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Intrinsic vs. extrinsic motivators on creative collaboration: The effect of sharing rewards*

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Abstract

Charness and Grieco (2019) have experimentally shown that financial incentives have a positive impact on *individual* creativity, but only in the case of "close" creativity, *i.e.*, when there are constraints to the creative task that a subject has to accomplish. In this paper, we build on the same "close" creativity assignments of Charness and Grieco (2019) and analyze with undergraduate students and with experts in creativity the interplay between monetary incentives and *group cooperation* in creative assignments. We introduce a novel model of *intrinsic vs. extrinsic motivation* to group collaboration in creativity and run a theory-driven experiment to test our experimental hypotheses on the crowding out of intrinsic motivation due to extrinsic motivation to group creativity. We find more creativity in the group than in the individual treatment, apart when there are explicit monetary incentives to co-working (sharing ideas) in the creative assignment. Therefore, while Charness and Grieco (2019) show a positive interplay between monetary incentives (*extrinsic individual motivation*) and "close" creativity at the individual level, we provide evidence of a negative interplay between monetary incentives and "close" creativity at the group level (*crowding out of intrinsic group motivation*). Furthermore, and again in line with our model predictions, the latter effect is found more in the experimental sessions with experts in creativity than in those with undergraduate students.

Keywords: Creativity, Group cooperation, Intrinsic Motivation, Extrinsic Motivation, Crowding out, Experiment.

JEL codes: I23, O31, O32.

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1 Introduction

As well expressed by Scott (2010), the notion of creativity is inevitably caught between two polarities, one psychological (individual creativity), the other sociological (collective creativity). On the one side, creativity resides in the personal endowments and capacities of individuals: some have the native talent and/or acquired know-how for certain kinds of creative acts; some have little or none. On the other side, creativity is also embedded in concrete organizational contexts that shape its motions and objectives in many different ways.

Two important variables have been shown to impact on the creative processes within different organizational modes: financial incentives and peer effects. About the former, Charness and Grieco (2019) have proposed to undergraduate students in economics, at an individual level, two kinds of creative assignments: "close" and "open" creativity. In the former case, ex-ante goals and constraints are imposed, as is usually the case for most of the economically relevant creative activity (such as finding a way to decrease the size of a computer or developing a new drug for a specific purpose). In the latter case, no restrictions apply, so "thinking outside the box" should be more natural. Participants are randomly given one of three creative assignments – mathematical, graphical and verbal – under tournament incentives on the specific assignment, with monetary rewards to the winners only in half of the experimental sessions. Charness and Grieco (2019) find that financial incentives have a positive impact on creativity, but only in the case of "close" creativity, *i.e.*, when there are some constraints to the task that a subject has to accomplish.

In this paper, we build on the same "close" creativity assignments of Charness and Grieco (2019) and analyze – with undergraduate students in economics and with experts in creativity – the interplay between monetary incentives and group cooperation in three types of "creative" tasks – mathematical, graphical and verbal. More precisely: 120 undergraduate students in economics of University of Strasbourg participated in the lab experiments in 2015-2016, and 120 experts in creativity operating in the region of Strasbourg participated in the same experiments, during two major events organized at University of Strasbourg (Ecole d'Automne, November 2015; Tango & Scan, February 2016). The latter are professionals and entrepreneurs of creative industries, graduate students and researchers in economics of creativity, public officers responsible for policies incentivizing creativity.

We have four treatments (30 students and 30 experts for each treatment): "Individ-

ual" (Control), "Group with no monetary incentives to either cooperation and competition" (*G-no*), "Group with monetary incentives to cooperation" (*G-coop*), "Group with monetary incentives to cooperation and competition" (*G-comp*). We introduce a novel model of *intrinsic vs. extrinsic motivation* to group co-working on creativity over different individual assignments. Relying on this model, we elaborate experimental hypotheses on the impact of this intrinsic motivation over individual effort and co-working in the creative assignments, and on the crowding out of the intrinsic motivation due to extrinsic motivation to group creativity.

More precisely, the first treatment manipulation (*G-no*) is meant to state the impact on intrinsic motivation on individual effort and co-working in the group. The second manipulation (*G-coop*) tests for the crowding-out of intrinsic motivation due to the introduction of explicit monetary incentives to co-working. The last manipulation (*G-comp*) also introduces monetary incentives to within-group competion. The combination of monetary incentives to group cooperation (profit sharing) and to group competition (group tournament) is a quite common organizational mode in creative firms. In our design, treatment *G-comp* is especially meant to test whether the introduction of extrinsic motivation to group competition is sufficient to compensate the extrinsic motivation to group cooperation. A greater detected level of group creativity in (*G-comp*) than in (*G-coop*) would provide further support to the existence of an intrinsic motivation to sharing ideas when dealing with creative assignments.

Indeed, we find more creativity in the Group rather than in the Individual treatment only when no monetary incentives are provided to group cooperation in the creative assignment, *i.e.*, in *G-no* and *G-comp* but not in *G-coop*. Therefore, while the results of Charness and Grieco (2019) show a positive interplay between monetary incentives (extrinsic individual motivation) and "close" creativity at the individual level, we provide evidence of a negative interplay between monetary incentives and "close" creativity at the group level (intrinsic group motivation; see Festré and Garrouste 2015). Furthermore, in line with our model predictions, the latter effect is found more significant in the experimental sessions with experts in creativity than in those with undergraduate students.

Finally, psychological factors (risk attitudes) and social factors (generalized trust, city tolerance) that are usually found to stimulate creativity, in our study only impact on the creativity produced by the undergraduate students; for the experts in creativity, we only detect the theoretically predicted treatment effects. We provide an interpretation to this

result: being the experts already "creative" due to their professional activity, what matters for their (additional) group creativity is only the "right" organizational mode, *i.e.*, the one boosting their intrinsic motivation to co-working. We find two organizational modes that allow them to accomplish their own individual creative task by group co-working on creative assignments. The first one is characterized by no monetary incentives to sharing of creative ideas. The second one combines monetary incentives to cooperate with monetary incentives to compete on the creative assignments. The latter are needed to compensate the crowding out of the intrinsic motivation due to the former.

The positive theoretical test of our model highlights the importance of intrinsic motivation to group creativity especially in work environments where individual creative abilities are commonly known to be high.

The paper is organized as follows: Section 2 describes the experimental procedures and design. Section 3 presents the theoretical model and experimental hypotheses. Section 4 introduces and discusses the experimental results in the light of the theory-driven experimental hypotheses.

2 Experimental design

2.1 Experimental procedures

The experiment has a 2x4 design, consisting in 2 types of sessions (Student sessions and Expert sessions) and 4 treatments (*Individual*, *Group-no*, *Group-coop*, and *Group-comp*). For both types of sessions, each participant was assigned to only one of the four treatments (between-subject design). Eigth pen-and-paper sessions took place between April 2015 and May 2016 with a total of 240 participants (30 subjects per session), with 120 participants being undergraduate students in economics and 120 being experts in creativity (mainly professionals and entrepreneurs of creative industries, graduate students and researchers in economics of creativity, public officers responsible for policies incentivizing creativity.).

