PICK YOUR GROUP SIZE: A BETTER PROCEDURE TO RESOLVE THE FREE-RIDER PROBLEM IN A BUSINESS SIMULATION

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ABSTRACT

A procedure for resolving the free-rider problem that does not use peer evaluations is incorporated into a business simulation. The procedure consists of four parts: tracking each participant's actions, assigning participants to groups based on each participant's preferred group size, allowing each participant one opportunity to switch groups, and giving incremental credit towards grades each period based on the midpoint between the individual's performance and the average performance of the members of the individual's group. The simulation incorporating the procedure was administered as a single exercise to 139 students in Hong Kong and the United States. As hypothesized, Hong Kong students preferred larger-size groups than U.S. students, size preferences of both Hong Kong and U.S. students were distributed bimodally, and those not assigned to their preferred group size were no more likely to switch groups than those who were assigned to their preferred group size. About 6.90% of the 29 multi-person groups were troubled by free riders, significantly less than the 27% of a previous study that used peer evaluations.

INTRODUCTION

The free-rider problem has vexed economists from at least the time of Adam Smith (1776/1909/1937). The problem pervades every project in which the work to be done requires the efforts of two or more persons. If each desires the greatest gain for the least contribution, how does one assure that those who contribute more are at least as well rewarded as those who contribute less? If the assurance is not present, then each party's self interest would be to shirk. The work would falter, and the outcome would be suboptimal.

The work that participants of business simulations are required to do is often of this kind. Participants of a business simulation are generally organized into groups, and directed to pool their efforts in managing the virtual firm that is assigned to each group. Decisions are made collectively, and one member of the group represents the group in entering the group's decisions. Decisions of all groups are processed together, results returned, and the groups are then directed to arrive at decisions for the next period. To assure that rewards are commensurate with effort, group members may be asked to evaluate each other's contributions, usually once at the end of the multiple-period exercise. These peer evaluations are then used to assign differential credit towards grades (Hall & Ko, 2006; Malik & Strang, 1998; Morse, 2002; Payne & Whittaker, 2005; Poon, 2002). The knowledge that group members will rate each other may forestall free riding, and the fact that peer evaluations affect grades may fairly align rewards with contributions.

Yet, peer evaluations may not be an ideal solution to the free-rider problem. Vo (1982) points out that students dislike the practice and that the knowledge that members will rate each other harms esprit de corps. Page and Donelan (2001), supports the practice, but concedes that students resist and suggests that the resistance should be overcome by presenting peer evaluation as ethical responsibility. Morse (2003) observes that members from low-context cultures tend to be biased in perceiving those from a different culture as free riders. These concerns hint at the inconsistent logic underlying the use of peer evaluations. If participants are unfair in the efforts they expend in the simulation, why would they not be unfair in the peer evaluations? Would not the optimally rational strategy be to practice self-interest on both the simulation exercise and the peer evaluations? Such a strategy imposed by the majority on the minority would be especially devious.

LITERATURE REVIEW

The inconsistent logic of peer-evaluation exemplifies what economists have proven: It is impossible to design a self-contained system for a voluntary group that optimizes group outcomes without incentivizing free riding. This is because the optimal group outcome depends on knowing what each member truly wants and contributes, so that a suitable incentive package can be tailored to each to elicit that member's optimum efforts, a finding known as the revelation principle (Gibbard, 1973); and because no self-contained system can assure that members will not be disadvantaged for being honest (Green & Laffont, 1977).

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Yet, as Krajbich, Camerer, Ledyard, and Rangel (2009) have observed, the impossibility result depends on the assumption that no information about what members truly want is available beyond that which each member chooses to reveal. To the extent that independent information is available from other sources, such as private communications, behavioral cues, members' previous experiences with each other (Rand, Dreber, Ellingsen, Fudenberg, & Nowak, 2009), and even neural measures from magnetic resonance imaging (Krajbich, Camerer, Ledyard, & Rangel, 2009), self-revelation becomes less valuable, so the problem would be resolvable.

