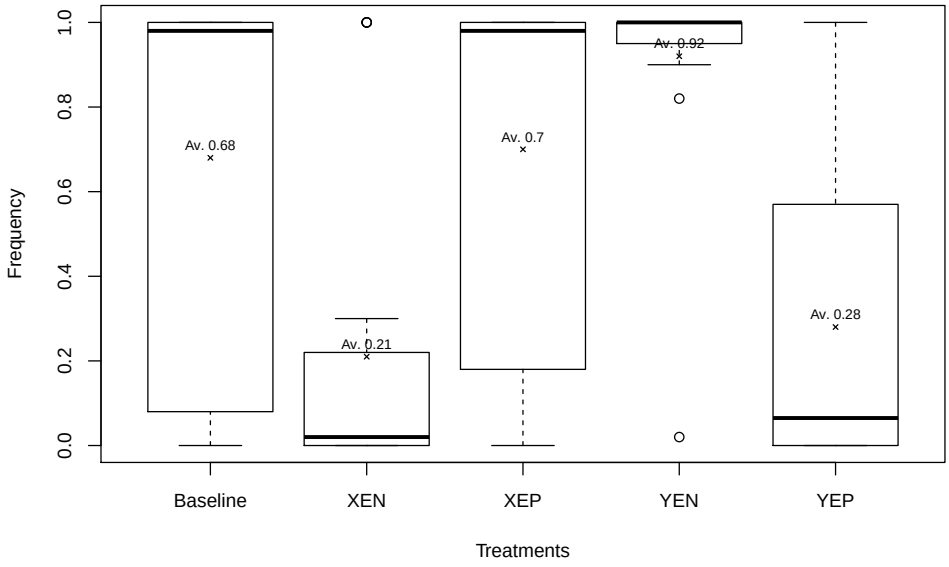

Figure 2: Distribution of the average frequency of X in the repeated game

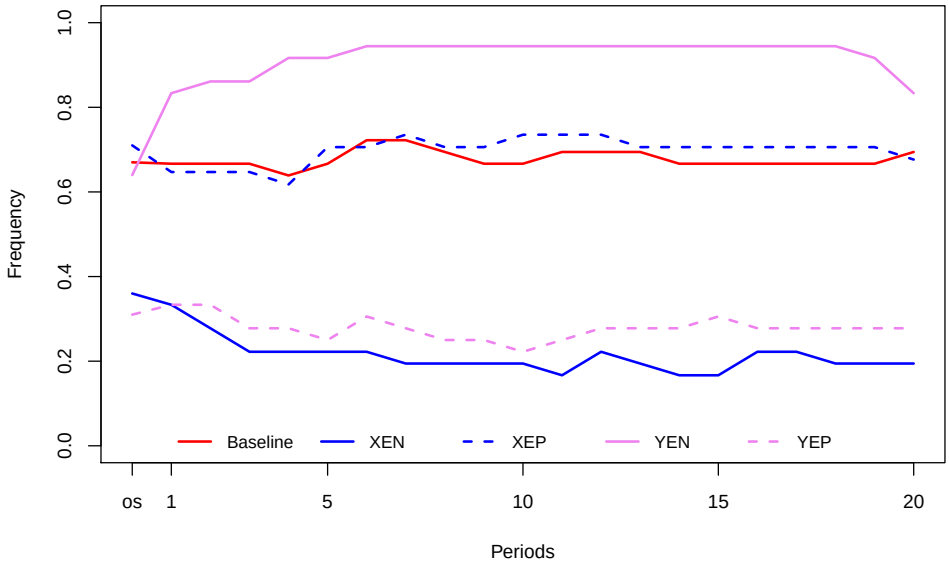

Figure 3: Evolution of the frequency of strategy X in the repeated game

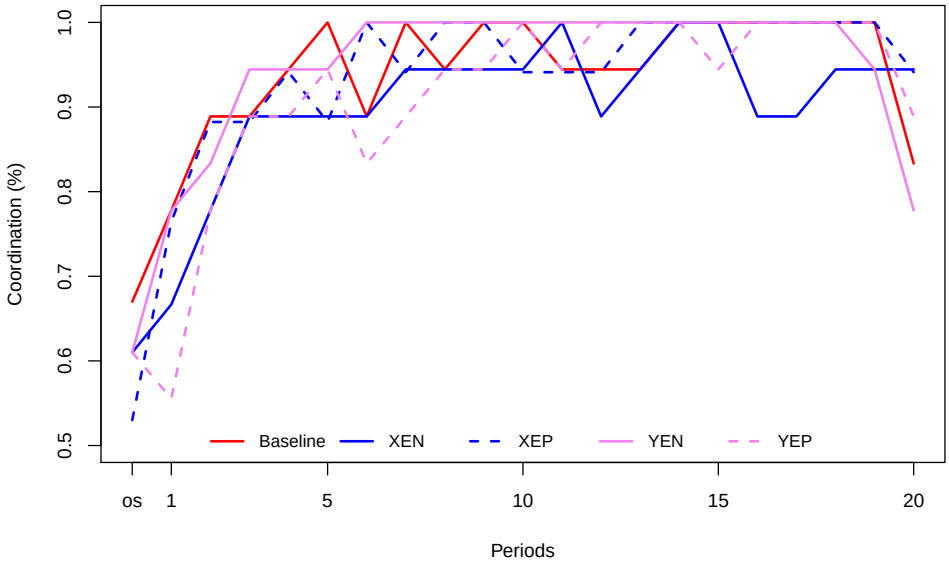