The *Student* sessions took place in classrooms of University of Strasbourg during the standard academic calendar. Also the *Expert* sessions took place in classrooms of the same university, during two major events on creativity organized in Strasbourg (Ecole d'Automne – Creativity School in November 2015, Tango & Scan – Creativity Prize in February 2016) with experts in creativity operating in the region of Strasbourg as participants.

All the experiments have been carried out in English, with French-speaking helpers, to cope with some possible misunderstanding in the interpretation of the instructions. The reason to run all sessions in English is because subjects could only fill in the creative tasks in English. This has allowed us to implement a full double blind procedures of task evaluation by external judges (see Section 2.4). The latter evaluated all together similar tasks filled in by subjects of different nationalities participanting in the same experiment implemented in two different countries, namely France and Vietnam (see the companion paper Attanasi et al. 2019, with sessions carried out in English, with Vietnamese-speaking helpers).

Each session had 30 participants splitted into two rooms with 15 subjects per room. Two experimenters held the session contemporaneously into the two rooms. The experiment was made of two incentivized tasks. **Task 1** was intended to capture subjects' creativity. **Task 2** was meant to record subjects' risk and ambiguity attitudes. A **Final Questionnaire** was distributed to observe their idiosyncratic characteristics, social habits and geographical features.

2.2 Timeline of the experiment

Written instructions were delivered to the subjects and read aloud by the experimenter. The instructions explained that the experiment consisted into two tasks and gave rules for task 1. **Task 1** asked participants to perform a – still unknown – assignment in a creative way within 15 minutes under a tournament scheme (see Section 2.3 for treatment differences). A different ID number has been allocated to each subject in the two rooms of each experimental session.

Then, task 1's sheets were distributed to the participants (one sheet per subject). There were 3 different close-creativity assignments – draw, math and verbal – same as in Charness and Grieco (2019) (see the Appendix). Each of the 30 participants was given only one assignment. More precisely, in each room each participant was allocated to only 1 out of 3 assignments, 5 people per assignment, hence 1 draw-cohort, 1 math-cohort, and 1 verbal-cohort (5 draw, 5 math, and 5 verbal per room). Within each cohort, a participant was competing on the same assignment with the other 4 unknown people having the same assignment. Each participant was given 15 minutes to complete his/her assignment in a more creative way with respect to the other 4 participants in the same cohort.

After the 15 minutes of task 1, written instructions for task 2 were delivered to the sub-

jects and read aloud by the experimenter. **Task 2** is the same as in Charness and Grieco (2019), *i.e.*, the combination of the risk-elicitation task of Gneezy and Potters (1997), and the ambiguity-elicitation task of Charness and Gneezy (2010). The instructions invited participants to invest a fraction $x \in \{0\%, 1\%, ..., 99\%, 100\%\}$ of their (still unknown) earnings for task 1 into a lottery with *known* probabilities (*transparent* urn, with 50% probability of multiplying the invested amount by 2.5 times, and 50% probability of losing it), and a fraction $y \in \{0\%, 1\%, ..., 99\%, 100\%\}$ of the same earnings into a lottery with *unknown* probabilities (*obscure* urn, with a probability of multiplying the invested amount by 2.5 times belonging to the set {0%, 10%, ..., 90%, 100%}). The choice x represents a proxy of a subject's proneness to risk. The sign of the difference $y - x$ represents a proxy of a subject's ambiguity attitude, with the subject showing ambiguity aversion if $y < x$, ambiguity neutrality if $y = x$ and ambiguity proneness if $y > x$. Participants wrote down their x and y bets on the bottom of the instruction sheet of task 2.[1] Only one of the two urns (transparent or obscure) was randomly selected and played at the end of the experiment.

After the end of task 2, the relative creativity of each participant has been evaluated mutually-anonymously by subjects taking part in the same session, but in the other room. More precisely, each cohort received the five sheets containing the assignments of another cohort, and discussed together and agreed on the final rank. To avoid any conflict of interest and comparison with own performance in the assignment, each cohort received the five sheets of a cohort in the other room, and of a different assignment than its own.[2] Before the evaluation, subjects were told that the criteria for the classification were two: the creativity demonstrated in completing the assignment, and the correspondence between the work and the (close creativity) assignment's constraints. Each cohort ranked the five assignments of the other cohort from the most creative (1st position) to the least creative (5th position), after having reached a unanimous agreement on this ranking, in line with Amabile (1982)

[1] An important issue raised in the experimental literature about Ellsberg-type tasks is subjects' thinking about strategic behavior and/or manipulations by the experimenter (see Schneeweiss 1973, Kadane 1992). To prevent the possibility that subjects might suspect they can be tricked on the realization of the unknown urn, we implemented a combination of three features, similar to Attanasi *et al.* (2014, 2018) and d'Albis *et al.* (2019). First, we determined the white-green tickets composition of the urn prior to the experiment. Second, subjects are assigned the same obscure urn, hence the same urn composition of white and green tickets. Third, in task 2 we let each subject choose one of two ticket colors (white or green), and indicate it on the bottom of the sheet explaining task 2. The chosen color is associated to the positive outcome for each lottery that the subject might play in task 2 (transparent urn or obscure urn). The fact that the chosen "winning" color is not the same for all subjects should prevent the possibility of strategic manipulations of the white-green tickets composition realization by the experimenter.

[2] More precisely, the draw-cohort of room 1 (resp., 2) evaluated the math-cohort of room 2 (resp., 1), the math-cohort of room 1 (resp., 2) evaluated the verbal-cohort of room 2 (resp., 1), and the verbal-cohort of room 1 (resp., 2) evaluated the draw-cohort of room 2 (resp., 1).

stating that the idea of creativity has to be shared among evaluators.

Finally, participants received and filled-in the **Final Questionnaire** on their idiosyncratic characteristics, social habits and geographical features. The majority of the 30 questionnaire items come from cultural economics and economic geography literature, and can be grouped in the following categories: *Demographic characteristics* (gender, age, origin, place of residence, education, and job of participants); *Social habits* (how often they meet known or new people; how often they go to cafes, bar, pubs); *Leisure habits* (how often they do new things; how often they go to theater, cinema, concerts; how often they go out in the evening); *Tolerance and openness* (how many foreign friends they have; do they frequent places where immigrants usually go; are they tolerant towards homosexual people); *Self-assessed creativity* (would they define themselves as creative, definition of creativity); *Social capital* (do they think that most people can be trusted; how much do they trust people in general on a 0–10 scale; does a person they do not know for the fact of being from Strasbourg deserves to be trusted more than another one they do not know and who does not live in town?); *City Tolerance* (do they think they live in a tolerant city); *Member of a cultural association* (Yes or No, and mission of the association); *City facilities* (do you think you live in a city which offers a wide set of amenities and chances for entertainment).

When all participants completed the questionnaire, similarly to Charness and Grieco (2019), 6 over the 30 IDs have been randomly drawn sequentially from an envelop containing the 30 IDs of the experimental session. The first 3 IDs extracted have been asked to draw a ticket from the transparent urn of task 2. The second 3 IDs extracted have been asked to draw a ticket from the obscure urn of task 2. Then, the ranking and payment for task 1 was privately communicated to each subject according to the unanimous cohort-classification outcome of the evaluation process taking place at the end of task 2. For the 24/30 subjects not being randomly drawn to participate in task 2 this determined the experimental earnings (see Section 2.3 for treatment differences). For the 6/30 subjects randomly drawn to participate in task 2, the ranking in task 1, given the fractions x and y chosen in task 2, determined respectively the amounts invested in the outcome of transparent urn (first 3 subjects) and of the obscure urn (other 3 subjects). Then, 6 consecutive random draws made at the end of the experiment determined the experimental earnings for these 6 subjects. Besides the experimental earnings, all 30 subjects in a session received a 5 euro show-up fee, both in cash individually and privately. This determined an average payment

of 16.25 euro, for a 75 minutes average duration of a session, including instructions reading and subjects' individual payment.

