

## REEXPRESSING THE NEGATIVE EXTERNALITY

A simple algebraic reframing highlights the equivalence between a positive externality in production and an enhanced negative externality in rent-seeking; letting  $x_{-i} = \sum_{j \neq i} x_j$ :

$$\alpha(1 - x_i) + \beta \sum_{j \neq i} (1 - x_j) + R \frac{x_i}{\sum_j x_j} \equiv \alpha(1 - x_i) + (n - 1)\beta - \beta x_{-i} + R \frac{x_i}{x_i + x_{-i}}$$

## MODELING INSTITUTIONS

Let  $\theta \geq 0$  denote the quality of institutions; redefine  $i$ 's payoff as:

$$y_i = \alpha(1 - x_i) + \beta \sum_{j \neq i} (1 - x_j) + R[1 - f(\theta)] \left( \frac{x_i}{\sum_j x_j} \right) + \delta_i R f(\theta) + g(\theta) \sum_{j \neq i} y_j - h(\theta) x_i$$

$$\delta_i \geq 0, \quad \sum_i \delta_i = 1$$

$$f' \geq 0, g' \geq 0, h' \geq 0, \quad f(0) = g(0) = h(0) = 0, \quad f(\theta) \in [0,1]$$

Each of the functions  $f, g, h$  refers to an aspect of good institutions described by Ostrom (2000) and others. When  $\theta = 0$ , the payoff function reduces to its original form. The value of  $\theta$  does not alter the fact that  $x_i = 0 \forall i$  is efficient.

$f$  (inversely) refers to the scope for rent-seeking in the natural resource sector. With transparent control of the natural resource sector and a clear allocation of property rights ( $f(\theta) = 1$ ), each player  $i$  receives a fixed share  $\delta_i$  of natural resource income, and rent-seeking is completely ineffective in securing a larger share of natural resource income. Thus for a sufficiently large  $f$ , players play cooperatively.

$g$  is a (positive) measure of other-regarding preferences (There are many ways to model other-regarding preferences; this happens to be the simplest one). It reflects the finding that successful cooperation is often underpinned by a sense of community and mutual affection (Durlauf and Fafchamps 2004); alternatively, it can reflect a social norm about anti-social behavior (both relate to the literature on social capital). The larger  $g$ , the greater the marginal incentive to refrain from rent-seeking due to its adverse effect on other players' payoffs. For a sufficiently large  $g$ , players play (approximately) cooperatively as the symmetric Nash equilibrium and efficient outcome converge. (As long as  $f(\theta) < 1$ , the upper- and lower-Inada conditions apply to  $y_i$  with respect to  $x_i$ , and so there will always be some positive rent-seeking under the symmetric Nash. However this amount tends to zero as  $\theta$  increases.) Communication is critical for establishing social norms and mutual affection (Ostrom 2000, Durlauf and Fafchamps 2004).

$h$  is a (positive) measure of punishment for rent-seeking. The larger  $h$ , the greater the marginal incentive to refrain from rent-seeking, and for a sufficiently large  $h$ , players play (approximately) cooperatively. Effective punishment requires monitoring and communication systems, especially in the case of verbal sanctions, which have been shown to be effective in social dilemma situations (Ostrom et al. 1992).

If we solve for the symmetric Nash equilibrium under the new payoff function, letting  $\gamma(\theta) = \alpha + (n-1)\beta g(\theta) + h(\theta) > 0 \Rightarrow \gamma'(\theta) \geq 0$ , we obtain:

$$x^{NE} = \frac{(n-1)R[1-f(\theta)]}{n^2\gamma(\theta)}; \quad \frac{\partial x^{NE}}{\partial R} = \frac{(n-1)[1-f(\theta)]}{n^2\gamma(\theta)} \geq 0;$$

$$\frac{\partial^2 x^{NE}}{\partial R \partial \theta} = -\frac{(n-1)[\gamma(\theta)f'(\theta) + \gamma'(\theta)(1-f(\theta))]}{[n\gamma(\theta)]^2} \leq 0$$

In words, assuming a quality of institutions that does not induce a corner solution, resource booms still cause increased rent-seeking. However the higher the quality of institutions  $\theta$ , the lower the responsiveness of rent-seeking to a resource boom.

Defining *measured* GDP ( $Y$ ) as output ignoring social preferences  $g(\theta)$  and punishment  $h(\theta)$  yields:

$$\frac{\partial^2 Y^{NE}}{\partial R \partial \theta} = -\beta n(n-1) \frac{\partial^2 x^{NE}}{\partial R \partial \theta} \geq 0$$

These comparative statics represent continuous versions of the dichotomies presented in Proposition 1 and Proposition 2. The difference between Nash (non-cooperative) and efficient (cooperative) behavior shrinks and ultimately vanishes as institutions  $\theta$  improve in quality. Finally, since communications and monitoring are important determinants of institutional quality, we arrive at Proposition 3.

