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In broad daylight: Full information and higher-order punishment opportunities promote cooperation

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**Supplementary Online Appendix for Kamei and Putterman, 2012,
“In Broad Daylight: Full Information and
Higher-order Punishment Opportunities Promote Cooperation”**

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Appendix A: Experimental Procedure and Instructions

[Note: the following combines relevant sections of the instructions used in all treatments reported in the paper. Separate and complete instructions for each individual treatment are viewable at http://www.brown.edu/Departments/Economics/Papers/2012/2012-3_appendix2.pdf.]

A.1 Main Part of Experiments

[Note: Instructions for all treatments began with the same instructions for playing a VCM.]

At the beginning of the session, the experimenter said to all subjects present: “Today you will take part in one main experiment and one shorter task, and we expect the whole thing to take less than one and a half hours. The main experiment has 15 periods. We will now read the instructions.” Then the experimenter began to read aloud the following instructions, of which the subjects also had printed copies:

Instructions

Welcome to our decision-making experiment. Depending on your decisions and the decisions of other participants, you will be able to earn money in addition to the \$5 guaranteed for your participation. Please listen and read the following instructions carefully.

During the experiment you are not allowed to communicate with other participants. You are likewise not allowed to use your cell phone or other communications media, including computer applications other than the experiment software. If you have a question, raise your hand. One of us will come to answer your question.

During the experiment your earnings will be calculated in points. At the end of the experiment, points will be converted to U.S. dollars at the rate

20 points = \$1

This means each point will exchange for 5 cents of real money. At the end of the experiment your total earnings (including the \$5 participation fee) will be paid out to you privately in cash to the nearest one cent.

In the experiment, each participant is randomly assigned to a **group of 4**. This means that you will be in a group with three other participants. **You will be part of the same group throughout the entire experiment.** You will not be told which other participants are in your group, nor will you be informed who was in which group after the experiment ends.

In this experiment, participants and their groups interact together for a total of **15 periods**. Every period, each group member, yourself included, begins with an **endowment of 20 points**. Each period consists of two stages.

Stage 1: allocation decisions

At the beginning of each period, you and the three others in your group simultaneously decide how to use your endowments. There are two possibilities:

- 1. You can allocate points to a group account.**
- 2. You can allocate points to a private account.**

You will be asked to indicate the number of points you want to allocate to the group account. Only integers between 0 and 20 are allowed for this purpose. The remaining points will automatically be allocated to your private account. Your earnings depend on the total number of points in the group account, and the number of points in your private account.

Calculating earnings from the allocation decisions

Your earnings from your private account are equal to the number of points you allocate to it. That is, **for each point you allocate to your private account you get 1 point as earnings**. The points you allocate to your private account do not affect the earnings of the others in your group.

Your earnings from the group account equal the **sum** of points allocated to the group account by all 4 group members multiplied by 0.4. **For each point you allocate to the group account you and all others in your group each get 0.4 points as earnings**. For example, if the sum of points in the group account is 30, then your earnings from the group account and the earnings of each of the others in your group from the group account are equal to $0.4 * 30 = 12$ points.

Your earnings can be calculated with the following formula:

$$(20 - \text{points you allocated to the group account}) + 0.4 * (\text{sum of points allocated by all group members to the group account})$$

Note that you get 1 point as earnings for each point you allocate to your private account. If you instead allocate 1 extra point to the group account, your earnings from the group account increase by $0.4 * 1 = 0.4$ points and your earnings from your private account decrease by 1 point. However, by allocating 1 extra point to the group account, the earnings of each of the other 3 group members also increase by 0.4 points. Therefore, the total group earnings increase by $0.4 * 4 = 1.6$ points. Note that you also obtain earnings from points allocated to the group account by others. You obtain 0.4 points for each point allocated to the group account by another member.

After each member completes their allocation decision, they will be informed of other members' allocation decisions. You will be shown the amount allocated to the group account by each of the others in your group, in an order that remains the same for all 15 periods.

Example

Suppose you allocate 10 points to the group account, the second member of your group allocates 20 points to the group account, the third member allocates 15 points and the remaining member allocates 0 points to the account. In this case, the sum of points in the group account is $10 + 20 + 15 + 0 = 45$ points. Each group member gets earnings of $0.4 * 45 = 18$ points from the group account. In this situation,

Your total earnings are: $(20 - 10) + (0.4 * 45) = 10 + 18 = 28$ points.

The second member's earnings are: $(20 - 20) + (0.4 * 45) = 0 + 18 = 18$ points.

The third member's earnings are: $(20 - 15) + (0.4 * 45) = 5 + 18 = 23$ points.

The fourth member's earnings are: $(20 - 0) + (0.4 * 45) = 20 + 18 = 38$ points.

Another set of decisions will follow after the allocation decisions in each period, so your earnings for the period are not yet final at this stage. Before we describe the next stage, we'll pause to help you make sure you've understood the first one.

Comprehension questions

Please answer the following questions. Raise your hand if you need help. A member of the experiment team will come to help you and will check your answers when you are done.

1. Suppose all four individuals in your group allocate 0 points to the group account.

a) How much do you earn? _____ points

b) How much do the others each earn? _____ points

2. Suppose all four allocate 20 points to the group account.

- a) How much do you earn? _____ points
- b) How much do the others each earn? _____ points

3. Suppose the others in your group allocate 30 points in total to the group account.

- a) How much do you earn if you allocate 0 points to the group account? _____ points
- b) How much do you earn if you allocate 10 points to the group account? _____ points
- c) How much do you earn if you allocate 20 points to the group account? _____ points

[When the comprehension questions were reached, the experimenter asked the subjects to try to answer on their own and said members of the experiment team would come around to check that participants had correctly answered all questions, and that if any had any questions about the questions they should raise their hand and one of us would come to help them. When subjects appeared to have finished answering the comprehension questions, the experimenter briefly explained the answers using the front board, then invited subjects to ask questions of clarification regarding the instructions while indicating that questions of experiment motivation and subject strategy would not be entertained, then answered any clarification questions publicly. The same procedure was followed after each further instruction portion]

[Continuously, the experimenter began to read aloud additional instructions, of which the subjects were also given printed copies:]

Stage 2: reduction decisions

[In Reference, F3n, F3h and F2 treatments: After the first stage of each period, you will be shown the amount allocated to the group account by each of the others in your group, with each identified by numbers (Player 1, Player 2, etc.) that are randomly assigned to them but then remain fixed for the duration of the experiment.] [In E3n, E3h and E2 treatments: After the first stage of each period, you will be shown the amount allocated to the group account by each of the others in your group in a random order. Each member, yourself included, will be identified as Player 1, Player 2, Player 3 or Player 4, although the label “You” rather than a player number will identify you on your own screen. These identification numbers are fixed for one period only and then randomly changed. This

means that the group member identified to you as Player 2 in a certain period is equally likely to have any of the four player numbers in the next period. (The same holds for the presentation of information about your decisions to the others.))] In a box to the right of the allocation information, you will be asked to enter a whole number of points (if any) that you wish to use to reduce the earnings of the individual who made that allocation decision. Each point you allocate to reduce another's earnings **reduces your own earnings by 1 point and reduces that individual's earnings by 3 points**. Your own earnings can be reduced in the same way by the decisions of others in your group. You are free to leave any or all others' earnings unchanged by entering 0's in the relevant boxes.