2.3 The treatments

The experiment consisted in four different treatments according to four different types of *organizational modes* of the creative assignments in task 1. We had one individual treatment and three group treatments. For each treatment, two paper-and-pen sessions of 30 subjects each took place with a total of 60 subjects (30 students and 30 experts) per treatment.

Treatment **Individual** is the same as the Individual treatment of Charness and Grieco (2019) with close-creativity and financially-incentivized assignments. It consisted in asking subjects to perform individually within 15 minutes an assignment (draw, math, or verbal) in a creative manner, this assignment presenting constraints that a subject has to accomplish (see the Appendix). Subjects were sitting isolated (without having the chance to talk among them), and paid according to their individual performance only. Individual earnings were determined through a tournament scheme within each cohort: The most creative subject received a payoff of 15 euros, the least creative received a payoff of 3 euros, the three intermediate payoffs being respectively 12, 9, and 6 euros.

In the three **Group** treatments, the creative assignment was still individual; however, each subject was allocated to a group of 3 subjects having the chance to collaborate by talking and helping each other during the 15 minutes of task 1. More precisely, each subject performing a specific assignment (*e.g.*, draw task) was sitting close to other two subjects performing the other two types of assignment (*e.g.*, math and verbal tasks). In each of the two rooms, each group of 3 subjects was sitting isolated from the other 4 groups of 3 subjects in the room. No group deliverable has been allowed, neither switch between assignments.

In treatment **Group-no**, individual earnings were determined as in the Individual treatment, through the same within-cohort tournament scheme.

In treatment **Group-coop**, individual earnings were the average of the group earnings obtained in the three separate cohort tournaments. For example, suppose that a group was made by subjects 1, 2, and 3. Subject 1 has been assigned the draw task, subject 2 the math task, and subject 3 the verbal task. Also suppose that subject 1 was ranked 3rd in his/her

draw-cohort, subject 2 was ranked 1st in his/her math-cohort, and subejct 3 was ranked 4th in his/her verbal-cohort. Therefore, subject 1 brought 9 euros, subject 2 brought 15 euros, and subject 3 broought 6 euros to the group. Each of the three subjects got, as individual earnings, the average of these three earnings, *i.e.*, $(9 + 15 + 6)/3 = 10$ euros.

In treatment **Group-comp**, individual earnings were determined through within-group competition over the group earnings obtained in the three separate cohort tournaments. More precisely, in this treatment during the evaluation process each subject, besides his/her ranking within his/her cohort (implemented as in the other treatments), was also assigned by two judges being physically present at the experimental sessions (and not participating to it) a score (from 1 to 10) according to how creative his/her assignment was. The subject's ranking determined the earnings he/she brought to the group. His/her average judges' score determined which one of the three group earnings he/she was individually assigned. Consider the previous example, with subject 1 being ranked 3rd in his/her draw-cohort with an average judges' score of 8, subject 2 being ranked 1st in his/her math-cohort with an average judges' score of 6, and subejct 3 being ranked 4th in his/her verbal-cohort with an average judges' score of 7. Therefore, subject 1 brought 9 euros, subject 2 brought 15 euros, and subject 3 brought 6 euros to the group. By within-group competition over the marks, subject 1 got 15 euros, subject 2 got 6 euros, and subject 3 got 9 euros.

The last treatment replicated a common workplace situation in which each employee works in a team where he/she is responsible for a specific task, and at the end of the year/project the whole team will receive a bonus according to the success of the project, with profits being assigned among team members according to the relative individual performance within the team.

2.4 Post-experimental external evaluation of creativity

As explained in Section 2.2, evaluation of task 1 within the experiment (*i.e.*, to determine participants' earnings) was double blind, made at the end of task 2, by groups of a different classroom and creative assignment (cohort).

A few days after the last experimental session (May 2016), 4 external judges assigned a score (from 1 to 10) to each subject according to how creative his/her task-1 assignment was. This was necessary in order to obtain a measure of individual creativity for each of

the 240 participants independent of the type of session (Students or Experts) and the four treatments. This measure is the average score obtained by each participant for the creative performance in his/her task-1 assignment by the four external judges, and it represents the main object of our experimental hypotheses of Section 3, and the dependent variable of our data analysis in Section 4.

In particular, following Charness and Grieco (2019), the four judges are necessary in order not to lose one of the essential characteristics of creativity according to Amabile (1982): creativity has to be identified individually but by more than one appropriate observer. Moreover, no guiding definition of creativity was provided, since creativity is something that people can recognize by themselves (Amabile, 1982; Barron, 1965). Each task was evaluated on a 1–10 scale, being 1 the lowest possible level of creativity and 10 the highest.

The four external judges (two males, two females; two graduate students, a post-doctoral student, an artist), blind to treatments and conditions, did not know the identity of each other, and separately received a Dropbox folder invitation with 360 task-1 creative assignments, namely the 240 assignments of the experiment of this paper, and other 120 assignments of the same type of the companion paper we have mentioned in Section 2.1 (Attanasi et al. 2019). The 360 sheets were scanned in a random order and identified by a sequential number. To avoid biases due to accustomedness, two judges have been asked to evaluate the assignments starting from number 1 by following an increasing order, and the other two were asked to start from number 360 and follow a decreasing order. Each judge was given up to twelve hours to evaluate the 360 assignments and for this job he/she was paid 0.5 Euro per assignment (180 Euro in total).

3 Theoretical model and experimental hypotheses

3.1 Definitions of creativity and intrinsic motivation

With regards to the experimental setting presented in the previuos section, we rely on three complementary definitions of creativity: i) the production of novel and useful ideas *in any domain* (Stein 1974; Woodman *et al.* 1993), which explains the fact that we propose different creative tasks, namely graphical, mathematical and verbal; ii) the definition provided by Ochse and Ochse (1990, p. 4), which acknowledges a creative person as someone who has been recognized by experts opinion as being creative (Amabile 2012), which motivates our

choice of relying on four external judges with some experience in creative fields, coupled with Scott (2010), stating that creativity, to be so, must be recognized by the group; iii) the theory of creativity as an investment, thus stressing the role of the risk-taking attitudes, which is in line with the measurement of risk and ambiguity attitudes in task 2 of our experiment.

With respect to Charness and Grieco (2019) and previous theoretical and behavioral models of creativity, the new ingredient of our framework is the *interplay between intrinsic and extrinsic motivation to group creativity*. Empirical evidence shows that individual creativity is linked to intrinsic motivation (*e.g.*, Eisenberger and Shanock 2003). We assume that intrinsic motivation to be creative is boosted by the group working in the creative tasks: in the group treatments there is an intrinsic motivation to cooperate in the assignments (help the other two members by sharing creative ideas on each other's assignment). We also assume that group extrinsic motivation (group monetary incentives) crowds out intrinsic motivation (see, *e.g.*, Benabou and Tirole 2003). Finally, in line with the intuition that group extrinsic motivation to cooperate is detrimental to intrinsic motivation while group extrinsic motivation to compete is not, we assume that the crowding out occurs in the case of group payoff sharing (treatment *Group-coop*, with individual payoff equal to average group payoff) than in the case of within-group payoff competition (treatment *Group-comp*, with within-group tournament on the creative score in the individual task).