## MODEL PROOFS

Player  $i$ 's problem:

$$\max_{x_i \in [0,1]} \left\{ \alpha(1-x_i) + \beta \sum_{j \neq i} (1-x_j) + R \frac{x_i}{\sum_j x_j} \right\}$$

This is globally concave and so the first-order condition is sufficient; we only have to make sure that it corresponds to an element of the support. The first-order condition is:

$$-\alpha + \frac{\sum_{j \neq i} x_j}{(\sum_j x_j)^2} R = 0$$

Setting  $x_j = x \forall j$ , we solve for the symmetric Nash equilibrium:

$$\frac{n-1}{n^2 x} = \frac{\alpha}{R} \Rightarrow x^{NE} = \frac{(n-1)R}{\alpha n^2}; \quad \frac{\partial x^{NE}}{\partial R} = \frac{(n-1)}{\alpha n^2} > 0$$

GDP:

$$\begin{aligned} Y &= \sum_i \left\{ \alpha(1-x_i) + \beta \sum_{j \neq i} (1-x_j) + R \frac{x_i}{\sum_j x_j} \right\} \\ \Rightarrow Y^{NE} &= \alpha n(1-x^{NE}) + \beta n(n-1)(1-x^{NE}) + R \\ &= (\alpha + \beta(n-1))(1-x^{NE})n + R \\ &= (\alpha + \beta(n-1)) \left( n - \frac{(n-1)R}{\alpha n} \right) + R \\ &= \frac{1}{\alpha n} \left( (\alpha + \beta(n-1))(\alpha n^2 - (n-1)R) + \alpha n R \right) \\ &= \frac{1}{\alpha n} \left( \beta(\alpha n^2 - (n-1)R)(n-1) + \alpha^2 n^2 + \alpha R \right) \\ &= \frac{1}{\alpha n} \left( (\alpha - \beta(n-1)^2)R + \alpha^2 n^2 + \alpha \beta(n-1)n^2 \right) \\ &\therefore \frac{\partial Y^{NE}}{\partial R} = \frac{\alpha - \beta(n-1)^2}{\alpha n} \end{aligned}$$

As  $\beta \rightarrow \infty$ , we have that  $\partial Y^{NE} / \partial R \rightarrow -\infty$ , i.e., the resource curse.

Allow for institutions,  $i$ 's problem is:

$$\max_{x_i \in [0,1]} \left\{ (1-x_i) + \beta \sum_{j \neq i} (1-x_j) + R[1-f(\theta)] \left( \frac{x_i}{\sum_j x_j} \right) + \delta_i R f(\theta) + g(\theta) \sum_{j \neq i} y_j - h(\theta) x_i \right\}$$

$$\delta_i \geq 0, \quad \sum_i \delta_i = 1$$

$$f' \geq 0, g' \geq 0, h' \geq 0, \quad f(0) = g(0) = h(0) = 0, \quad f(\theta) \in [0,1]$$

The first-order condition is:

$$-\alpha + \frac{\sum_{j \neq i} x_j}{(\sum_j x_j)^2} R[1 - f(\theta)] - (n - 1)\beta g(\theta) - h(\theta) = 0$$

Let  $\gamma(\theta) = \alpha + (n - 1)\beta g(\theta) + h(\theta) > 0$ . Setting  $x_j = x \forall j$ , we solve for the symmetric Nash equilibrium:

$$x^{NE} = \frac{(n - 1)R[1 - f(\theta)]}{n^2\gamma(\theta)}; \quad \frac{\partial x^{NE}}{\partial R} = \frac{(n - 1)[1 - f(\theta)]}{n^2\gamma(\theta)} \geq 0$$

Partially differentiating with respect to  $\theta$  yields the cross-partial:

$$\frac{\partial^2 x^{NE}}{\partial R \partial \theta} = - \frac{(n - 1)[\gamma(\theta)f'(\theta) + \gamma'(\theta)(1 - f(\theta))]}{[n\gamma(\theta)]^2}$$

$$\gamma'(\theta) = (n - 1)\beta g'(\theta) + h'(\theta) \geq 0 \Rightarrow \frac{\partial^2 x^{NE}}{\partial R \partial \theta} \leq 0$$

*Measured* (physical) output is still defined:

$$Y = \sum_i \left\{ \alpha(1 - x_i) + \beta \sum_{j \neq i} (1 - x_j) \right\} + R \Rightarrow Y^{NE} = \alpha n(1 - x^{NE}) + \beta n(n - 1)(1 - x^{NE}) + R$$

$$\Rightarrow \frac{\partial Y^{NE}}{\partial R} = 1 - (\alpha n + \beta n(n - 1)) \frac{\partial x^{NE}}{\partial R}$$

$$\Rightarrow \frac{\partial^2 Y^{NE}}{\partial R \partial \theta} = -\beta n(n - 1) \frac{\partial^2 x^{NE}}{\partial R \partial \theta} \geq 0$$

## DATA STRUCTURE

With 45 minutes of continuous data per player per session, the challenge is to transform the data into observations that can be econometrically analyzed. An incredibly conservative approach involves creating one observation per player per session. This prevents us from taking advantage of the within variation in natural resource income as an additional source of identification, and so we regard it as wastefully conservative.