An example of what your screen will look like at the beginning of each period's Stage 2 follows.

[In Reference, F3n and E3n treatments:

Period 1 out of 15		
Player	Alloc. to group acct.	Points to reduction
You	5	
Player 1	15	<input type="text"/>
Player 3	10	<input type="text"/>
Player 4	20	<input type="text"/>

Remember that the earnings of other group members are reduced by 3 times the amounts you enter.
To leave an individual's earnings unchanged, enter 0.

Submit

Note: Numbers shown are for illustration only.]

[In F2 and F3h treatments:

Period
1 out of 15

Reduction Points from Row Player to Col. Player Last Period

Average reduction points from row player to col. player (earlier periods)

Player	Alloc. to group acct.	Points to reduction	Alloc. to group acct.	You	P1	P2	P4	Alloc. to group acct.	You	P1	P2	P4
You	15											
Player 1	5											
Player 2	10											
Player 4	20											

Remember that the earnings of other group members are reduced by 3 times the amounts you enter.
To leave an individual's earnings unchanged, enter 0.

Submit

Note: Numbers shown are for illustration only.]

[In E2 treatment:

Period
1 out of 15

Player	Alloc. to group acct.	Points to reduction	Row player's alloc. to group acct. last period	Your reduction points from row player last period
You	15			
Player 1	10			
Player 3	5			
Player 4	20			

Remember that the earnings of other group members are reduced by 3 times the amounts you enter.
To leave an individual's earnings unchanged, enter 0.

Submit

Note: Numbers shown are for illustration only.]

[In E3h treatment:

Period		1 out of 15					
				Last period choices		Avg. earlier period choices	
Player	Alloc. to group acct.	Points to reduction	Alloc. to group acct.	Reduc. pts. to You	Alloc. to group acct.	Reduc. pts. to You	
You	10						
Player 1	5	<input type="text"/>					
Player 2	15	<input type="text"/>					
Player 4	20	<input type="text"/>					

Remember that the earnings of other group members are reduced by 3 times the amounts you enter.
To leave an individual's earnings unchanged, enter 0.

Note: Numbers shown are for illustration only.]

There are several things to keep in mind regarding the reduction stage.

First, earnings reductions directed at you in this stage cannot bring your earnings for the period to less than zero. For example, if your first stage earnings were 15 points and the other members of your group devoted six points in total to reducing your earnings, you would not lose the $6 * 3 = 18$ points that would otherwise be deducted from your earnings for the periods, but would lose only the maximum possible in this case, 15 points.

However, the **cost of giving reductions** to others is always fully born by you even if it makes your period earnings negative. For instance, suppose that in the above example in which you incurred the maximum possible earnings reductions by others, you yourself had given, say, 3 reduction points to others. Then your earnings for the period would be -3 . If you lose points in a period, they are deducted from those you accumulate in other periods. Thus, final earnings for a period can be calculated as follows:

$$\left\{ \begin{aligned} &\text{The greater of } [(20 - (\text{points you allocate to group account}) + 0.4 * (\text{sum of points} \\ &\quad \text{allocated by all in group to group account}) - \\ &\quad 3 * (\text{sum of reduction points directed at you by others in your group})] \text{ and } 0 \} \\ &- (\text{points you use to reduce others' earnings}) \end{aligned} \right.$$

[In Reference treatment: At the end of the reduction stage, you will learn by what amount, in total, others decided to reduce your earnings (possibly 0), but you will not be told which individuals reduced your earnings or by how much any given individual

reduced your earnings. Others will also not know who in particular reduced their earnings by how much.]

[In F3n, E3n, F2, E2, F3h and E3h treatments: At the end of the reduction stage, you will learn by what amount, in total, others decided to reduce your earnings (possibly 0).]

In addition to the fact that earnings from the allocation stage and reductions received cannot go below zero, the earnings reduction process is subject to two limits. First, your reduction points must be an integer. Second, you cannot assign more than 10 reduction points to any one individual in your group.

Remember that if no reductions are imposed (the reduction boxes are filled in with 0's), earnings after the reduction stage are the same as those before it.

Comprehension questions

Please answer the following questions. Raise your hand if you need help. A member of the experiment team will come to help you and will check your answers when you are done.

- 1) How much does it cost you to reduce the earnings of another group member by 6 points? _____ points
- 2) Suppose that an individual earns 10 points from the allocation stage, spends 2 points on reducing others' earnings, and incurs no earnings reductions from others. What are the individual's earnings for this period? _____ points
- 3) Suppose that an individual earns 14 points from the allocation stage, spends 1 point on reducing others' earnings, and that others spend a total of 5 points to reduce her earnings. What are the individual's earnings for this period?
_____ points

[F2, E2, F3h and E3h treatments have additional instruction about information:]

Additional information in Stage 2 during later periods

[F2 and F3h treatments: In later periods, the 2nd stage screen of each period will contain more information than in the example above. The additional information concerns actions in previous periods, with the block of numbers in the middle reflecting the most

recent period, and the block of numbers on the right reflecting any periods before that. Consider the left-most of the new columns in the middle block in the example below. As the heading suggests, it shows the amount each group member allocated to the group account during the previous period. The remaining columns of the middle block show the number of reduction points each player gave to each other group member in that period. For example, the 2 in the second column, third row indicates that Player 2 (row heading) gave 2 reduction points to You (column heading) last period. The 3 in the first row, third column means that You (row heading) gave 3 reduction points to Player 1 (column heading) last period. The 0 on the right end of the bottom row indicates that Player 4 gave 0 reduction points to Player 2 last period.

Here is an example of a screen in the Period 2 reduction stage:

Period

2 out of 15

Reduction Points from Row Player to Col. Player Last Period								Average reduction points from row player to col. player (earlier periods)				
Player	Alloc. to group acct.	Points to reduction	Alloc. to group acct.	You	P1	P2	P4	Alloc. to group acct.	You	P1	P2	P4
You	10		15		3	2	1					
Player 1	3		5	0		1	1					
Player 2	8		10	2	0		1					
Player 4	5		20	10	0	0						

Remember that the earnings of other group members are reduced by 3 times the amounts you enter. To leave an individual's earnings unchanged, enter 0.

Submit

Note: Numbers shown are for illustration only.