As to the business simulation and gaming literature on free riding, the first appearance of the term *free ride* in the proceedings of the Association for Business Simulation and Experiential Learning (ABSEL) is in a paper describing a program of the Small Business Institute, where teams of business students serve as consultants to small businesses (Coleman, Cooke, & Maronick, 1978). That paper and subsequent ones suggest that free riding can be controlled by keeping group sizes below four, five, or six (Biggs, 1986; Brozik, Cassidy, & Brozik, 2008; Cassidy & Brozik, 2009; Fritzsche & Cotter, 1990; Gentry, 1980; Wolfe & Chacko, 1983; Wilson, 1974). Besides reduced group sizes and peer evaluations, others ABSEL papers that mention free riding discuss dividing the exercise into two phases such that an individual phase precedes the group phase (Foltos, 2009), giving frequent graded exercises drawn from concepts embodied in the simulation (Gold, 2008), keeping individualized performance scores (Thavikulwat & Pillutla, 2004), allowing self-selection of group members (Wolfe & McCoy, 2008), and authorizing groups to remove recalcitrant members (Cruikshank, 1988). These other approaches may be more effective because they do not suffer from peer evaluation's inconsistent logic: that participants will be unfair in the efforts they expend on the simulation exercise but not be unfair on the peer evaluations they submit.

OUR PROCEDURE

Our resolution to the free-rider problem incorporates elements of all of the previously proposed procedures, excepting peer evaluations. It is based on the principle that individuals have different propensities to shirk and different attitudes towards free riders. While some will put forth no effort for the group without compelling assurance of personal profit, others will do their utmost, even if assured that they will not be the one to profit; and while some will take umbrage at a free-rider, others will see an opportunity to extend a helping hand. Accordingly, we allow each individual to choose the character of the group to whom he or she will belong, by choosing the size of the group. Our procedure consists of four parts:

1. Track the actions of each participant
2. Assign participants to groups based on each participant's preferred group size
3. Allow each participant one opportunity to switch groups
4. Give incremental credit towards grades each period based on the midpoint between the participant's performance and the average performance of the members of the participant's group

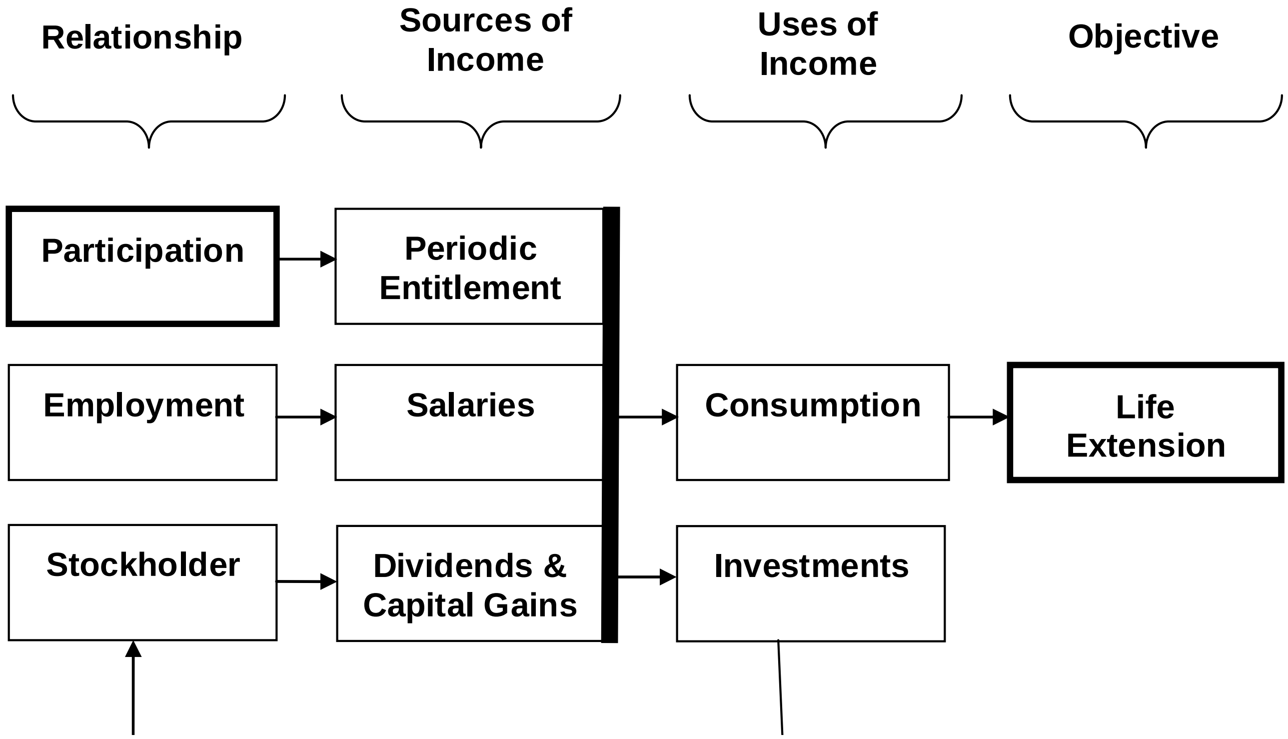
Part 1, tracking the actions of each participant, is possible with GEO, the simulation used in this study, because GEO requires that every decision be entered by participants for themselves, and never collectively as a representative of a group. Participants are free to work with or apart from the group to which they are assigned. For example, if the group decides to raise the price of the company's product, the price will not change unless the member with price-setting authority runs the simulation program, logs in, and executes that change. If the authoritative member does not act on the group's decision, the group must then depend on the recalcitrant member's immediate superior to run the program, log in, and execute decisions to move price-setting authority from the recalcitrant member to a willing member, who must then run the program, log in, and execute the change in price. Thus, every decision is bound to the participant authorized to execute it.