There are multiple ways of creating two observations per player per session. The simplest is to only use data from the round where natural resource income is shocked (round 2): one observation from the 7½ minutes prior to the shock, and the other observation from the 7½ minutes after the shock. This approach suffers from the drawback that it completely ignores two thirds of the data collected.

An alternative is to combine data from round 1 with the data from the first half of round 2 into one observation, and to combine data from the second half of round 2 with the data from round 3 into the other observation. The drawback with this approach is that it complicates controlling for group effects: group composition differs across the rounds, and treating an observation from round 1 in the same way as one from the first half of round 2 ignores this effect.

This leads us to the possibility of using four observations: one from round 1, two from round 2, and one from round 3. This approach leaves the data unbalanced: half of the observations are each based on 15 minutes of continuous decisions, while the other half are each based on 7½ minutes of continuous decisions. To address this, we propose six observations: two from each round, with the first observation based on the first 7½ minutes in that round and the second observation based on the second 7½ minutes.

This final configuration of six observations per player per session represents an empirically less conservative approach than our departure point of one observation per player per session, but it does address all of the above drawbacks. Moreover, it remains itself quite conservative: six observations per player for 45 minutes of continuous decisions. For these reasons, we use it as our benchmark. However in the interests of investigating our results' robustness, we explore the two different two-observation structures described above.

To construct the six observations per player per session, we average each player's 45 minutes of continuous data to 2 observations per player per round: 1 for the first 7½ minutes and 1 for the last 7½ minutes. We let  $t \in \{1, 2, \dots, 6\}$  denote the time period.

## ROBUSTNESS OF MAIN RESULTS

The first area of robustness concerns the data structure. The regressions in Table 3 were based on six observations per player per session. Consider two alternatives, each of which results in two observations per player per session, i.e., a third of the observations used in Table 3. In the first, we only use data from round 2; now  $t = 1$  denotes the first half of round 2 and  $t = 2$  denotes the second half of round 2. The econometric rent-seeking model becomes:

$$x_{it} = a + b^H H_{it} + b_{Int}^{Partial} H_{it} D_{it}^{Partial} + b_{Int}^{Full} H_{it} D_{it}^{Full} + \sum_{j=2}^{144} b_F^j F_i^j + T_t^2 + u_{g(it)} + \varepsilon_{it}$$

Where the only change from the model in Table 3 is that now there is only one time dummy (rather than five).

Model	1a	1b	2a	2b
Dependent variable	Rent-seeking	Rent-seeking	Earnings	Earnings
High natural resource income	31.1*** (4.85)	32.5*** (6.64)	-33.9 (110)	-47.9 (128)
High natural resource income x Partial-comms	-15.3 (9.13)	-13.2 (8.45)	353 (209)	297 (174)
High natural resource income x Full-comms	-27.8*** (7.46)	-27.4** (10.1)	643*** (168)	689*** (224)
Player fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Rounds used for data	2 only	All rounds	2 only	All rounds
Clustering by	Group	Session	Group	Session
Number of observations	288	288	288	288
R-squared	0.75	0.693	0.700	0.608

**Table A1: Regression models investigating robustness to data structure**

Asterices denote significance: \* = 10%, \*\* = 5%, \*\*\* = 1%. All regressions include player fixed effects and time fixed effects.

In the second alternative, we use data from all rounds, but the first observation is the average across all of round 1 and the first half of round 2, and the second observation is the average for the second half of round 2 and all of round 3. The econometric rent-seeking model becomes:

$$x_{it} = a + b^H H_{it} + b_{Int}^{Partial} H_{it} D_{it}^{Partial} + b_{Int}^{Full} H_{it} D_{it}^{Full} + \sum_{j=2}^{144} b_F^j F_i^j + T_t^2 + u_{session(it)} + \varepsilon_{it}$$

Where  $t = 1$  denotes the first of the two observations and  $t = 2$  the second. Since group composition changes across rounds, we cannot cluster at the group level, and so we resort to our next best alternative: clustering at the session level. Analogous changes to the models are used when earnings  $y_{it}$  is the dependent variable. Table A1 contains the four new models. Models that end in ‘a’ use only round 2 data. Models that end in ‘b’ use data from all rounds.

**Robustness result 1:** Results 1a-1c and 2a-2c are robust to using two (rather than six) observations per player per session, whichever of the two methods we use.

Coefficient estimates barely differ between Table 3 and Table A1. The substantive differences are restricted to the standard errors. As one would expect, using less data generates larger

standard errors. However none of Results 1a-1c or 2a-2c are affected by using this data structure (precise p-values available upon request).

The second area of robustness concerns the possibility of order effects. The models in Table 3 pool data from the sessions where natural resource income was initially low (and subsequently shocked up) with those where it was initially high (and subsequently shocked down). The bottom panel of Figure 3 looks similar to the top panel with the two halves switched, but it does look somewhat muted. Table A2 investigates this empirically by repeating the models in Table 3 by initial natural resource income level.