During the third and later periods under the scheme, the right block will contain corresponding information about periods before the most recent period. For example, suppose that you have reached the 2nd stage of period seven. In that case, the middle block will reflect what happened during period six, while the right block will reflect average actions during periods one through five. As shown in the example, the number 9.8 in the first column of the right block in the bottom row means that Player 4 (row heading) assigned an average of 9.8 points to the group account during the first through fifth periods. The 1.0 in the third column, first row of the right block means that You (row heading) assigned an average of 1.0 reduction point per period to Player 1 (column heading) during the first five periods.

Here is an example of a screen in the Period 7 reduction stage:

Period
7 out of 15

Player	Reduction Points from Row Player to Col. Player Last Period						Average reduction points from row player to col. player (earlier periods)					
	Alloc. to group acct.	Points to reduction	Alloc. to group acct.	You	P1	P2	P4	Alloc. to group acct.	You	P1	P2	P4
You	1		11		0	2	0	9.0		1.0	1.0	0.6
Player 1	4		0	0		0	1	8.2	0.8		0.6	2.2
Player 2	8		1	0	1		1	8.6	1.6	0.2		1.0
Player 4	11		4	0	3	0		9.8	2.4	0.4	0.4	

Remember that the earnings of other group members are reduced by 3 times the amounts you enter.
To leave an individual's earnings unchanged, enter 0.

Submit

Note: Numbers shown are for illustration only.

]

[E2 treatment: In later periods, the 2nd stage screen of each period will contain more information than in the example above. Specifically, in addition to showing the amounts allocated to the group account by each other group member in the current period, the screen will also show the amounts (if any) by which each group member reduced your earnings in the previous period, and the amount allocated to the group account last period by any group member who reduced your earnings (that is, assigned you a positive number of reduction points). This information will be displayed as you decide how much if at all you wish to reduce each other group member's earnings this period. In the example shown below, for instance, the number 1 in the middle of the right column indicates that the subject identified to you this period as Player 2 allocated 1 point to reducing your earnings last period, while the number 15 to the left of that entry indicates that that subject allocated 15 points to the group account last period. Note that while player numbers change randomly from period to period, the information in each row concerns one specific group member, and the current period number is used to identify that individual so as to avoid confusion. Note also that in the next to last column, last period allocations to the group account are shown only for those who assigned a positive number of reduction points to you.

Here is an example of a screen in the Period 2 reduction stage:

Period
2 out of 15

Player	Alloc. to group acct.	Points to reduction	Row player's alloc. to group acct. last period	Your reduction points from row player last period
You	3		5	
Player 1	5			0
Player 2	10		15	1
Player 3	8			0

Remember that the earnings of other group members are reduced by 3 times the amounts you enter.
To leave an individual's earnings unchanged, enter 0.

Submit

Note: Numbers shown are for illustration only.

]

[In E3h treatment: In later periods, the 2nd stage screen of each period will contain more information than in the example above. The additional information concerns actions in previous periods, with the block of numbers in the middle reflecting the most recent period, and the block of numbers on the right reflecting any periods before that. Consider the left of the pair of new columns in the middle block in the example below. As the heading suggests, it shows the amount each group member allocated to the group account during the previous period. The right column of the middle block shows the number of reduction points each player gave to you in that period. For example, the 2 in the second row indicates that Player 2 (row heading) gave 2 reduction points to you last period. In those cases in which the group member in question assigned no reduction points to you last period, i.e. the reduction column shows a 0, the allocation column next to it will be left empty, as in the bottom row in the example.

An example of a screen in Stage 2 of Period 2.

Period		Last period choices				Avg. earlier period choices	
Player	Alloc. to group acct.	Points to reduction	Alloc. to group acct.	Reduc. pts. to You	Alloc. to group acct.	Reduc. pts. to You	
You	3		5				
Player 2	8	<input type="text" value="1"/>	10	2			
Player 3	10	<input type="text" value=""/>	15	3			
Player 4	5	<input type="text" value=""/>		0			

Remember that the earnings of other group members are reduced by 3 times the amounts you enter.
To leave an individual's earnings unchanged, enter 0.

Submit

Note: Numbers shown are for illustration only.

During the third and later periods, the right block will contain corresponding information for periods before the most recent period. For example, suppose that you have reached the 2nd stage of period seven. In that case, the middle block will reflect what happened during period six, while the right block will reflect average actions during the first five periods. As shown in the example, the number 4.2 in the first column of the right block in the Player 1 row means that that group member assigned an average of 4.2 points to the group account during the first five periods. The 1.2 in the second column and the row labeled Player 3 means that Player 3 assigned an average of 1.2 reduction points per period to you during the first five periods.

An example of a screen in Stage 2 of Period 7.

Period		7 out of 15				
Last period choices				Avg. earlier period choices		
Player	Alloc. to group acct.	Points to reduction	Alloc. to group acct.	Reduc. pts. to You	Alloc. to group acct.	Reduc. pts. to You
You	1		14		10.2	
Player 1	11	<input type="text"/>		0	4.2	1.8
Player 3	4	<input type="text"/>		0	9.8	1.2
Player 4	0	<input type="text"/>	12	3	6.4	1.8

Remember that the earnings of other group members are reduced by 3 times the amounts you enter.
To leave an individual's earnings unchanged, enter 0.

Submit

Note: Numbers shown are for illustration only.

]

[E3n, F3n, E3h and F3h treatments have instructions for Stage 3 as follows:]

Stage 3: another set of reduction decisions

[In E3n and E3h treatment: After each group member has made their allocation decision and their initial reduction decisions, there is a final stage in each period during which each may have an additional opportunity to reduce others' earnings should he or she wish to. Specifically, you will be shown the amounts, if any, by which other group members reduced your earnings during Stage 2, and you will have an opportunity in Stage 3 to reduce the earnings of those individuals who reduced your own earnings in Stage 2.]

[In F3n and F3h treatments: After each group member has made their allocation decision and their initial reduction decisions, there is a final stage in each period during which you will see the number of reduction points, if any, that each group member assigned to each other group member in the second stage and you will have the opportunity to reduce their earnings should you wish to.]

The reduction process in Stage 3 is the same as in Stage 2 in that you must enter [in E3n and E3h treatments: an integer] [in F3n and F3h treatments: integers] between 0 and 10 into [in E3n and E3h treatment: a box in the row for the relevant member or members of your group,] [in F3n and F3h treatments: boxes in the rows for the relevant members of

your group,] and each 1 point you spend on reducing another member's earnings causes that person's earnings for the period to decline by 3 points (unless the sum of reductions from others in Stages 2 and 3 have already brought his or her earnings for the period to zero). As with Stage 2, your own earnings are always reduced by the number of reduction points you assign to others, even if this causes your earnings for the period to become negative (or, if they were negative already, to become a still larger negative number). [In E3n and E3h treatment: (Note that if no group member reduces your earnings in Stage 2 of a certain period, there is no one whose earnings you can reduce in Stage 3 of that period, so you will have no decision to make at that time.)]