In the next subsection we present the theoretical model that relies on the above mentioned assumptions, by distinguishing between the case of complete information of subjects' high creative ability (Expert sessions) and the case of incomplete information of subject's creative ability (Student sessions).

3.2 A model of intrinsic motivation to group creativity

Call c_j subject j's creative ability. Suppose that it can only take two values $c_j \in \{0, 1\}$, with $c_j = 0$ indicating a non-creative subject and $c_j = 1$ indicating a creative subject.[3] We assume that in the Student sessions c_j is not known to the other experimental participants, since in these sessions there is common knowledge that every participant is an undergraduate stundent in Economics, which does not say much about a participant's creative ability. In the Expert sessions, c_j is commonly known to be equal to 1 for each experimental participant.

[3]The conclusions of our analysis also hold for the continous case $c_j \in [0, 1]$, with $c_j = 1$ indicating the highest level of creative ability in the population.

Call $e_j \in [0,1]$ player j's effort in the creative assignment.

The expected monetary payoff of player j, m_j, positively depends on the creativity shown in the assignment after the 15 minutes of work, which in turn is assumed increasing in the individual creative ability c_j and effort e_j in the assignment. We also assume a positive interplay between effort and creative ability, *i.e.*, $(\partial^2 m_j / \partial e_j \partial c_j) > 0$.

We disentangle m_j into m_j^i—the payoff arising because of the individual creative ability c_j and effort e_j—and m_j^g—the payoff arising because of group collaboration in j's creative task. Both payoffs positively contribute to the expected monetary payoff, *i.e.*, $m_j = m_j^i + m_j^g$, and are uncertain, because of the tournament scheme and — in the group treatments — also of the group interaction.

As regards the latter, in all treatments but the *Individual* treatment, subject j is assigned to a group of 3 members, who can talk to each other while completing their different creative assignment (resp., draw, math, and verbal). Call t_j the percentage of time subject j uses to *t*alk with the other two subjects in his/her group during the 15-minute creative task, thereby sharing creative ideas: $t_j = 0$ indicates a subject who essentially works alone and in isolation, while $t_j = 1$ indicates a subject using all his/her 15-minute time to talk and share ideas with the other two. We assume m_j^g to be boosted by both t_j and t_{-j}, the latter representing the percentage of time the other two subjects in the group use to talk with subject j.

Furthermore, m_j^g is increasing in c_{-j}, the creative ability of the other group members talking with j thereby sharing ideas about j's assignment. We also assume that m_j^g depends on e_{-j}, the other subjects' creative effort, although, by design, a subject cannot physically intervene with his/her pen on the paper assignment of another one. However, we interpret a subject's creative effort e_j as the whole creative mental effort he/she exerts during the 15 minutes of task 1. Hence, we implicitly assume that a subject exerts the same level of effort e_j in his/her assigned individual task and in the task of the other group members, if he/she decides to spend time to share ideas with them, *i.e.*, in the case $t_j > 0$. Therefore, the convex cost of effort, $(e_j)^2/2$, represents the cost of the individual effort exerted in all group assignments, which shrinks to the individual effort exerted in one's own assignment if $t_j = 0$. The latter holds by construction in the *Individual* treatment.

Finally, we assume that j has social preferences in the sense of an **intrinsic motivation to group creativity**: he/she gets additional utility from the creativity generated on the

assignments of the other two group members, $-j$, by talking with them. Recall that the creativity shown in $-j$'s assignment positively impacts on $-j$'s monetary payoff through the tournament scheme. Thus, we model j's intrinsic motivation to group creativity through j's utility being increasing in m^g_{-j}, the monetary payoff of the other group members due to j's sharing ideas on their creative task. As above for m^g_j increasing in c_{-j}, we assume that m^g_{-j} positively depends on j's creative ability, besides $-j$'s effort. To simplify the functional form of the utility, we further assume that j's contribution to the monetary payoffs from his/her creative ability and effort is a convex linear combination of the individually-generated payoff, $m^i_j(c_j, e_j)$, and the one generated by collaboration in group creativity, $[m^g_{-j}(c_j, e_j) + t_{-j} \cdot m^g_j(c_{-j}, e_{-j})]$, with weights $(1 - t_j)$ and t_j, respectively. Notice that, due to j's intrinsic motivation, $m^g_{-j}(c_j, e_j)$ positively impacts on j's utility independently of t_{-j} (time spent to talk by the other two subjects in j's group). Conversely, to generate $m^g_j(c_{-j}, e_{-j})$, an interaction between t_j and t_{-j} is needed.

With all this in mind, the generalized version of subject j's utility function is given by:

$$u_j(e_j, e_{-j}, t_j, t_{-j}|c_j) = (1 - t_j) \cdot m^i_j(c_j, e_j) + t_j \cdot [m^g_{-j}(c_j, e_j) + t_{-j} \cdot m^g_j(c_{-j}, , e_{-j})] - \frac{e_j^2}{2} \quad (1)$$

Eq. (1) represents the trade off between group "competition" and "cooperation" in the three creative tasks within a group. Competing means using the available time for individual work on one's own task (lower t_j). Cooperating means using the available time to share ideas with the other group members (higher t_j). Each player chooses e_j and t_j in order to maximize u_j in eq. (1), knowing his/her own creative ability c_j. The other group member's creative ability $c_{-j} \in \{0, 1\}$ is unknown in the *Student* sessions and commonly known to be $c_{-j} = 1$ in the *Expert* sessions.

Let us now determine the equilibrium values e^*_j and t^*_j in each treatment. First, we focus on the *Student* sessions, where e^*_j and t^*_j also depend on j's beliefs about c_{-j}.

In the **Individual** treatment, $t_j = t_{-j} = 0$ by construction. In fact, absent a group, j cannot talk with the other group members ($t_j = 0$) and the other group members cannot talk with j ($t_{-j} = 0$) during the 15 minutes of the assignment. Therefore, eq. (1) reduces to

$$u_j(m_j, c_j, e_j) = m^i_j(c_j, e_j) - (e_j)^2 / 2 \quad (2)$$

where neither extrinsic nor intrinsic motivation to group collaboration creativity is possible.

The FOC for (2) with respect to e_j leads to

$$e_j^{ind} = \frac{\partial m_j^i}{\partial e_j^{ind}} \tag{3}$$

Deriving (3) with respect to the creative ability, due to the assumption $(\partial^2 m_j / \partial e_j \partial c_j) > 0$, we get the standard result that the creative effort is increasing in the creative ability.