Model	1a	1b	2a	2b
Dependent variable	Rent-seeking	Rent-seeking	Earnings	Earnings
High natural resource income	38.3*** (4.19)	23.2*** (4.77)	-171 (157)	104 (168)
High natural resource income x Partial-comms	-19.8*** (6.63)	-6.49 (7.06)	439** (212)	156 (194)
High natural resource income x Full-comms	-44.6*** (3.98)	-10.1* (5.70)	997*** (143)	380* (200)
Player fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Clustering by group	Yes	Yes	Yes	Yes
Starting level of $R$	\$1,200	\$4,000	\$1,200	\$4,000
Number of observations	432	432	432	432
R-squared	0.758	0.566	0.588	0.398

**Table A2: Regression models investigating robustness to initial conditions**

Asterices denote significance: \* = 10%, \*\* = 5%, \*\*\* = 1%. All regressions include player fixed effects, time fixed effects and clustering by group.

**Robustness result 2:** Results 1a-1c and 2a-2c are robust to the initial natural resource income level, though the results are slightly stronger when initial natural resource income is low.

In Table A2, the models ending in ‘a’ correspond to the low starting level of natural resource income, while those ending in ‘b’ correspond to the high starting level of natural resource income. Visually, both sets of results look very similar to the results in Table 3. In all earnings regressions, a Wald test fails to reject the hypothesis that under full comms, there is a one-to-one increase in earnings resulting from a resource boom (Result 2b). The most notable differences occur when initial natural resource income is high: the coefficients on the interaction between

high natural resource income and the full comms dummy are significant at the 10% level rather than the 1% level. This is reflected in the ‘muted’ nature of the bottom panel of Figure 3 compared to the top panel.

We believe that the results are slightly weaker when initial natural resource income is high because the rent-seeking level at the start of a round is set to zero by default. At the start of the first round, as players familiarize themselves with the controls and the environment, in the no comms conditions, they are a little slow at approaching the Nash, which involves rent-seeking with 94 tokens out of 100 (compared to 28 in the low natural resource income condition). They inch upwards. Conversely in the full comms condition, even though they may quickly agree on not rent-seeking, they spend some time experimenting with the new environment, including rent-seeking. This is why behavior in round 1 of the bottom panel of Figure 3 is much closer to the middle than in round 3 of the top panel.

In contrast when initial natural resource income is low, the predicted differences in behavior between no comms and full comms are not so large anyway, and so the period of experimentation at the start of round 1 does not dampen the results as much.

## ANCILLARY RESULTS

We used three unspecified levels of quality of institutions in this paper:  $(\theta_0, \theta_1, \theta_2)$  where  $0 \leq \theta_0 < \theta_1 < \theta_2$ . Our predictions related to the *relative* rather than absolute proximity of behavior to efficiency, e.g., we claimed that behavior would be more efficient under  $\theta = \theta_2$  than under  $\theta = \theta_1$ . Despite this, it remains interesting to examine how close to Nash equilibrium behavior was in the no comms ( $\theta = \theta_0$ ) and how close behavior was to efficiency in the full comms ( $\theta = \theta_2$ ). The caption beneath Table 1 contains a reminder of the Nash equilibrium and efficient levels of rent-seeking and earnings for comparison with the realized amounts displayed in Table 1.

To test hypotheses about the proximity of behavior to a fixed benchmark, we can use simple one-sample tests such as the t-test. Such tests typically assume that the data are IID; to allow for non-spherical errors, we can estimate regressions with clustered error terms (in a similar fashion to our main regressions above) and conduct hypothesis tests on the estimated intercept term. As it happens, none of our ancillary results below depend upon the test used. Finally, we conduct our comparisons in the rent-seeking domain rather than in the earnings domain; our results do not depend upon this.



# **EXPERIMENTAL INSTRUCTIONS**

Welcome to our study in decision-making. If you pay attention and make good decisions, you may earn a considerable amount of money. At the end of the experiment, you will be paid your earnings privately and in cash. All earnings from the experiment will be in addition to your show-up fee of \$5.

If you have any questions, please raise your hand and I will approach you individually.