Your final earnings for the period as a whole are equal to your earnings from the allocation stage minus your total losses from reductions assigned to you by other group members in stages 2 and 3 (or zero if that result is negative) minus the total number of points you assign to reduce others' earnings in stages 2 and 3. (A negative earnings total in one period will be made up out of the positive earnings totals of other periods.) In other words, your final earnings are:

$$\left\{ \begin{aligned} &\text{The greater of } [20 - (\text{points you allocate to group account}) + 0.4 * (\text{sum of points allocated by all} \\ &\quad \text{in group to group account}) - \\ &\quad 3 * (\text{sum of reduction points directed at you by others in your group in the two reduction stages})] \\ &\quad \text{and } 0 \end{aligned} \right\} \\ - (\text{sum of points you use to reduce others' earnings in the two reduction stages}).$$

An example of the screen on which you enter your Stage 3 reduction decisions is shown below.

[In E3n treatment:

Period
1 out of 15

Player	1st Stage Reduction Points from Row Player	2nd stage reduction points
You	--	
Player 1	1	<div></div>
Player 3	2	<div></div>
Player 4	0	

Remember that the earnings of other group members
are reduced by 3 times the amounts you enter.
To leave an individual's earnings unchanged, enter 0.

Submit

Note: Numbers shown are for illustration only.

]

[In F3n treatment: The information on Stage 2 reductions will appear as a block of numbers near the right side of your screen, as illustrated by the example below. In this example, the 2 in the first column, third row indicates that Player 2 (row heading) gave 2 reduction points to You (column heading) in Stage 2. The number 3 in the first row, second column means that You (row heading) gave 3 reduction points to Player 1 (column heading) in Stage 2. The number 1 on the right end of the bottom row indicates that Player 4 gave 1 reduction point to Player 2 in Stage 2.]

Period
1 out of 15

1st Stage Reduction Points from Row Player to Col. Player

Player	Alloc. to group acct.	You	P1	P2	P4	Points to reduction (2nd reduction stage)
You	15		3	2	1	
Player 1	5	0		1	1	<input type="text"/>
Player 2	10	2	0		1	<input type="text"/>
Player 4	20	0	0	1		<input type="text"/>

Remember that the earnings of other group members
are reduced by 3 times the amounts you enter.
To leave an individual's earnings unchanged, enter 0.

Submit

Note: Numbers shown are for illustration only.

]

[In E3h treatment:

In addition to the reduction points that you received in Stage 2, shown in the column to the left of the decision box or boxes, the screen will also show the average reduction points (if any) by which each group member reduced your earnings in earlier periods, and the average amount allocated to the group account in those earlier periods by any group member who reduced your earnings at least once in earlier periods. (Earlier reduction amounts are the *sum* of Stage 2 and Stage 3 reductions.) For example, if it is now period 7, the right two columns show average allocations to the group account and average reduction points directed at you during the first six periods. In Period 1, these right two columns will be blank since there is no history at that moment.

Period
7 out of 15

Avg. earlier period choices (including last period)				
Player	Reduc. pts. to You this period	Points to reduction (2nd reduction stage)	Alloc. to group acct.	Reduc. pts. to You
You			5.7	
Player 2	2		10.8	1.8
Player 3	0		10.7	1.2
Player 4	0		7.3	0.8

Remember that the earnings of other group members are reduced by 3 times the amounts you enter.
To leave an individual's earnings unchanged, enter 0.

Submit

Note: Numbers shown are for illustration only.

]

[In F3h treatment: Notice that the middle block of numbers shows the numbers of points that each group member has used to reduce the earnings of each other group member in Stage 2 of the current period. For example, the 2 in the first row, second column means that You (row heading) assigned 2 points to reducing the earnings of Player 2 (column heading) during Stage 2 of this period. The right block shows the averages of past reductions given and past allocation decisions from the first period to the most recent period. (Earlier reduction amounts are the *sum* of Stage 2 and Stage 3 reductions.) For example, if it is now period 7, the right block shows average allocations during the first six periods.

An example of a screen in Stage 3 of Period 7.

Period
7 out of 15

Player	Alloc. to group acct.	2nd stage reduction points from row player to col. player				Points to reduction (2nd reduction stage)	Alloc. to group acct.	Average past reduction points from row player to col. player in previous periods			
		You	P1	P2	P4			You	P1	P2	P4
You	1		0	2	0		10.8		2.3	2.8	0.7
Player 1	0	0		0	1	<input type="text"/>	7.3	1.8		1.5	2.7
Player 2	11	0	1		1	<input type="text"/>	5.7	2.5	2.0		2.2
Player 4	4	0	3	0		<input type="text"/>	10.7	1.8	1.0	1.7	

Remember that the earnings of other group members are reduced by 3 times the amounts you enter.
To leave an individual's earnings unchanged, enter 0.

Submit

Note: Numbers shown are for illustration only.

]

At the end of Stage 3, you'll see a summary of your earnings for the period and how they were calculated, which will include information on the total number of points (if any) that were deducted from your earnings due to points directed at you by others in Stage 3.

[In E3h and F3h treatments: Note again that when reduction points of past periods are displayed during future periods, first and second stage reduction points are added together.]

Summary

You will interact with three other individuals whose identities will not be made known to you either during or after the experiment, for a total of fifteen periods. Each period, you and each other member of your group will receive an endowment of 20 points and will decide on its allocation between a private and a group account. Points allocated to the group account raise each group member's earnings by 0.4 points, while points allocated to the private accounts raise the allocator's earnings by 1 point with no effect on others' earnings. Once each group member has made his or her allocation decisions, each will see how much each other has allocated to the group account [In Reference, F3n, F3h and F2 treatments:, in a fixed order,] and has an opportunity to reduce his or her earnings at a cost of 1 point to the assigner per 3 points lost by the recipient of the reduction. [In E3n and E3h treatments: Each period then has a third and final stage in which group members

learn by how much (if at all) their earnings were reduced by each other group member and each has a second opportunity to reduce the earnings of those who had reduced their own earnings, at the same cost of 1 point per 3 points lost.] [In F3n and F3h treatments: Each period then has a third and final stage in which group members learn how many reduction points each group member received from each other member and each has a second opportunity to reduce the earnings of the others should she wish to, at the same cost of 1 point per 3 points lost.] [In F2 treatment: In later periods, information on past reduction decisions and past allocations will be displayed during each reduction stage.] [In F3h treatment: In later periods, information on past reduction decisions and past allocations will be displayed during each reduction stage, with reductions of both the first and second reduction stages of a given past period being added together for ease of display.] [In E2 treatment: In the second and later periods, information on reductions of your earnings by others in your group in the previous period will also be displayed during each reduction stage.] [In E3h treatment: In later periods, information on reductions of your earnings by others in your group and past allocations by any group member who reduced your earnings in the period(s) will be displayed during each reduction stage, with reductions of both the first and second reduction stages of a given past period being added together for ease of display.] [In E2, E3n and E3h treatments: Information regarding other group members will be presented in a random order using the identifications Player 1 2, 3 or 4. These numbers are reshuffled each period, so that the information about a given group member is equally likely to be identified by any of the numbers this period, regardless of which number it was associated with during the previous period. The 2nd stage screen refers to each individual by their current period number only.] At the end of each period, a summary of allocation and reduction decisions and your earnings for the period will be displayed.