In treatment **Group-no**, we rely on eq. (1), with intrinsic motivation to group collaboration. The FOCs for (1) with respect to e_j and t_j lead respectively to

$$e_j^{intr} = \frac{\partial m_j^i}{\partial e_j^{intr}} + t_j^{intr} \cdot \left(\frac{\partial m_{-j}^g}{\partial e_j^{intr}} - \frac{\partial m_j^i}{\partial e_j^{intr}} \right) \tag{4}$$

and

$$m_j^i(c_j, e_j^{intr}) = m_{-j}^g(c_j, e_j^{intr}) + t_{-j} \cdot m_j^g(c_{-j}, e_{-j}) \tag{5}$$

where $e_j^{intr} > 0$ is determined in equilibrium from (5) by comparing the individual payoff a subject gets by working alone on his/her own task m_j^i (cost) and the sum of the individual payoffs the other two group members get and the individual payoff he/she gets because of group collaboration (benefit). The latter depends on t_{-j}, *i.e.*, the time spent in group collaboration by the other two group members. Note that in the Expert treatments where it is common knowledge that $c_j = c_{-j} = 1$; then, $m_j^i(c_j, e_j^{intr}) = m_j^g(c_{-j}, e_{-j}^{intr})$ in equilibrium, and the right-hand side of (5) is greater than the left-hand side, because of the intrinsic motivation $m_{-j}^g(c_j, e_j^{intr}) > 0$. Therefore, we have the corner solution $t_j^{intr} = 1$ for each j. Comparing (4) to (3), we get that $e_j^{intr} > e_j^{ind}$ if the subject's intrinsic motivation is strong enough, *i.e.*, $\left(\frac{\partial m_{-j}^g}{\partial e_j^{intr}} - \frac{\partial m_j^i}{\partial e_j^{intr}} \right) > 0$ in the right-hand side of (4). In other words, the increase in the other group members' payoffs due to the subject's creativity is greater than the one he/she would have gotten had he/she used time t_j to work on his/her assignment in isolation. In that case, the size of the positive difference $(e_j^{intr} - e_j^{ind})$ is greater in the Expert than in the Student sessions, since in the former it is $t_j^{intr} = 1$, due to complete information about $c_j = 1$ for each j. This ultimately boosts the average creativity level in the *Group-no* with respect to the *Individual* treatment.

In the **Group-coop** treatment, each subject in the group is paid the average group payoff

$$\bar{m}_j(c_j, e_j) = \frac{1}{3} \sum_{j=1}^{3} m_j(c_j, e_j) = \frac{1}{3} \sum_{j=1}^{3} [m_j^i(c_j, e_j) + m_j^g(c_{-j}, e_{-j})] \tag{6}$$

Therefore, group collaboration leads to an increase in one's own average payoff. Following Benabou and Tirole (2003), we assume that this crowds out intrinsic motivation. Therefore, the utility function introduced in eq. (1) shrinks to

$$u_j(e_j, e_{-j}, t_j, t_{-j}|c_j) = (1 - t_j) \cdot \bar{m}_j^i(c_j, e_j) + t_j \cdot t_{-j} \cdot \bar{m}_j^g(c_{-j}, e_{-j}) - \frac{e_j^2}{2} \tag{7}$$

where, from eq. (6), $\bar{m}_j^i(c_j, e_j) = \frac{1}{3}\sum_j m_j^i(c_j, e_j)$ is the average individually accrued payoff, and $\bar{m}_j^g(c_{-j}, e_{-j}) = \frac{1}{3}\sum_j m_j^g(c_{-j}, e_{-j})$ is the average payoff accrued through group collaboration. Note that $\bar{m}_j^i(c_j, e_j) + \bar{m}_j^g(c_j, e_j)$ is the right-hand side of eq. (6). Then, the FOCs for (7) with respect to e_j and t_j lead respectively to

$$e_j^{coop} = (1 - t_j^{coop}) \cdot \frac{\partial \bar{m}_j^i}{\partial e_j^{coop}} \tag{8}$$

and

$$\bar{m}_j^i(c_j, e_j^{coop}) = t_{-j} \cdot \bar{m}_j^g(c_{-j}, e_{-j}) \tag{9}$$

Comparing (8) to (4) for the equilibrium effort, and (9) to (5) for the equilibrium shared time, it is easy to check that $e_j^{coop} < e_j^{intr}$ and $t_j^{coop} < t_j^{intr}$, respectively. This ultimately reduces the average creativity level in the *Group-coop* with respect to the *Group-no* treatment. The size of the negative difference $(e_j^{coop} - e_j^{intr})$ is greater in the Expert than in the Student sessions. In fact, due to complete information about $c_j = 1$ for each j, it is $t_j^{coop} = 1$, *i.e.*, using time to talk with commonly-known creative subjects in the group is profitable, which, absent intrinsic motivation to group creativity, shrinks the effort j puts in helping the other group members in their assignment, thereby reducing e_j^{coop}. Since also in treatment *Group-no* it is $t_j^{intr} = 1$, the size of the negative difference $(e_j^{coop} - e_j^{intr})$ increases with respect to the Student sessions, where instead $t_j^{coop} < 1$ and $e_j^{intr} < 1$, depending on j's beliefs on c_{-j}.

Finally, in the **Group-comp** treatment, each subject brings to the group a prize by within-cohort competition (*i.e.*, within draw-cohort, math-cohort, and verbal-cohort). Then, these three prizes are assigned according to within-group competition. Hence, within-group cooperation increases the average group payoff $\bar{m}_j$, since it increases the size of each prize a subject brings to the group from within-cohort competition by his/her side. However, at the same time it decreases (resp., increases) the probability that j will get the highest (resp., lowest) of the three prizes, due to less within-group competition. Therefore, intrinsic

motivation is needed to establish full within-group cooperation, since a subject has to accept that helping other group members in their own assignment could ultimately lead to a lower individual payoff. With all this in mind, the net effect of the **Group-comp** *vs.* **Group-coop** manipulation is the re-introduction of intrinsic motivation to group collaboration. Therefore, a good approximation of j's utility function in this treatment is eq. (6) where $t_j \cdot \bar{m}^g_{-j}(c_j, e_j)$ adds to the right-hand side. In fact, by using his/her own time to help other group members, j ultimately increases the other group members' payoff (eventually to the detriment of his/her own). Then, the FOCs of the extended version of (6) with respect to e_j and t_j lead respectively to

$$e_j^{comp} = (1 - t_j^{comp}) \cdot \frac{\partial \bar{m}^i_j}{\partial e_j^{comp}} + \frac{\partial \bar{m}^g_j}{\partial e_j^{comp}} \tag{10}$$

and

$$\bar{m}^i_j(c_j, e_j^{comp}) = \bar{m}^g_{-j}(c_j, e_j^{comp}) + t_{-j} \cdot \bar{m}^g_j(c_{-j}, e_{-j}) \tag{11}$$

Comparing (10) to (8) for the equilibrium effort, and (11) to (9) for the equilibrium shared time, it is easy to check that $e_j^{comp} > e_j^{coop}$ and $t_j^{comp} > t_j^{coop}$, respectively. This ultimately increases the average creativity level in the *Group-comp* with respect to the *Group-coop* treatment. The size of the positive difference $(e_j^{comp} - e_j^{coop})$ is greater in the Expert than in the Student sessions, due to $t_j^{comp} = t_j^{coop} = 1$ in the former sessions.

3.3 Experimental hypotheses

Our theory-driven experimental hypotheses rely on the model presented in Section 3.2. All experimental hypotheses concern treatment differences about the average score obtained by experimental participants for the creative performance in their task-1 assignment. This average score is the result of the indepedent evaluation made by the four experimental judges after the end of all experimental sessions (see Section 2.4 for the details). We call *Creativity* that average score obtained by an experimental participant. We have checked that j's post-experimental score represents a good approximation of his/her experimental earnings from task 1, due to a significant correlation between the former and m_j.