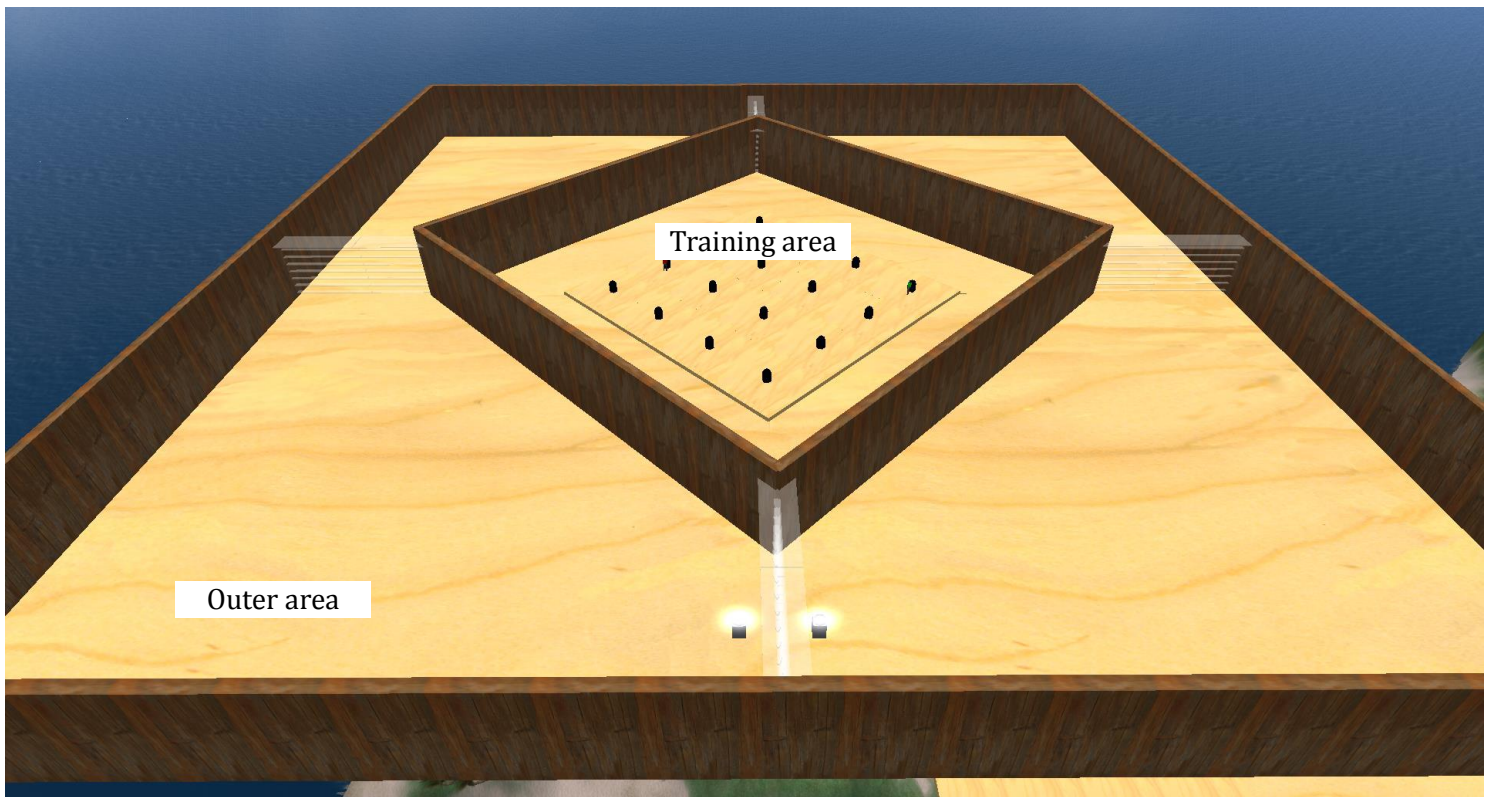
The software is a 3D simulation. You control a character called your avatar.

Some of you will be familiar with the software that we are about to use. Regardless of your familiarity with the software, please follow the instructions in the experiment and only attempt actions that are described in the instructions. **You are not to use the menus in the program at any time.** If you violate these rules you will be asked to leave the experiment and you will earn nothing beyond your show-up fee.

## GROUPS

You will be separated into groups of 4 for this experiment. Each avatar has a different name and a different color of shirt. Each avatar's first name will be the name a US state, e.g., Arkansas or Maine.

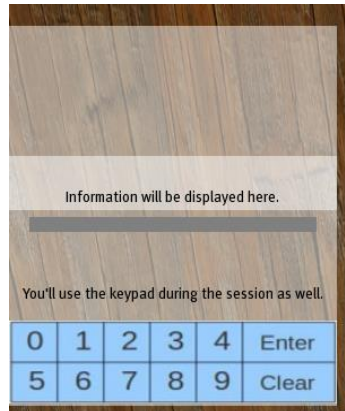
On the picture below, you can see the environment. It consists of an inner training area and four outer areas. You will stay in the inner area for the tutorial, and then each member of your group will travel to one of the four outer areas. You will remain in these outer areas for the actual experiment. More details about the outer areas will be provided later in the documentation.



Your avatar should currently be in the training area. The following tutorial will explain the purpose of its various features.

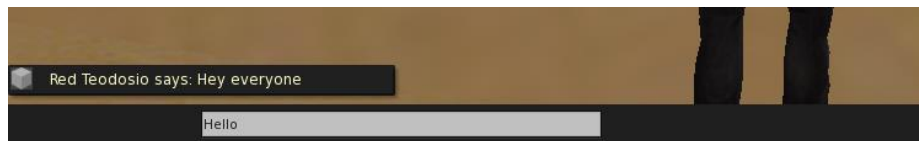
## TUTORIAL

In order to familiarize yourself with the software, you will participate in a tutorial. This tutorial will take the form of a sequence of 3 different tasks which you will need to complete. Once everyone in your group has completed a task, you will be able to move on to the next one. On your screen, your HUD is the box that contains information. You can see it in the screenshot below:



## TASK 1: CHAT

You can communicate with your group members using chat. In order to chat, click on the area on the bottom of the screen that says "Click here to chat" and type a message, and then press "Enter." When someone chats, you will see what they wrote in the bottom-left corner of your screen. Messages sent by you or those who are close to you will be displayed twice.