During the experiment, you are welcome to write down notes on scratch paper if you want to do so, to help you recall more detailed information.

After fifteen repetitions of this process, the experiment will be over, and you will be asked to answer a few questions while the experimenters count out payments based on each person's accumulated earnings and the rate \$1 = 20 points, plus a show-up fee of \$5 for each participant. A member of the experiment team will then come to your desk to deliver your payment to you privately in a sealed envelope.

Please raise your hand now if you have any questions. Once all questions have been answered, the experiment will begin.

A.2 Exit and Open-ended Questions

[When Period 15 of the main part of experiments was completed, the following instructions were read:]

This is the final task for today. You will be asked a several last questions about your semester level, economics course experience, concentration, nationality and gender. After you have done this, your exact earnings will be calculated and shown to you. Then there will be a few open-ended questions to get your feedback about today's experiment while we prepare to give you your earnings. Any questions? Please begin.

Exit Question

- 1) Please indicate your concentration(s).
- 2) How many semesters of college or university (not including this semester) have you completed?
- 3) How many economics courses have you taken?
- 4) What was your SAT math score?
- 5) Have you taken and passed a college-level mathematics or applied mathematics course, including AP Calculus? (Write down your answer by filling in the blank "Yes" or "No")
- 6) What is your nationality? (Ex. American)
- 7) Gender (Male, Female)

Open-ended Questions

- 1) How often did you incur the cost to reduce other participants' earnings?
- 2) What were the main circumstances under which you reduced others' earnings?
- 3) Did having your own earnings reduced by others influence your decisions, and if so, how?

Appendix B: Supporting Analysis and Additional Tables and Figures

B.1 Supporting Analysis

B.1.1 Statistical tests of the difference in percentage of punishments given (See Fig. B.2), out of the relevant set of occasions, across treatments

Method: Step 1: calculate the percentage by group; Step 2: conduct group-level Mann-Whitney tests for (a) to (e) below, or a group-level Wilcoxon Signed Ranks tests for (e) below.

(a) The percentage of total opportunities to engage in punishment in Stage 2 in which the individual gave a positive amount of punishment (panel (a) of Fig. B.2)

	E3n	F3n	E3h	F3h
E3n	----	.0124**	.1906	.3053
F3n	----	----	.5387	.4867
E3h	----	----	----	.9647
F3h	----	----	----	----

Notes: Numbers are p -values (2-sided test). ** indicates significance at the 0.05 level.

Result: 2nd stage punishment was significantly more common in E3n than in F3n. Other differences are not significant.

Interpretation: In F3n, subjects could delay punishing Stage 1 free riders until Stage 3, in order to escape from counter-punishment. In E3n, such a delay strategy was difficult to follow because a subject could give Stage 3 punishment only to a group member who punished him/her in Stage 2 of the same period.

(b) The percentage of pro-social punishment out of the punishment events in Stage 2 (panel (b) of Fig. B.2)

	E3n	F3n	E3h	F3h
E3n	----	.9248	.6721	.2964
F3n	----	----	.6329	.4342
E3h	----	----	----	.1458
F3h	----	----	----	----

Notes: Numbers are p -values (2-sided test). No observation is included if the number of Stage 2 punishment events in a group is zero. This leads to the exclusion from these tests of the data from one group in E3h and one group in F3h. We call a Stage 2 punishment event “pro-social” when the recipient contributed less than the group average, and “perverse” otherwise.

Result: While perverse 2nd stage punishment seems to account for a higher proportion of overall punishment in each E than in its corresponding F treatment, no differences are statistically significant.

(c) The percentage of pro-social Stage 2 punishment events in which the second stage pro-social punisher was counter- punished in Stage 3 (panel (c) of Fig. B.2)

	E3n	F3n	E3h	F3h
E3n	----	.4109	.2848	.0698*
F3n	----	----	.7358	.0068***
E3h	----	----	----	.0056***
F3h	----	----	----	----

Notes: Numbers are *p*-values (2-sided test). A Stage 2 punishment event is counted as pro-social if the individual receiving the punishment contributed less than the group average in Stage 1. * and *** indicate significance at the .10 level and at the .01 level, respectively.

Result: The percentage of pro-social punishments that elicit counter-punishment is significantly lower in F3h than in any other treatment with three stages

Interpretation: Counter-punishing a pro-social punisher is an anti-social or perverse act likely to reduce cooperation and efficiency. We find less such anti-social Stage 3 counter-punishment in F3h, which helps to explain why it was the most efficient treatment.

(d) The percentage of perverse Stage 2 punishment events in which the second stage punisher was counter- punished in Stage 3 (panel (d) of Fig. B.2)

	E3n	F3n	E3h	F3h
E3n	----	.2076	.1400	.6072
F3n	----	----	.7609	.1219
E3h	----	----	----	.6657
F3h	----	----	----	----

Notes: Numbers are *p*-values (2-sided test). Data whose number of perverse punishment events in Stage 2 is zero are not used. This leads to absence of observations for 6 groups in E3n, 7 groups in F3n, 7 groups in E3h, and 4 groups in F3h, leaving the number of remaining observations quite small. A Stage 2 punishment event is counted as perverse if the punished individual contributed at least the group average amount in Stage 1.

Result: there are no significant differences among treatments with regard to the percentage of 2nd stage perverse punishment events that are counter-punished in the 3rd stage.

(e) Is there a significant difference between the percentage of pro-social punishments that are counter-punished (panel (c) of Fig. B.2) and the percentage of perverse punishments that are counter-punished (panel (d) of Fig. B.2) in a given treatment?

	E3n	F3n	E3h	F3h
Group-level Wilcoxon Signed Ranks test p-values (2-sided)	.7150	.1655	.6547	.3961

Note: Numbers are *p*-values (2-sided test). Only data whose numbers of both pro-social and perverse punishment events in Stage 2 are non-zero are used. This leaves the number of included observations quite small (see note under (d) above).

	E3n	F3n	E3h	F3h
Group-level Mann- Whitney test <i>p</i> -values (2-sided)	.8298	.0778*	.8958	.5591

Note: Numbers are *p*-values (2-sided test). * indicates significance at the .10 level.

Result: Signed rank tests, which pair the first and second percentages for given groups, find no significant differences. Mann-Whitney tests, which treat observations of share of pro-social punishment counter-punished and observations of share of perverse punishment counter-punished without regard to which group generates each observation, find the larger share of counter-punishment of perverse than of pro-social punishments in F3n to be statistically significant at the 10% level. The difference is not statistically significant for any other treatment.