Part 2, assigning participants to groups based on each participant's preferred group size, is the core of our approach. Those with higher propensity to shirk have more to gain when the group is larger. If they understand this logic, they will express a preference for a larger-size group than those less predisposed to shirk. If groups are then assigned based only on preferred group size, the propensity to shirk will tend to be evenly distributed among the members of each group such that smaller groups are composed of lower-propensity shirkers and larger groups are composed of higher-propensity shirkers. If a group's effectiveness relates directly to its size, because bigger size generally mean more resources, and inversely to the members' collective propensity to shirk, then this pick-your-group-size procedure should tend to equalize the potential for effectiveness across groups.

Part 3, allowing each participant one opportunity to switch groups adds flexibility, which may be essential to forestall and resolve conflicts. We require participants who switch to be acceptable to every member of the entering group and we permit single-person groups, so if no existing group will accept a new member, the participant can always choose to switch to a single-person group.

Part 4, giving incremental credit towards grades each period based on the midpoint between the participant's performance and the average performance of the members of the participant's group has two advantages. First, it gives group members who perform relatively better an incentive to assist group members who perform relatively less well. Second, because credit is given each period, rather than one

Figure 1
Performance Flow Diagram



time at the conclusion of the exercise, changing group membership midway into the exercise creates no difficulty in assigning group credit.

THE SIMULATION

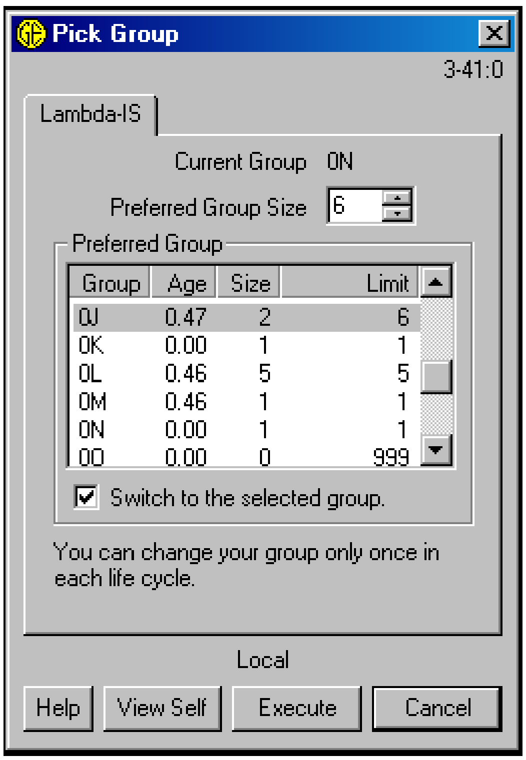
GEO is a computer-assisted (Crookall, Martin, Saunders, & Coote, 1986), Internet-based (Pillutla, 2003), clock-and-activity driven (Chiesl, 1990) simulation of a global economy. As a computer-assisted simulation, GEO enables participants to do much of what they are able to do in the everyday business setting. As an Internet-based simulation, it accesses its data directly through the Internet, without requiring a browser. As a clock-and-activity driven simulation, it advances from one period to the next depending on the time that has elapsed and the activity level of the participants. Generally, GEO is administered over the entire length of a semester, with the periods advancing at the rate of about one period every 48 hours at the start and accelerating gradually up to the rate of about one period every 6 hours. The pace slows down automatically during weekends and breaks, when participants are least active, and speeds up on class days, when participants are most active. Unlike many total enterprise simulations (Keys, 1987), GEO refers to a period simply as a *period*, rather than as a quarter or a year. Like those simulations, production, interest payments, and salary disbursements occur on a period-by-period basis, rather than continuously over the duration of a period.