During this task, to familiarize you with the chat, you will be given a specific message to send to your group. The message that you will be asked to send will appear in your HUD.

You need to type it exactly as displayed – it is case-sensitive. That means that all the capital letters have to be correct and the spaces have to be correct too. Once you have typed it in correctly, the HUD will tell you that you have typed it in correctly.

During the experiment, we have 4 rules for chat:

- No profanity or threatening language
- No spamming
- No communication in any non-English language
- No personal information (name, age, sex) that would allow other participants in the experiment to determine which person in the room is controlling which avatar. This includes mentioning your computer number!

Other than these guidelines, you are free to communicate as you please during the experimental session. If you violate these rules you will be asked to leave the experiment and you will lose your earnings.

## **TASK 2: KEYPAD**

The bottom part of your HUD is a keypad. It can be used to enter a number from 0 to 100. In order to use the keypad, simply click on the numbers you wish to enter, and then hit the “Enter” key on the HUD keypad (not your keyboard!) If you wish to clear the numbers without entering them, hit the “Clear” key. If you enter a number greater than 100, your input will be rejected.

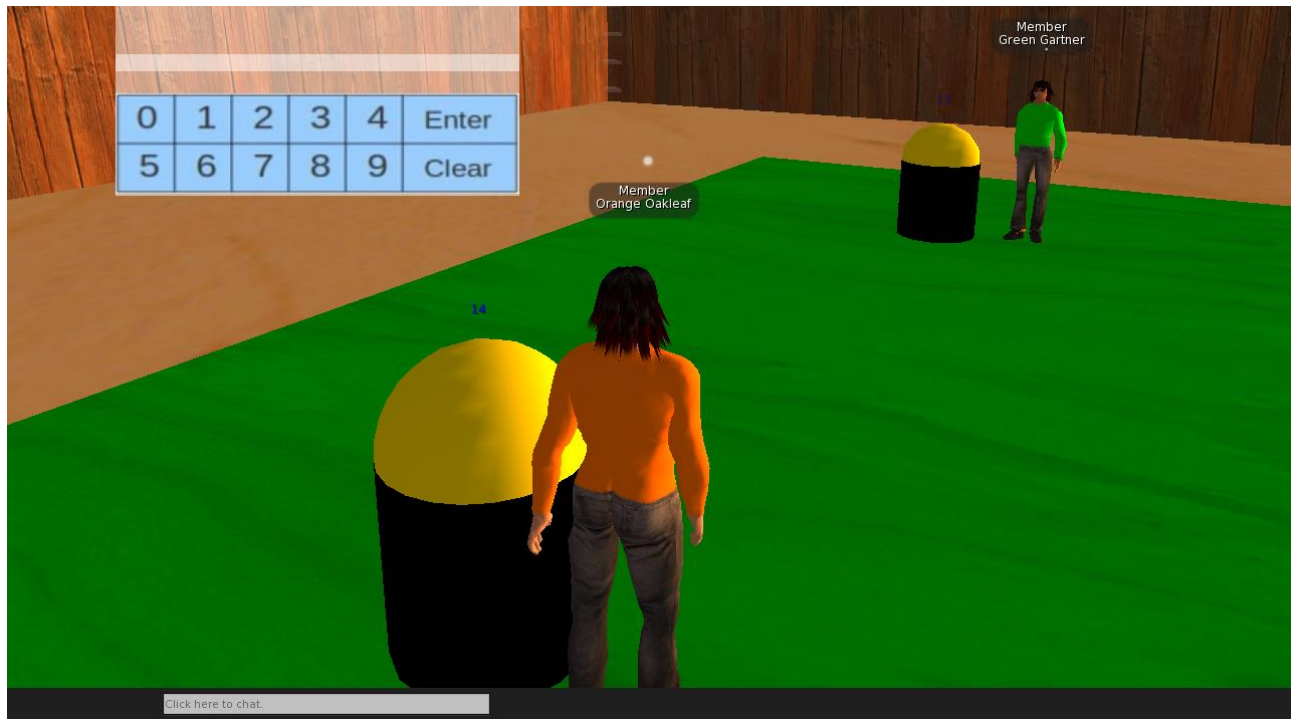
In this task, each member of your group will be given a number; your number will appear in your HUD. You need to communicate with your group members to calculate the sum of the 4 numbers that your group members received. Use that chat function to do this. Once you have calculated the sum, each group member must enter the number in the way described above in order to complete the task.

So, for example, if subject 1 got the number 10, subject 2 got the number 15, subject 3 got the number 30 and subject 4 got the number 0, then the sum is  $10 + 15 + 30 + 0 = 55$ . You would each have to type 55 into your keypad.

### TASK 3: BEACON BOARD

In order to move your avatar, you must use the arrow keys on your keyboard. Also, in order to interact with objects in the environment, you must click on them. Some objects will require you to be close to them when clicking in order to work properly.

The Beacon Board, depicted below, will allow you to practice using these skills. The Beacon Board consists of 16 beacons (a beacon is a short pole sticking out of the ground). Each one has a small number floating above it depicting which one it is – **you may have to get close in order to see it**.