Figure 4: Evolution of the coordination rate, in the one-shot and repeated game

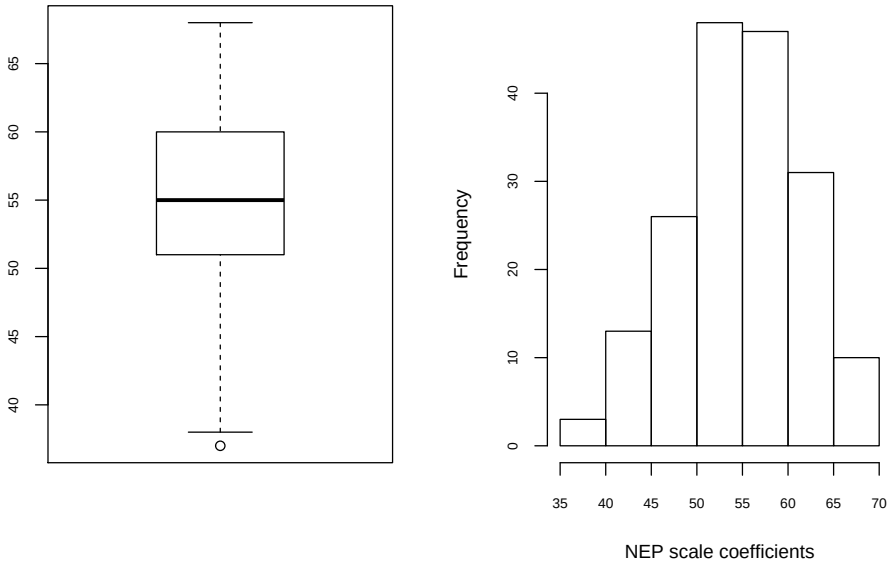

Figure 5: Distribution of the NEP scale coefficients

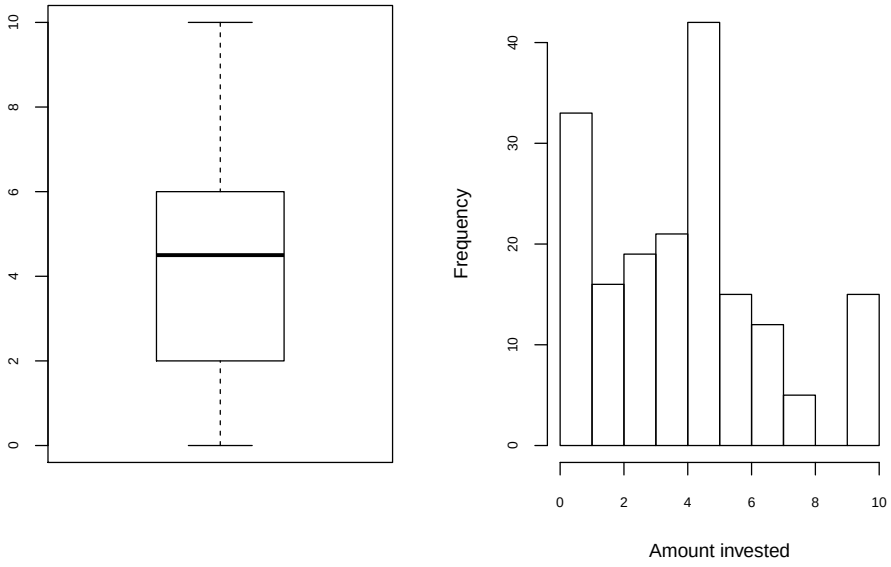

Figure 6: Distribution of the amount invested in the risky option of the portfolio choice problem