B.1.2. Statistical tests of the difference in percentage of punishments given (See Fig. B.2), out of the relevant set of occasions, across treatments

Higher-order Punishment Analysis by Type. 3rd-stage punishment of non-punishers (those who fail to punish low contributors in Stage 2) and perverse punishers (those who punish high contributors in Stage 2), treatments F3n and F3h

(I) Punishment of non-punishers (PEO)

In F3n, we identified a total of 764 opportunities in which an individual k could engage in punishment of an individual j in Stage 3, and three conditions were satisfied: (i) there were unequal contributions in their group, (ii) member j punished no one (failed to punish less-than-average contributors and was also not involved in punishing higher-than-average or equal-to-average contributors) in Stage 2, and (iii) k was not the lowest contributor in the group. These conditions reflect the logic of Henrich and Boyd (2001) insofar as pro-social agents are expected to punish only free riders and a group's greatest free rider can be presumed not to be a pro-social agent. The corresponding number of opportunities in F3h was 263.

Out of the 764 opportunities in F3n, we found 86 cases in which k gave a positive amount of Stage 3 punishment to j . These constitute 86 possible cases of second-order punishment for failure to engage in first-order punishing, referred to in our paper as PEO or punishment enforcement for omission, or 11.3% of opportunities. The percentage was similar in F3h. Out of the 263 opportunities in F3h, k gave a positive amount of Stage 3 punishment to j in 30 cases (11.4% of opportunities).

Of the 86 cases in F3n, 82 are cases in which the contribution of the punisher is greater than the contribution of the individual punished, and 79 are cases in which the punished individual contributed less than the group average in the period in question. Similarly, out of the 30 cases in F3h, 27 are cases in which the contribution of the punisher is greater than that of the individual punished, and 24 are cases which the punished individual contributed less than the group average. We conclude that at least 79 of the 86 cases in F3n and 24 of the 30 cases in F3h of apparent Stage 3 punishment given for non-punishment in the 2nd stage may actually be cases of delayed punishment for 1st stage free-riding with respect to contributions.

Evidence favoring the interpretation that most of the potential cases of punishment for not punishing are actually cases of delayed punishment for a low contribution comes from subjects' responses to being punished. If the punished subjects interpreted the punishment as being given for failure to punish, they might take to punishing in subsequent periods. However, we find no evidence that recipients of Stage 3 punishment who did not punish in Stage 2 increased the amount of punishment they gave in the following period. Instead, we find evidence that recipient of Stage 3 punishment increased their contributions in the following period. These results appear in Table B4.

(II) Punishment enforcement of perverse punishers (PEC)

We identified only 5 cases in F3n and only 11 cases in F3h in which a group member k had an opportunity to engage in punishment in Stage 3, satisfying the conditions (i) in Stage 2 some group member j punished a member who contributed an amount equal to or greater than the group average (i.e. j perversely punished another member in Stage 2), and (ii) j did not punish k in Stage 2 (so punishment of j by k cannot be explained by revenge).

The number of these potential opportunities for PEC is very small because in most instances in which an individual perversely punished in the 2nd stage, that individual also punished low contributors, so there are few instances in which an unaffected by-stander k can be identified.

Out of the above 5 and 11 opportunities, we found no case and 1 case, respectively, in which k punished j in Stage 3 (engaging in PEC [punishment enforcement for commission]).

B.2 Tables B.1 to B.6

Table B.1. Group-level Wilcoxon Signed-Ranks Tests on the Trends of Average Contributions and Average Earnings

(a) Average contribution

		(1) of Period 1 to Period 7	(2) of Period 8 to Period 14	Test for (1) = (2) <i>p</i> -value (2-sided)	(3) of all periods
Treatment	Reference	13.08	15.15	0.092*	14.00
	E3n	11.73	9.61	0.037**	10.31
	F3n	15.10	14.90	0.647	14.95
	E2	15.64	17.55	0.017**	16.47
	F2	16.02	17.50	0.005***	16.68
	E3h	14.19	14.65	0.441	14.39
	F3h	17.62	19.35	0.008***	18.32

(b) Average earnings

		(1) of Period 1 to Period 7	(2) of Period 8 to Period 14	Test for (1) = (2) <i>p</i> -value (2-sided)	(3) of all periods
Treatment	Reference	23.73	27.56	0.017**	25.49
	E3n	24.48	23.36	0.203	23.51
	F3n	26.09	27.57	0.241	26.36
	E2	26.77	29.70	0.007***	28.05
	F2	27.31	29.57	0.013**	28.29
	E3h	26.27	27.51	0.441	27.00
	F3h	28.51	31.05	0.008***	29.47

Notes: *, **, and *** indicate significance at the .10 level, at the 0.05 level and at the .01 level, respectively.

Result: contributions (earnings) are significantly higher in periods 8 – 14 than in periods 1 – 7 in Reference and three (three) other treatments. In E3n, contributions are significantly lower in the later periods than in the earlier periods. Period 15 is left out due to the end-game decline which our data share with other finitely repeated voluntary contribution experiments.

Table B.2. Group-level Mann-Whitney Test Results on the Efficiency of Treatments

(a) Average contribution, averaged over all 15 periods

		Treatment						
		Reference	E3n	F3n	E2	F2	E3h	F3h
Treatment	Reference	----	0.121	0.496	0.131	0.112	0.513	0.014**
	E3n	----	----	0.034**	0.005***	0.005**	0.060**	0.001***
	F3n	----	----	----	0.623	0.364	0.870	0.034**
	E2	----	----	----	----	0.910	0.513	0.221
	F2	----	----	----	----	----	0.462	0.221
	E3h	----	----	----	----	----	----	0.122
	F3h	----	----	----	----	----	----	----

(b) Average earnings, averaged over all 15 periods

		Treatment						
		Reference	E3n	F3n	E2	F2	E3h	F3h
Treatment	Reference	----	0.326	1.000	0.227	0.151	0.414	0.034**
	E3n	----	----	0.070*	0.003***	0.003***	0.060*	0.001***
	F3n	----	----	----	0.131	0.151	0.624	0.014
	E2	----	----	----	----	0.940	0.369	0.121
	F2	----	----	----	----	----	0.327	0.142
	E3h	----	----	----	----	----	----	0.122
	F3h	----	----	----	----	----	----	----

Note: Numbers in each panel are *p*-values for two-sided tests.

*, **, and *** indicate significance at the .10 level, at the 0.05 level and at the .01 level, respectively.