To enable business activities, every participant receives a beginning balance and a periodic monetary entitlement that the participant may use to found companies, purchase shares, and buy the virtual products produced by the virtual companies that the participants have founded. The incentive for activity arises from a life-cycle-simulating scoring system, whereby participants extend their lives, and therefore increase their scores, by buying products that they are then considered to have consumed. The flow, beginning with Participation and ending with Life Extension, is illustrated in Figure 1.

As Figure 1 illustrates, every participant receives a periodic monetary entitlement, for which no work is required. The participant chooses between spending the entitlement on consumption, which extends life, and on investments in company shares, which convey the rights of shareholders, including the right to receive company dividends and to sell company shares for capital gain. The participant may choose also to accept employment with the virtual companies of the simulation, in which case salaries received from employment add further to the participant's income. Increased income enables increased consumption, which gives rise to a longer life. Participants live multiple, sequential lives. Their scores, for which they receive credit towards grades, consist of the number of cumulative periods by which they have extended their lives.

To assign participants to groups, the GEO computer program requires each participant to specify a preferred group size at registration. The program then assigns participants to groups based solely on their specified preferred group size. Thus, those specifying a preferred group size of four are assigned to a group of three or fewer members, all of whom have specified four as their preferred group size; those specifying a preferred group size of three are assigned to a group of two or fewer members, all of whom have specified three as their preferred group size; and so forth. Assignments are made on a first-registering-first-assigned basis. Later registrants and registrants who specify a large group size may find that their groups are composed of fewer members than the numbers they prefer. Afterwards, participants have one opportunity in each life cycle to switch from their program-assigned group to another group whose size is below its limit, which is set to the smallest preferred size of its members.

Figure 2
Dialog Box for Switching Groups



To switch groups, the participant activates the Pick Group dialog shown in Figure 2. The dialog contains an edit box for the participant's preferred group size, a listing of all groups, a check box to request a change of groups, and an Execute button to execute the switch. Then the participant assures that the preferred-group-size edit box specifies a number equal to or greater than the final size of the group the participant wishes to join, selects a group from the list whose size is less than its limit, checks the switch-to-the-selected-group box, and depresses the Execute button. When the switch is executed, the program updates the size and size limit of the group. One zero-size group is always on the list, so any participant can switch to it to form a single-person group. Thus, participants have full collective control over switching groups, with no administrative permission or involvement required.

Consistent with the computer-assisted, participant-controlled nature of the exercise, no resources or tasks are assigned to the groups per se. The initial venture capital to start a company, however, must be contributed, voluntarily, by members of the founder's group. When the minimum capital requirement is satisfied, the company may, should it wish more capital, proceed with a public offering of shares to participants who are not members of the founder's group. Essentially, each group simulates a clan. Clan members do not have to involve each other in their business activities, but they frequently do, because the successes and failures of each member reflect on the other members of the clan.