The first experimental hypothesis compares average *Creativity* between treatments *Individual* and *Group-no*, due to intrinsic motivation to co-working in the creative assignments that characterizes the latter treatment.

H.1 *Average* Creativity *is significantly higher in* Group-no *treatment than in the* Individual *treatment.*

The second experimental hypothesis compares average *Creativity* between treatments *Group-no* and *Group-coop*, relying on the assumption that extrinsic motivation to group cooperation introduced in the latter treatment crowds out the intrinsic motivation.

H.2 *Average* Creativity *is significantly higher in* Group-no *treatment than in* Group-coop *treatment.*

The third experimental hypothesis compares average *Creativity* between treatments *Group-coop* and *Group-comp*. It relies on the assumption that the extrinsic motivation to compete (introduced in treatment *Group-comp*) counterbalances the extrinsic motivation to cooperate (common to both treatments), thereby re-establishing the intrinsic motivation to co-working on creative ideas.

H.3 *Average* Creativity *is significantly higher in* Group-comp *treatment than in* Group-coop *treatment.*

The last experimental hypothesis concerns the increased saliency in the *Expert* sessions of the treatment differences in H1–H3, due to common knowledge of high individual creative abilities in the *Expert* sessions *vs.* incomplete information of this feature in the *Student* sessions.

H.4 *The treatment differences about average* Creativity *hypothesized in H.1–H.3 are more salient in the* Expert *than in the* Student *sessions.*

4 Results

4.1 Dependent variable: Judges' evaluation of creativity

Table 2 provides information about the Cronbach Alpha test for the consistency of external evaluations among the four judges for the 240 assignments of our experimental subjects (120 students, 120 experts). The four evaluations exhibited a very good degree of correlation (Cronbach's alpha = 0.7989). This correlation is very high also if we include the remaining

120 assignments the four referees were evaluating (Cronbach's alpha = 0.7975 by considering all the 360 assignments, *i.e.*, also those made in Vietnam and analyzed in Attanasi *et al.* 2019). With this in mind, we call the average of the four judges' evaluation of a subject's assignment as his/her *Creativity*. The latter will be the dependent variable of our data analysis in Section 4.2.3.

Table 1: Cronbach Alpha and Related Statistics

Judges	item-test correlation	item-rest correlation	**average interim correlation**	**alpha**
Judge 1	0.8010	0.6291	0.4863	0.7396
Judge 2	0.8393	0.6931	0.4460	0.7072
Judge 3	0.7625	0.5675	0.5269	0.7696
Judge 4	0.7561	0.5575	0.5337	0.7744
Test scale			**0.4982**	**0.7989**

4.2 Explanatory variables

Recall that all experimental hypotheses presented in Section 3.3 concern treatment differences about the average *Creativity* of subjects in task-1 assignment. Therefore, our main explanatory variables are the three group-treatment dummies *Group-no*, *Group-coop*, and *Group-comp*, which take value 1 if a subject participated in the experiment in a *Group* treatment, respectively under a *no*, *coop*, or *comp* monetary incentive scheme. Treatment *Individual* is the control category.

Before presenting the results on the determinant of *Creativity* in Section 4.3, we present the other explanatory variables of our analysis, *i.e.*, those that are not theory-driven but could anyway be important determinants of creativity according to the literature in experimental economics (Task 2), or in social/cultural economics and economic geography (Final Questionnaire).

4.2.1 Task 2: Risk and ambiguity attitudes

Recall that in task 2 we measure risk and ambiguity attitudes by means of two incentivized questions (Gneezy and Potters 1997 for risk attitude; Charness and Gneezy 2010 for ambiguity attitude). Participants had to make an investment choice of the unknown award for the previously performed task 1. In particular, in the Gneezy-Potters' task, each subject was asked to indicate the percentage x from 0% to 100% of his/her tournament award that

he/she wanted to invest, knowing that there were 50% chances of receiving 2.5 times the invested amount and 50% of losing the invested amount. In the Charness-Gneezy's task, the same question about investment percentage y was asked, this time under unknown probabilities of the good – receiving 2.5 the invested amount – and the bad – losing the invested amount – state of the world.

From the Gneezy-Potter's risky task, we create the variable called *Risk Aversion*, which is the opposite sign of the invested percentage x. From the Charness-Gneezy's ambiguous task, we create the dummy variable *Ambiguity Aversion*, which is 1 for those participants that selected a lower percentage of investment at the ambiguous task than in the risky task (*i.e.*, $y < x$), and 0 otherwise.

4.2.2 Final Questionnaire

Recall that the questionnaire distributed at the end of the experiment contained 30 items borrowed from social/cultural economics and economic geography literature. The majority of them have been used for the cultural and geographical comparison of *Creativity* between France and Vietnam in the companion paper Attanasi *et al.* (2019). Here we present those used in the analysis of this paper. They can be grouped in four categories:

Demographic characteristics. *Gender* takes value 0 when the subject is male and 1 when is female. *Origin* takes value 1 if the participant is originary from Strasbourg, *i.e.*, the place where the experiment was run, and 0 otherwise.

Individual attitudes. *Self-assessed Creativity*: We ask the subject whether he/she defines him/herself as creative, non-creative, or he/she does not know. This variable takes value 1 if the subject answers the question affirmatively and 0 otherwise. *Leisure Activities*: We ask the subject how often does he/she go to the cinema, theater or to concerts. We assign value 1 if he/she declares to attend at least two or three times a week, and 0 otherwise (*i.e.*, if he/she declares to attend once a month or less than once a month). *Homosexual Friends* takes value 1 if the subject declares to have homosexual friends, and 0 otherwise. This can be considered as a variable to measure openness to different sexual orientations of individuals.

Social attitudes. *Social Activities*. We ask the subject how often does he/she meets his/her friends in his/her free time, and how often does he/she go out in the evening. We assign value 1 if he/she indicates that he/she goes out in the evening and meets his/her friends at least two or three times a week. We assign value 0 when he/she responds to at least

one of the two previous questions saying once a month or less than once a month. *Cultural Association Membership* takes value 1 if the subject belongs to any cultural association and 0 otherwise.

Social beliefs. *Generalized Trust* takes value 1 if the subject thinks that in general most people can be trusted and 0 if he/she thinks that distrusting them is better. *City tolerance* takes value 1 if the subject thinks that the city he/she lives in is tolerant, and 0 otherwise.

4.3 Test of experimental hypotheses

Figure 1 reports the average *Creativity* of the 240 subjects in our experiment, disentangled by treatment, by pooling Students and Experts (*i.e.*, 60 subjects per treatment). Dotted lines indicate treatment differences significant at the 10% level. Dashed lines indicate treatment differences significant at the 5% level. Continuous lines indicate treatment differences significant at the 1% level. Significant differences are stated according to a t-test of pairwise comparison of average *Creativity* across treatments.

Figure 1: Average creativity across treatments, pooled sample.