Table B.3. Determinants of first-order punishment received

Independent Variable	E3n	F3n	E2	F2	E3h	F3h
Average Contribution in Period t	-0.086 (0.052)	-0.015 (0.019)	-0.050 (0.027)	-0.081** (0.034)	-0.012 (0.029)	-0.032 (0.034)
Absolute Negative Deviation in Period t	0.24** (0.075)	0.16*** (0.042)	0.37*** (0.087)	0.33*** (0.097)	0.44*** (0.10)	0.34*** (0.067)
Positive Deviation in Period t	-0.0052 (0.027)	0.036*** (0.0066)	0.0057 (0.033)	-0.0028 (0.0096)	0.043** (0.017)	-0.0032 (0.034)
Constant	1.08* (0.53)	0.18 (0.26)	0.90* (0.49)	1.44* (0.66)	0.080 (0.45)	.636 (0.66)
# of Observations	600	600	600	600	540	540
F	7.02	11.23	7.45	49.26	9.59	12.02
Prob > F	.0099	.0021	.0082	.000	.0050	.0025
R-Squared	.173	.241	.418	.389	.363	.647

Notes: Individual fixed effect linear regression with standard errors clustered by group. The dependent variable is total punishment received by subject j in Stage 2 in Period t . *, **, and *** indicate significance at the .10 level, at the 0.05 level and at the .01 level, respectively.

Table B.4. Impact of Punishment on Contribution and Punishing by Non-punisher Subjects

Dependent variable: change in contribution ([1], [3]); change in punishment of low contributors ([2])

Independent Variable	Treatment F3n		Treatment F3h	
	[1]	[2]	[3]	[4]
(a) Total punishment received (the sum of the second and third stage punishment received) in period t apart from (b)	1.86** (0.79)	----	2.47*** (0.47)	----
(b) Stage 3 punishment received by recipient who did not punish low contributors in period t	1.62* (0.77)	-0.050* (0.027)	1.82*** (0.34)	----
Constant	-.92 (0.55)	0.11*** (0.0077)	-0.61* (0.35)	----
# of Observations	336	285	143	----
F	2.83	3.48	21.13	----
Prob > F	.111	.0951	.000	----
R-Squared	.1416	.000	.3859	----

Notes: Individual fixed effect linear regression with standard errors clustered by group. Dependent variable is the individual's change in contribution decision: $C(t+1) - C(t)$ in columns [1] and [3], and is the individual's change in second stage punishment given to below average contributors in columns [2] and [4]. We include observations for those subjects having the opportunity to punish in Stage 3 a group member who engaged in no Stage 2 punishment, conditional on the potential Stage 3 punisher *not* being the lowest contributor in the group. Column [4] could not be estimated due to insufficient observations.

Result: Punishment of non-punishers is effective in making the recipients increase their contribution in the next period, but not in making the recipients raise their Stage 2 punishment of low contributors.

Interpretation: Most low contributors who do not punish in Stage 2 and who are punished in Stage 3 appear to interpret the punishment that they receive as being a delayed punishment for free riding in the contribution stage, not punishment for failing to punish.

Table B.5. Determinants of punishment received in Stage 2 of treatments E2 and F2, including motives for higher-order punishment (supplementing the regression analysis in Table 3 of the paper).

Dependent variable: total punishment received by subject j in Stage 2 in Period t (in columns (2) and (3), net of predicted punishment)

Independent Variable	Reference (1)	E2 (2)	F2 (3)
Average Contribution in Period t	0.046 (0.037)	----	----
Absolute Negative Deviation in Period t	0.66*** (0.17)	----	----
Positive Deviation in Period t	0.11** (0.037)	----	----
(a) Total 2 nd Stage Informal Sanction Subject j gave to below average contributors in Period $t-1$	----	0.12** (0.047)	0.0093 (0.037)
(b) Total 2 nd Stage Informal Sanction Subject j gave to above or equal to average contributors in Period $t-1$	----	0.018 (0.14)	0.23*** (0.062)
Constant	-0.68 (0.64)	-0.43*** (0.018)	-0.42*** (0.42)
# of Observations	600	560	560
F	5.23	5.68	6.92
Prob > F	.231	.0253	.0152
R-Squared	.539	.0059	.0004

Notes: Individual fixed effect linear regression with standard errors clustered by group. On the first three independent variables, see Table B.3. The dependent variable in columns (2) and (3) is subject j 's total punishment received in Stage 2 minus j 's predicted informal sanctions for Stage 1 choice based on the coefficients on constant, average contribution, absolute negative deviation, and positive deviation, for Reference (column (1)). Data on period 1 punishment received is excluded in columns (2) and (3).

*, **, and *** indicate significance at the .10 level, at the 0.05 level and at the .01 level, respectively.

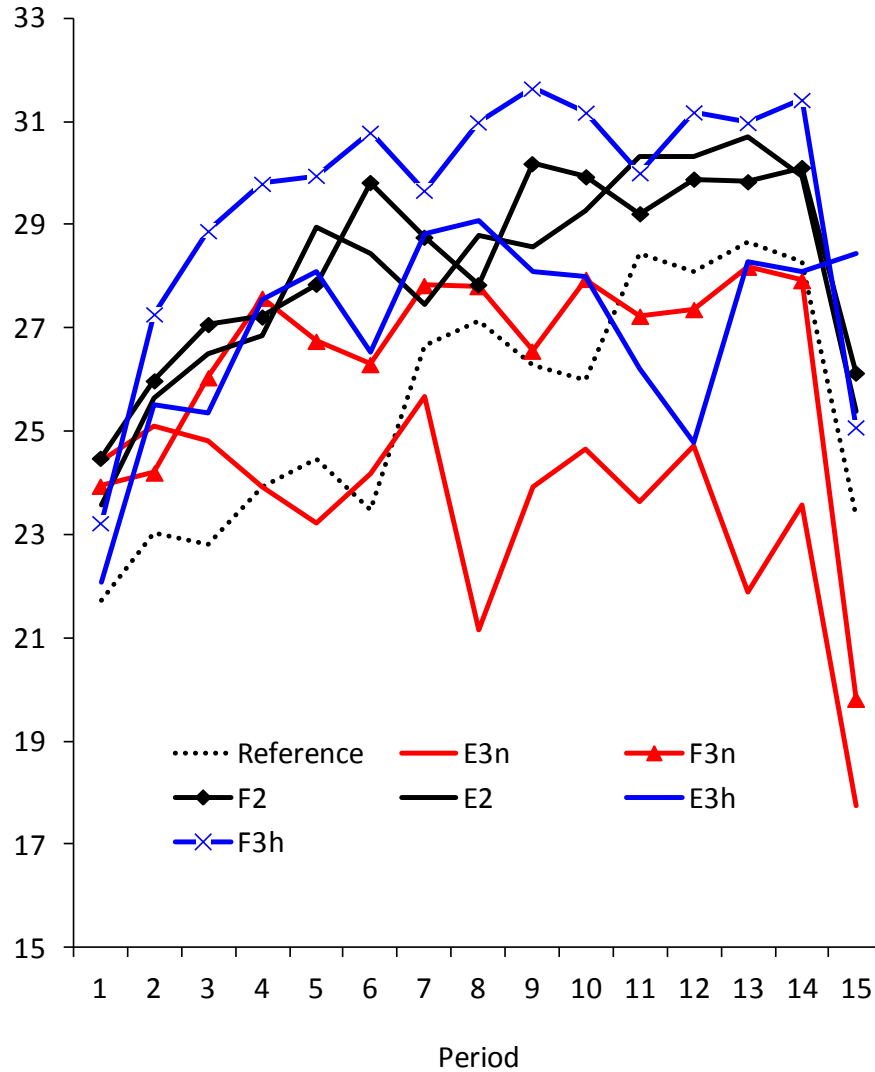
Table B.6. Determination of contributions and earnings by treatment settings