When a beacon is clicked on by an avatar who is sufficiently close to it, it will light up.

During this task, each member of your group has to go to a specific beacon and light it up. The information about which beacon each member has to go to will be delivered as messages in the HUDs of each member. However, your HUD will tell you where one of the **other** subjects has to go. In order to find out where you have to go, you will need to use the chat function to communicate with the other group members.

When each group member has clicked on a beacon, the beacon board will see whether each subject has chosen the correct beacon. If they have, then the task will be completed and the next one will start. If they have not, then all of the beacons will be reset and each group member will have to click on a new beacon. Once a new set of beacons have been clicked, the beacon board will check for correctness again.

Each subject may only have one beacon lit up at a time. Once you choose a beacon you can change your choice by clicking on a different beacon.

## TOKENS AND ACTIVITIES

You have 100 tokens that you can place in two different activities: Activity X and Activity Y. You will select how many tokens to put in Activity Y; the rest will automatically be put in Activity X. Your earnings will depend on your choices and the choices of others.

You will earn money continuously through time, and you will be able to change your allocation between Activity X and Activity Y at any point during the session. If you change how many tokens you are allocating to Activity Y, your earnings will change immediately.

EXCHANGE RATE: \$7,000 in the experiment = \$1 in real life

For each token that you put in Activity X:

- You will earn \$8/min
- The 3 other people in your group get \$5/min

This means that putting tokens in Activity X generates money for the other people in your group (in addition to generating money for you). Similarly, for each token that another group member puts in Activity X, you get \$5/min. Remember that you have 100 tokens in total and the above figures are *per token*.

Activity Y:

Activity Y generates \$4,000/min that will be divided between the 4 group members. **As a group, you will always earn \$4,000/min in total from Activity Y regardless of the decisions you make.** However each subject's individual share of \$4,000/min is determined by how many tokens that subject allocates to Activity Y compared to everyone else.

- If everyone allocates 0 to Activity Y, each of the 4 group members gets  $\frac{1}{4}$  of \$4,000/min = \$1,000/min
- If at least one person allocates some tokens to Activity Y, then each person earns a fraction of \$4,000/min. Your fraction is equal to the number of tokens you allocate to Activity Y divided by the total tokens that everyone (including you) are allocating to Activity Y.

Let's do an example to illustrate this. Suppose the group members allocate the following amounts to Activity Y:

- Subject 1: 0 tokens
- Subject 2: 20 tokens
- Subject 3: 20 tokens
- Subject 4: 40 tokens

Then the total number of tokens is 80. This is how much each subject earns:

- Subject 1 contributes none of the 80 tokens:  $(0 / 80) \times \$4,000/\text{min} = \$0/\text{min}$
- Subject 2 contributes 20 out of the 80 tokens:  $(20 / 80) \times \$4,000/\text{min} = \$1,000/\text{min}$
- Subject 3 contributes 20 out of the 80 tokens:  $(20 / 80) \times \$4,000/\text{min} = \$1,000/\text{min}$
- Subject 4 contributes 40 out of the 80 tokens:  $(40 / 80) \times \$4,000/\text{min} = \$2,000/\text{min}$

Remember: as a group, you will always earn \$4,000/min in total regardless of the number of tokens the group allocates to Activity Y. If one of you increases how many tokens he is allocating to Activity Y, that subject will increase his earnings from Activity Y but everyone else's earnings from Activity Y will go down. The total will still stay at \$4,000/min.

If you are allocating 0 tokens to Activity Y, you will nothing from Activity Y **unless everyone else is also allocating 0 tokens to Activity Y**. If everyone is allocating 0 tokens to Activity Y, then each person gets \$1,000/min.

- If you are earning more than \$1,000/min from Activity Y, then you are allocating more tokens to Activity Y than the average of the other 3 people in your group.
- If you are earning less than \$1,000/min from Activity Y, then you are allocating less tokens to Activity Y than the average of the other 3 people in your group.

Total earnings: Your total earnings will be the sum of three things:

1. Your earnings from your tokens allocated to Activity X
2. Your earnings from other group members allocating their tokens to Activity X (remember that for each token someone allocates to Activity X, everyone else each gets \$5/min)
3. Your earnings from your tokens allocated to Activity Y

If all members of your group are allocating all of their tokens to activity X, then each member of your group will earn \$3300/min. If all tokens are allocated to activity Y, then each member of your group will earn \$1000/min. As more tokens are allocated to activity Y, the total group earnings fall.