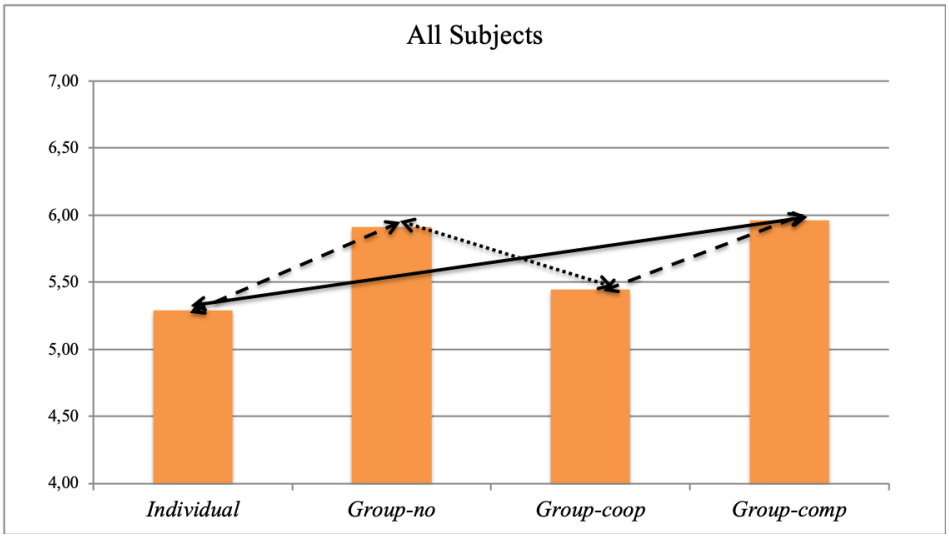


Figure 1 shows that H1 (*Group-no vs. Individual*) is verified (difference significant at the 5% level), thereby suggesting that intrinsic motivation to group collaboration does increase the average individual creativity. Therefore, the following result can be stated.

Result 1 *Group collaboration in creative assignments with no monetary incentive significantly increases creativity compared to individual work. This seems to be associated to intrinsic motivation to group collaboration.*

Figure 1 also indicates that H2 (*Group-no vs. Group-coop*) is verified (difference significant at the 10% level). In particular, the slight increase in average *Creativity* in the *Group-coop* with respect to the *Individual* treatment is non-significant. This leads us to conclude that the crowding out of intrinsic motivation due to the exogenous introduction of an extrinsic motivation to collaborate makes the positive effect of group interaction on creativity negligible. Therefore, the following result can be stated.

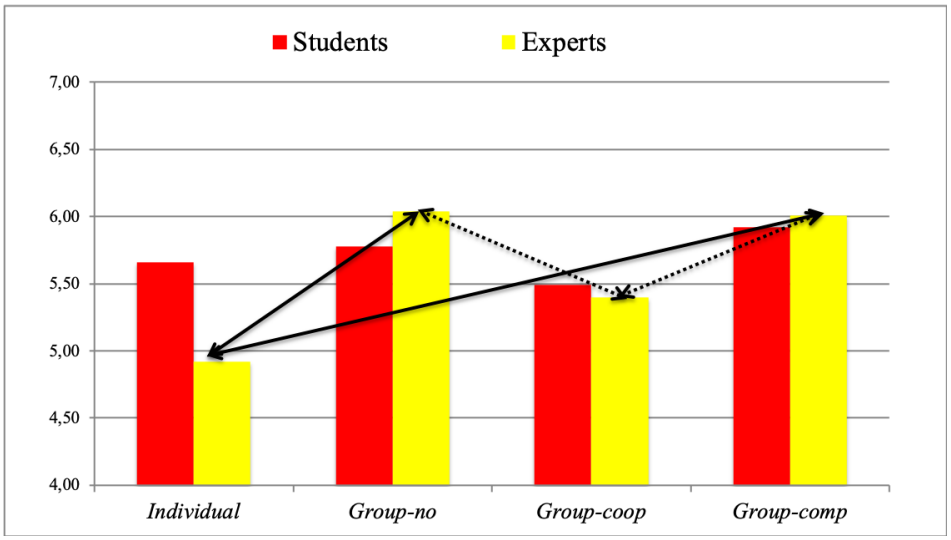
Result 2 *Monetary incentive to group collaboration in creative assignments does not increase creativity compared to individual work. This seems to be associated to a crowding out of intrinsic motivation to group collaboration.*

Finally, Figure 1 shows that H3 (*Group-comp vs. Group-coop*) is verified (difference significant at the 5% level). Indeed, Result 2 states that positive extrinsic motivation to group creativity hinders the increase in creativity. Adding a negative extrinsic motivation to the positive one, counterbalances this effect. Indeed, in that case intrinsic motivation is needed in order to collaborate with other subjects that are (also) in competition with you. This monetary scheme which combines extrinsic motivation to collaborate with extrinsic motivate to compete in the group ultimately leads to a significant (at the 1% level) increase in creativity with respect to the *Individual* treatment. Therefore, the following result can be stated.

Result 3 *Monetary incentive to group cooperation coupled with monetary incentive to group competition in creative assignments significantly increase creativity compared to individual work. This seems to be due to the latter extrinsic motivation counterbalacing the former in its crowding out of intrinsic motivation to group collaboration.*

Let us now look at Figure 2, where we disentangle the observations about average *Creativity* into the two categories of Students and Experts.

Figure 2: Average creativity across treatments, disentangled by type of sessions.



The former category (red bars) concerns experimental sessions where it was common knowledge that all participants were undergraduate *Students* of the University of Strasbourg. The latter category (yellow bars) includes instead experimental sessions where participants were *Experts* in creativity operating in the region of Strasbourg.

To provide econometric support to the results shown in Figure 2, we perform parametric regressions to test the effect of the candidate explanatory variables introduced in Section 4.2 over the (average Judges' evaluation of subjects') *Creativity*. Results of the regression analysis are shown in Table 2.

Looking at the red bars of Figure 2, we note that Students' creativity does not change much across treatments, with no pair of treatments showing a significant difference. However, the direction of increase is the one predicted by our model of Section 3.2, with average creativity in the *Group* treatments being greater than in the *Individual* treatment under both *Group-no* and *Group-comp* scheme (respectively, 5.78 and 5.92 *vs.* 5.66), but not under *Group-coop* scheme (5.49). Table 2 confirms that all the group treatment dummies have the predicted positive sign, although only *Group-no* treatment has a significant effect over the *Individual* treatment (at the 10% level), and only when introducing the controls for demographic characteristics and individual and social attitudes. All this is coherent with our model predictions. In fact, incomplete information about subjects' creative ability in the experimental session – which characterizes *Student* sessions – hinders the positive impact of

group interaction on average group's creativity.