Independent Variable	Dependent variable: Avg. contribution by subject i	Dependent variable: Avg. earnings of subject i
T: Third Stage Punishment Dummy (1 if E3n, E3h, F3n, F3h; 0 otherwise)	-3.69*** (1.01)	-1.98*** (.75)
F: Full Information Dummy (1 if F, F3n, F3h; 0 otherwise)	1.21 (1.76)	.92 (1.32)
H: History Dummy (1 if E2, F2, E3h, F3h)	2.47** (1.01)	2.56*** (0.75)
T * F	3.42** (1.44)	1.94* (1.08)
T * H	1.91 (1.42)	1.23 (1.07)
F * H	-1.00 (1.44)	-0.68 (1.08)
Constant	14.00*** (0.71)	25.5*** (0.53)
# of Observations	276	276
F	12.50	13.54
Prob > F	.000	.000
Adjusted R-Squared	.201	.215

Notes: *, **, and *** indicate significance at the .10 level, at the 0.05 level and at the .01 level, respectively. No clustering of errors by group, for reasons discussed in the text. Results are considered suggestive, only.

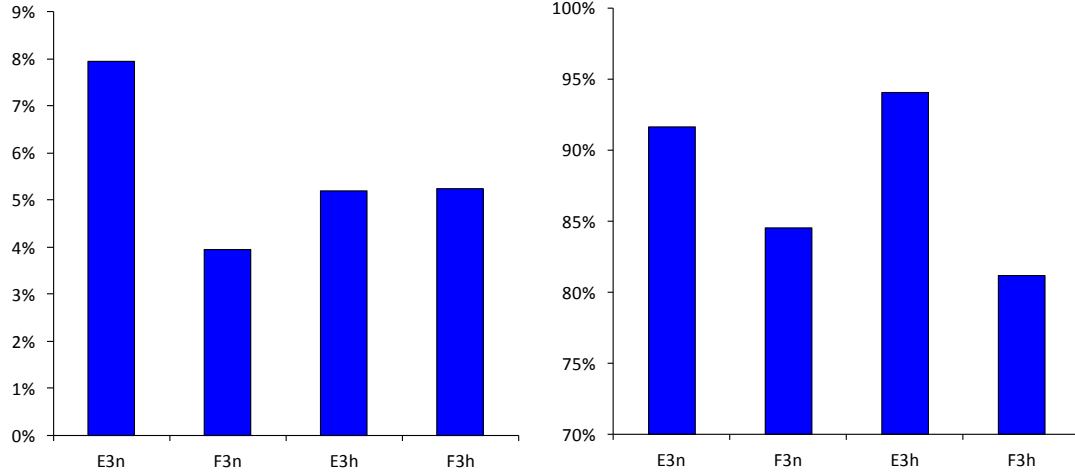
B.3 Figures B.1 and B.2

Fig. B.1. The trends of average earnings by treatment

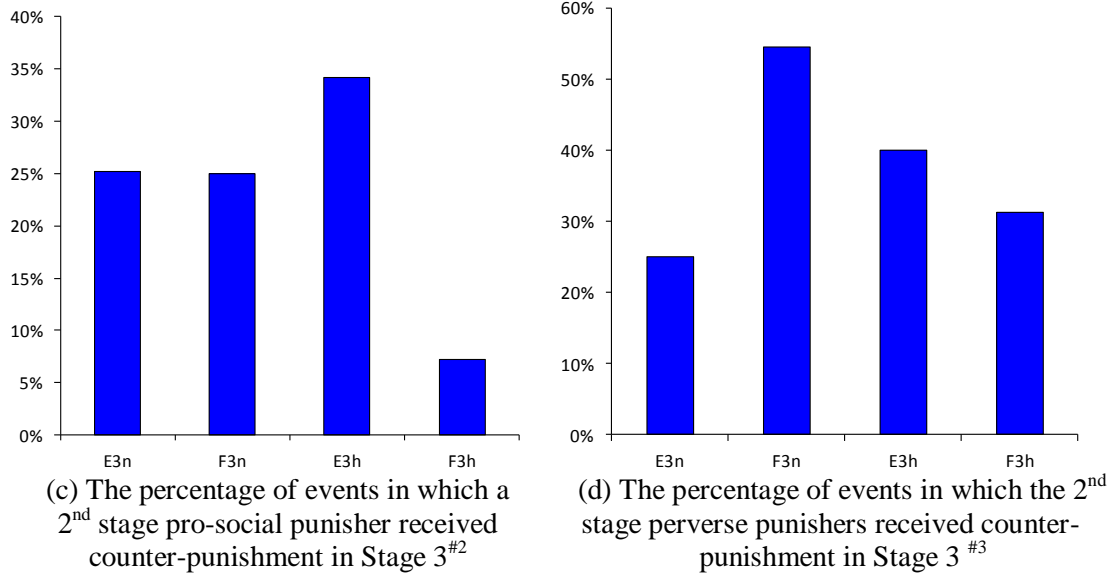


Remark: earnings trends resemble contribution trends in that treatment F3h displays the highest earnings, E3n the lowest, and all other treatments' earnings are either similar to or above those of Reference. Note that while the average payoff from contributions and retained endowment rises monotonically with the average contribution, final earnings are reduced by punishment costs to punishers and punishment recipients.

Fig. B.2. Punishment and Counter-punishment Decisions in 3-Stage Treatments, Average Shares



- (a) The percentage of total opportunities to engage in punishment in Stage 2 in which the individual gave a positive amount of punishment^{#1}
- (b) The percentage of pro-social punishment out of the punishment events in Stage 2^{#2}



- (c) The percentage of events in which a 2nd stage pro-social punisher received counter-punishment in Stage 3^{#2}

- (d) The percentage of events in which the 2nd stage perverse punishers received counter-punishment in Stage 3^{#3}

Notes: ^{#1} The total number of punishing opportunities (the denominator of the fraction) is 1,800 in E3n and F3n, and is 1,620 in E3h and F3h. ^{#2} The punishment is “pro-social” if it is directed at an individual who contributed less than the average contribution in his/her group. ^{#3} The punishment is “perverse” if it is directed at an individual who contributed more than or equal to the average contribution in his/her group.