Accordingly, our approach to the free-rider problem is to enhance the scope of the simulation to encompass a greater number of natural social relationships, rather than to introduce the artificiality of peer evaluations into the relationships. We do not go as far as to allow participants to freely select the members of their groups, as Wolfe and McCoy (2008) advocate, for free selection advantages those with a wider network of friends, tends to give rise to groups whose membership is less diversified, and embarrasses those who must be imposed on others because they were not invited to join any group.

THE STUDY

We studied the efficacy of our procedure on a population of 139 students who participated in a single administration of the simulation that lasted 12 weeks. Of this number, 42 were graduates students of a comprehensive university in Hong Kong enrolled in a class on quality management, and 97 were undergraduate business students of a comprehensive university in the United States enrolled in three sections of a class on international business. The two sub-populations are graded separately, but an integrated text-messaging system enables cross-location communication and a unitary scoring system allows members of one sub-population to compare their performance to benchmarks of the other sub-population, promoting friendly rivalry.

HYPOTHESES

Our study is a field study, not an experimental study. We applied our procedure because we view it as superior to other procedures that had previously been used, including no group and groups of constant size administratively assigned to maximize heterogeneity with respect to sex, major, home town, and the like. Even though we did not modify our pedagogy to test our procedure, the setting of our study permits four hypotheses to be tested that bear on the efficacy of our procedure.

First, if the students' expressed preference for group size is genuine, we would expect their expressed preferences to reflect their culture. We know from Hofstede's (2001)

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work that the cultural milieu of Hong Kong is predominantly collectivistic whereas that of the U.S. is predominantly individualistic. Hong Kong students should therefore generally favor larger group sizes than U.S. students, thus:

H1: *The preferred group sizes of Hong Kong students will be larger than the preferred group sizes of U.S. students.*

Second, despite a plethora of studies on the educational efficacy of group assignments (Gillies & Ashman, 2003; Johnson, Johnson, & Stanne, 2000), some students vociferously object to this practice, complaining, as reported in *The Chronicle of Higher Education*, that "it's inevitable that a member of the team will shirk" (Glenn, 2009). The students' concern is corroborated by Markulis and Strang's (1995) ethnographic study, which found free riding to be a substantial problem that had deleterious effects on both the functional and social aspects of collaborative-learning groups. Hence, when given a choice of group sizes for an assignment, students are likely to choose a size of one, where shirking is impossible, or a size of 3 or more, where the work that the shirker does not do might be taken up by or shared with others. This reasoning leads to the next hypothesis:

H2: *Students' preferred group size will be distributed bimodally, with many preferring the size of one and many others preferring sizes of 3 or more.*

Third, although no procedure is perfect, our procedure allows us to measure the degree of imperfection in the procedure. We see two points where imperfection can be measured. At the point of assigning students to groups, some students may be assigned to a group of a smaller size than the size they prefer. We consider these to be *compromised* assignments. At a later point, students may exercise their option to switch groups. We consider those who switch within the first six weeks of the 12-week duration of the simulation to have received an *unsatisfactory* assignment. To the extent that a compromised assignment is seen as unfair, compromised assignments will more frequently be unsatisfactory assignments. To the extent that compromised assignments are accepted as fair, compromised assignments will not be associated with a greater frequency of unsatisfactory assignments. So, on the expectation that students will see their group assignments as fair even when compromised, our third hypothesis is as follows:

H3: *Those who receive compromised assignments will be no more likely to switch groups than those who receive perfectly matched assignments.*

Fourth, our procedure allows us to identify likely misfits and shirkers, and by extension, groups with and without troublesome free-riders. If a few members of a group leave their group to form one or more groups consisting only of themselves, the members who leave are likely to be seen as misfits by those they leave behind. If most members of a group leave their group together to form a new group consisting only of themselves, then those who leave are likely to view the members they leave behind as shirkers. Considering that substantial free riding should give rise to either misfits or shirkers, it follows that the number of groups expelling misfits and retaining shirkers is an objective measure of the number of groups troubled by free riding. Hornaday (2001) reported that 27% of 70 groups in an administration of a total enterprise business game had troublesome free riders, which he measured through peer-evaluation comments by any member that one or more members of the group had not done their share. Using Hornaday's report as a benchmark and expecting that our procedure will reduce the number of groups troubled by free-riding, our fourth hypothesis follows:

H4: *The percentage of groups troubled by free riding will be less than 27% of the groups.*

RESULTS

The frequency distribution of preferred group size by location is shown in Table 1. Two outliers are evident at the preferred group size of 15. The outliers came from two adjacently seated students, who probably coordinating their preferred-group-size entry such as to assure that the simulation program would assign them and only them to the same group, considering that no other student is likely to enter a preferred group size of 15.