## EXAMPLES (ASSUMING RESOURCE VALUE = 2400)

#1:

Subject #	Tokens in X	Tokens in Y	\$ from X (self)	\$ from X (other)	\$ from Y	Total \$
1	80	20	640	1200	600	2440
2	80	20	640	1200	600	2440
3	80	20	640	1200	600	2440
4	80	20	640	1200	600	2440
Totals	320	80	2560	4800	2400	9760

#2:

Subject #	Tokens in X	Tokens in Y	\$ from X (self)	\$ from X (other)	\$ from Y	Total \$
1	20	80	160	300	600	1060
2	20	80	160	300	600	1060
3	20	80	160	300	600	1060
4	20	80	160	300	600	1060
Totals	80	320	640	1200	2400	4240

#3:

Subject #	Tokens in X	Tokens in Y	\$ from X (self)	\$ from X (other)	\$ from Y	Total \$
1	90	10	720	950	200	1870
2	90	10	720	950	200	1870
3	10	90	80	1350	1800	3320
4	90	10	720	950	200	1870
Totals	280	120	2240	4200	2400	8930

#4:

Subject #	Tokens in X	Tokens in Y	\$ from X (self)	\$ from X (other)	\$ from Y	Total \$
1	10	90	80	550	771	1401
2	10	90	80	550	771	1401
3	90	10	720	150	86	956
4	10	90	80	550	771	1401
Totals	120	280	960	1800	2400	5159



## INFORMATION THAT APPEARS IN THE HUD

Throughout the session, you will see the following information in your HUD:

- The number of tokens that you are currently allocating to Activity Y (remember that you have 100 in total and whatever doesn't get allocated to Activity Y gets automatically allocated to Activity X)
- The amount you are currently earning from your own tokens in Activity X (\$/min)
- The amount you are currently earning from other group members' tokens in Activity X (\$/min)
- The amount you are currently earning from Activity Y (\$/min)
- The total that you are currently earning (\$/min)
- Your gross earnings so far in the session (total \$)
- The time remaining in the session

When you increase the number of tokens allocated to Activity Y, you earn more from Activity Y and you earn less from Activity X (since you shifted tokens away from Activity X). Your **total** earnings may increase or decrease. To help you with calculations, the HUD will give you two additional pieces of information:

- What happens to your total earnings if you **increase by one** the number of tokens allocated to Activity Y
- What happens to your total earnings if you **decrease by one** the number of tokens allocated to Activity Y

These two numbers will change whenever **anyone** changes how many tokens they have in Activity Y, so don't be surprised to see them changing throughout the experiment even when you yourself aren't doing anything.

## CHANGING YOUR ALLOCATION

If you want change to how many tokens you are allocating to Activity Y, use the keypad to select a number between 0 and 100 and then hit the 'Enter' key on the keypad on the screen (not the one on the keyboard!). It's just like the tutorial.

## THE ENVIRONMENT

Each of you is in your private area. Each area borders on two other areas, allowing you to see 2 out of your 3 group members. A barrier stops you from stepping into anyone else's area. You move around just like the tutorial.



You will find a beacon (like the ones in training) on either side of the barrier that separates you from your neighbor. If you click on the one on your side, nothing happens. If you click on the one that is on your neighbor's side (make sure you are close enough), it will tell you how many tokens your neighbor is currently allocating to Activity Y.

### [PARTIAL/FULL COMMS TREATMENT ONLY]

The entire experimental session will have 3 15-minute rounds where you will earn money based on your decisions. Each round will be preceded by a 2-minute break period where you will be able to move around and communicate with your group, although you will not earn any money during this time. Additionally, in the first round you will have a 3-minute practice period which will simulate the actual experiment – you will be able to earn money during this

period, however it will not contribute to your payoff at the end of the experiment. At the beginning of each round your earnings will be reset, however you will be paid based on your earnings at the end of the previous round(s).

[NO COMMS TREATMENT ONLY]

The entire experimental session will have 3 15-minute rounds where you will earn money based on your decisions. Additionally, before the first round you will have a 3-minute practice period which will simulate the actual experiment – you will be able to earn money during this period, however it will not contribute to your payoff at the end of the experiment. Following this, you will have a 2-minute break where you will not earn additional practice earnings but can move around and communicate with your group. At the beginning of each round your earnings will be reset, however you will be paid based on your earnings at the end of the previous round(s).

[PARTIAL COMMS TREATMENT ONLY]

Additionally, you will only be able to chat and check the beacons of your neighbors during the 3-minute practice and 2-minute break periods. Once the 15-minute round begins, you will no longer be able to communicate or check the activity Y allocations of your neighbors for the remainder of the round.

[NO COMMS TREATMENT ONLY]

During the 15-minute rounds, you will not be able to communicate with or check the Activity Y allocations of your group members. You will only be able to do these things in the 3-minute practice / 2-minute break preceding the first round.

During the session, we may change the total amount (\$4,000) that the group gets from Activity Y. If we do that, we will make an announcement and then the information in your HUD will be updated to reflect this.

If you have any questions at any time, please raise your hand and I will approach you individually.

**Session Timeline [PARTIAL/FULL COMMS TREATMENT ONLY]:**

1. Round 1

- a. 3-minute practice period
- b. 2-minute break
- c. 15-minute round

2. Round 2

- a. 2-minute break
- b. 15-minute round

3. Round 3

- a. 2-minute break

b. 15-minute round

4. Collect payouts

**Session Timeline [NO COMMS TREATMENT ONLY]:**

1. Practice

a. 3-minute practice period

b. 2-minute break

2. Round 1 – 15 minutes

3. Round 2 – 15 minutes

4. Round 3 – 15 minutes

5. Collect payouts