As for risk and ambiguity attitudes, we find no effect of the latter on *Creativity* in the *Student* sessions. Quite surprisingly, differently from what found in the literature on economics of innovation – higher risk proneness correlates with higher creative and innovation attitudes –, we find that a higher degree of monetary risk aversion detected in task 2 is associated with a more creative assignment in task 1 of our experiment. We have two complementary explanations for this finding. The first interpretation highlights the specific features of the *close* creativity assignments – draw, math, and verbal – that we borrowed from Charness and Grieco (2019). In fact, all these assignments involved a constraint that subjects had to satisfy, namely a minimum number of geometric forms in the draw assignment, a minimum number of mathematical operations in the math assignment, and a minimum number of words in the verbal assignment. Risk-averse subjects showed more accuracy in satisfying these constraints, thereby ensuring themselves a higher "sure" payoff under tournament evaluation of their *Creativity*. The second interpretation relies on the specific features of the risk-elicitation task 2. This task is a modified version of the one of Gneezy and Potters (1997), which – following Charness and Grieco (2019) – we have proposed without previously telling subjects their earnings from (creative) task 1. Therefore, when subjects choose the percentage x of their earnings from task 1 to invest in the risky lottery of task 2, they do not know the actual invested amount, although they can form expectations about it. Here we suppose that the higher their *Self-assessed Creativity* (elicited through the Final Questionnaire), the higher the expected earnings from task 1, hence the higher the invested amount for the same percentage x chosen in the Gneezy-Potter's task 2. If Constant Absolute Risk Aversion (CARA) is assumed, as Charness and Grieco (2019) do, then no measurement problem arises under uncertainty of this invested amount: being risk aversion independent from the initial wealth, the elicited degree of risk aversion only depends on x. However, if Constant Relative Risk Aversion (CRRA) is assumed, as it seems it might be the case in these kinds of elicitation tasks (see, *e.g.*, Crosetto and Filippin 2016, and Attanasi *et al.* 2018), then the higher the (expected) earnings from task 1, the higher x a risk-averse subject would indicate in task 2. Therefore, a CRRA assumption might explain the positive impact of x over experimentally measured *Creativity* as not (only) due to monetary risk aversion, but rather to *Self-assessed Creativity*.

Table 2: Marginal effects from ordinary least squares regressions, explaining average judges' score

Variables	Students w/o controls	Students w/ controls	Experts w/o controls	Experts w/ controls
Group-no	0.455	0.589*	1.114**	1.150***
	(0.334)	(0.352)	(0.446)	(0.418)
Group-coop	0.139	0.180	0.461	0.508
	(0.396)	(0.394)	(0.434)	(0.452)
Group-comp	0.606	0.683	1.087**	1.140**
	(0.385)	(0.423)	(0.422)	(0.488)
Risk Aversion	0.022***	0.026***	0.002	0.006
	(0.006)	(0.006)	(0.006)	(0.006)
Ambiguity Aversion	-0.213	-0.278	-0.135	-0.248
	(0.187)	(0.195)	(0.236)	(0.240)
Gender		-0.058		-0.064
		(0.258)		(0.334)
Origin		-0.422		0.158
		(0.273)		(0.370)
Self-assessed Creativity		0.007		0.410
		(0.290)		(0.337)
Leisure activities		0.042		-0.009
		(0.274)		(0.434)
Homosexual Friends		0.355		-0.377
		(0.241)		(0.436)
Social activities		0.558*		0.211
		(0.300)		(0.366)
Cultural Association Membership		0.084		-0.774**
		(0.458)		(0.375)
Generalized Trust		0.642**		0.470
		(0.306)		(0.541)
City Tolerance		-0.849***		-0.269
		(0.293)		(0.699)
Constant	6.377***	6.386***	5.015***	5.273***
	(0.327)	(0.707)	(0.441)	(0.962)
Observations	120	120	120	119
R-squared	0.156	0.300	0.076	0.135

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Among the controls, both *Generalized Trust* and *City Tolerance* play a significant effect on *Creativity* in the direction predicted by the literature on cutural and social economics. Indeed, the former plays a positive effect: the higher the level of a subject's perception that in general most people can be trusted, the higher his/her willingness to cooperate in group creativity; the latter plays instead a negative effect: the higher the subject's perceived tolerance of the city he/she lives in, the lower the willingness/need to be creative so as to increase city tolerance.

All this leads to state the following result:

Result 4 *The positive impact of group interaction and of intrinsic motivation to it over average group creativity is low a non-significant in the Student session, where there is incomplete information of subjects' creative ability. In these sessions, subjects' creativity positively depends on their risk aversion and social beliefs.*

Finally, we focus on the *Expert* sessions, where it is common knowledge that all experimental participants have expertise on creative activities. Again in line with the predictions of our model, Figure 2 shows a general "group-creativity" effect, that is not significant only in treatment *Group-coop*. More precisely, H1 (*Group-no vs. Individual*) is verified (difference significant at the 1% level); H2 (*Group-no vs. Group-coop*) is verified (difference significant at the 10% level); H2 (*Group-comp vs. Group-coop*) is verified (difference significant at the 10% level).

Therefore, both incentive schemes which allow for intrinsic motivation to group interaction (*i.e.*, *Group-no* and *Group-comp*) produce an increase in individual *Creativity* as compared to the *Individual* treatment (both differences significant at the 1% level). This is also confirmed by the regression analysis of Table 2, where both the dummy *Group-no* and the dummy *Group-comp* are significant, independently from including or not in the regression the controls for demographic characteristics and individual and social attitudes.

Conversely, although the *Group-coop* dummy has the predicted positive sign, its effect on individual *Creativity* due to co-working is not significant, eventually due to crowding out of intrinsic motivation. This confirms the non-significant difference in average *Creativity* between the *Group-coop* and the *Individual* treatment (5.40 *vs.* 4.92).

As for risk and ambiguity attitudes, we find no significant effect on the Experts' *Creativity*, although the sign of both *Risk Aversion* and of *Ambiguity Aversion* are the same found

in the *Student* sessions, respectively.

As for the controls, none of the demographic characteristics or individual and social attitudes has a significant effect on the Experts' *Creativity*. To be more precise, only *Cultural Association Membership* has a significant effect, but of the opposite sign than the one predicted by the literature on cultural economics. All this is not surprising: Experts are creative due to their own daily work/research on creativity. Therefore, holding already a high creative ability (*i.e.*, $c_j = 1$ in our model of Section 3.2), idiosyncratic features should not boost this (already high) ability. Recall that the picture is different in the *Student* sessions (see the last part of Result 4), for which in our model it is assumed a heterogeneous distribution of creative ability (*e.g.*, $c_j \in \{0, 1\}$), and incomplete information about it.

All this leads to state the last result:

Result 5 *Common knowledge of subjects' creative ability boosts the positive effect of the intrinsic motivation to group interaction in providing creative assignments.*

Therefore, psychological factors (risk attitudes) and social factors (generalized trust) usually found to stimulate creativity only impact on the creativity produced by undergraduate students. For experts in creativity, we only detect significant treatment effects, in line with our theoretical predictions. We interpret this finding as important support for the application of our results in designing right organizational modes to stimulate group creativity.

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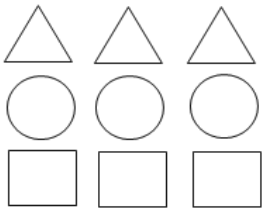
Appendix: Close-creativity Assignments (Task 1)

Draw

ASSIGNMENT ♥

Draw a picture using any combination of shapes you like: the only constraint you have is that you must use all the following shapes:



Math

ASSIGNMENT ♣

Starting from the number 27, obtain the number 6 by using at least two different numerical operations. Possible answers include: $(27 : 3) - 3 = 6$, or $[(27 + 3) : 2 - 12]! = 6$.

Verbal

ASSIGNMENT ♠

Choose a combination of words in the list below to create an interesting story:
House, Zero, Forgive, Curve, Relevance, Cow, Tree, Planet, Ring, Send