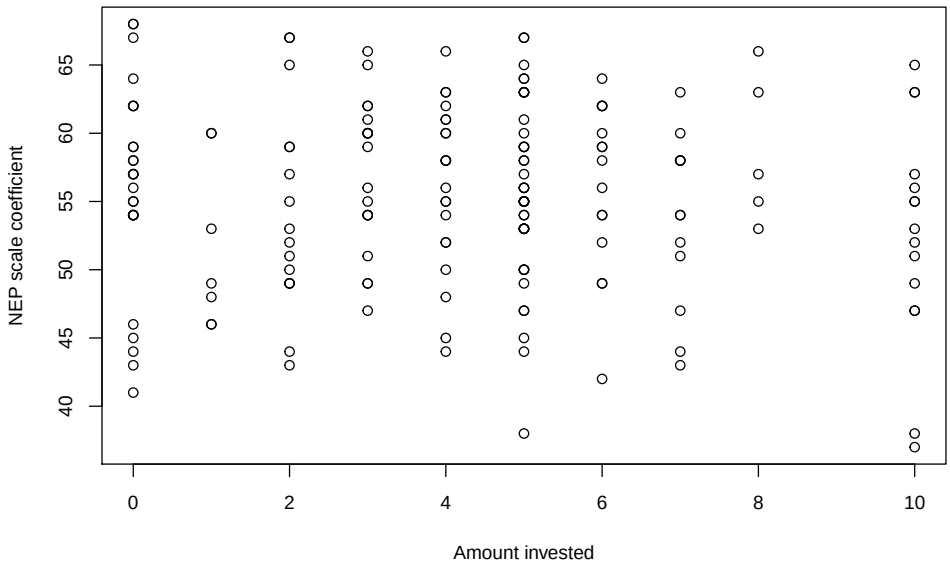

Figure 7: Correlation between NEP scale coefficient and sensitivity to risk

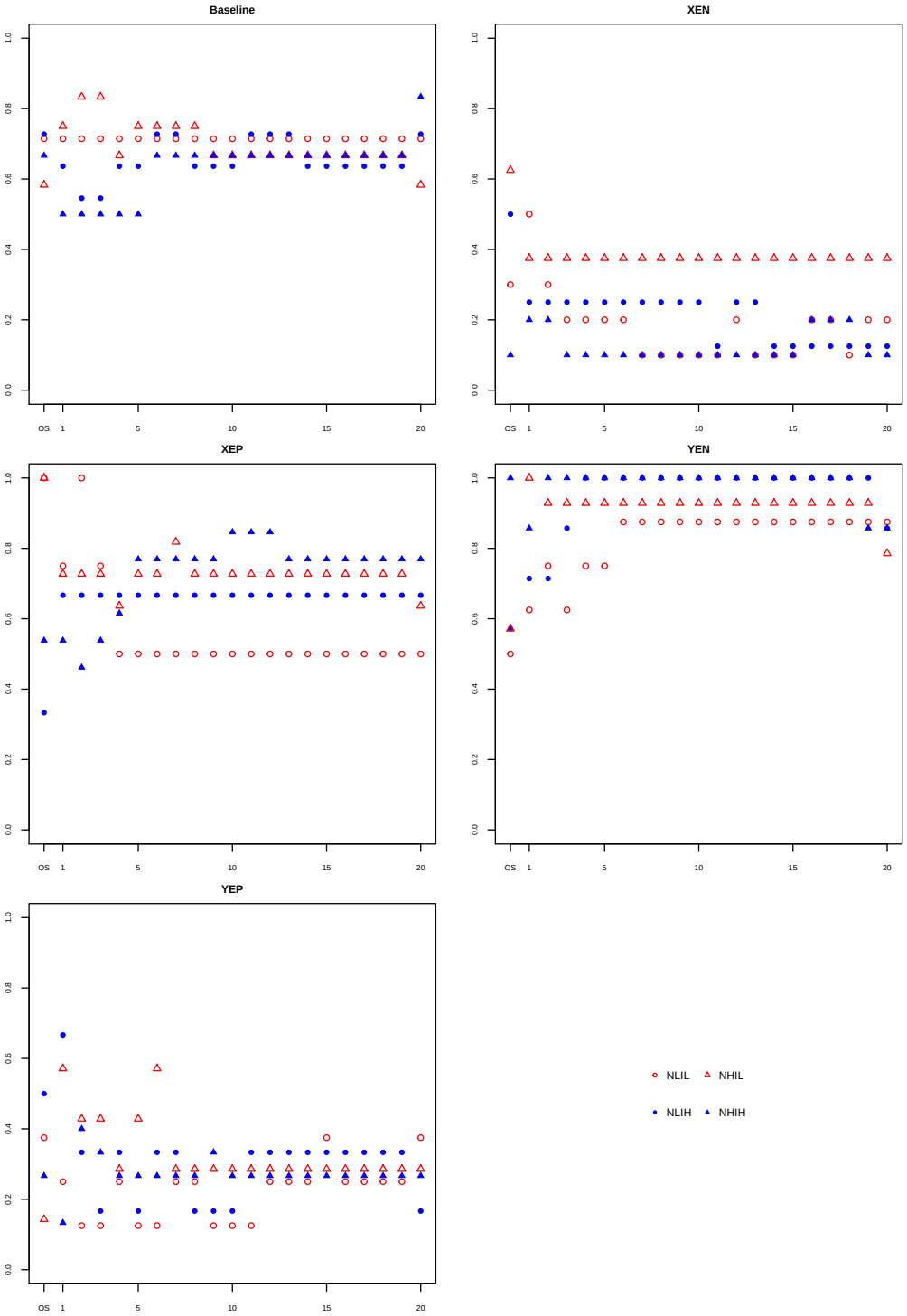

Figure 8: Choices according to NEP and Risk profiles