Table 1
Frequency Distribution of Preferred Group Size by Location

Preferred group size	Location	
	Hong Kong	U.S.A.
1	7	27
2	1	7
3	1	29
4	12	27
5	13	5
6	8	0
15	0	2
Total	42	97

Removing the two outliers from the population, the remaining students' mean preferred group size by sex and location is shown in Table 2. Analysis of variance by sex and location reveals that the specified preferred group sizes of Hong Kong students are significantly greater than those of U.S. students, F (1, 133) = 25.539, p = .000), supporting H1, but that neither sex, F (1, 133) = 0.735, p = .393, nor the interaction of location and sex, F (1, 133) = 1.074, p = .302, are significant in explaining the students' group-size preferences.

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Table 2
Mean Preferred Group Size by Sex and Location

Sex	Location	N	Mean	S.D.
Female	Hong Kong	18	3.83	1.886
	U.S.A.	44	2.77	1.309
Male	Hong Kong	24	4.33	1.465
	U.S.A.	51	2.73	1.282
Total	Hong Kong	42	4.12	1.656
	U.S.A.	95	2.75	1.288

To test for the bimodal distribution of the students' group-size preferences, the normal distribution that would be expected of a unimodal distribution was calculated from the mean and standard deviation of each sub-population. The results are shown in Table 3. The fit between the observed (Table 1) and expected (Table 3) distributions of group-size preferences is poor for both the Hong Kong students, χ^2 (3) = 20.34, *p* = .001, and the U.S. students, χ^2 (3) = 26.51, *p* = .000. The data therefore supports H2, the hypothesis that the distributions would be bimodal rather than normal.

Table 3
Expected Distribution of Preferred Group Size by Location

Preferred group size	Location	
	Hong Kong	U.S.A.
1	2.388	15.809
2	4.504	24.457
3	7.987	28.183
4	9.943	18.306
5	8.689	6.698
6	8.490	1.548

Table 4 shows the cross tabulation of participants' preferred group size by assigned group size, and Table 5 shows the cross tabulation of matched group assignments to switched groups. About 28.5% of the students received compromised assignments, with Hong Kong students tending to receive a greater proportion of compromised assignments than U.S. students, 38.1% vs. 24.2%, χ^2 (1) = 2.118, *p* = .146. About 6.6% of the students switched groups, a proportion that differed hardly at all by whether nor not their assignment was compromised, χ^2(1) = 0.000, *p* = 1.000. Accordingly, H3, that those who receive compromised assignments are no more likely to switch groups than those who receive perfectly matched assignments, because the compromised assignments are accepted as fair, is supported.

Table 4
Preferred Group Size by Assigned Group Size of Participants

Preferred group size	Assigned group size					
	1	2	3	4	5	6
Hong Kong						
1	7	0	0	0	0	0
2	1	0	0	0	0	0
3	1	0	0	0	0	0
4	1	0	3	8	0	0
5	0	0	0	8	5	0
6	0	2	0	0	0	6
U.S.A.						
1	27	0	0	0	0	0
2	3	4	0	0	0	0
3	3	2	24	0	0	0
4	0	4	6	17	0	0
5	0	2	0	3	0	0

Table 5
Matched Group Assignments by Switched Groups

Matched group assignment	Switched groups	
	No	Yes
Hong Kong		
Perfect	23	3
Compromised	16	0
U.S.A.		
Perfect	69	3
Compromised	20	3

Table 6 is a listing of the students who switched groups. The first five students on the list switched to an existing group, apparently because they saw the new group as more attractive than the group to which they were assigned, so the switches do not signal trouble. The sixth student (No. 53), who switched from a group of three to a single-person group, is apparently a misfit, and the seventh to ninth students (Nos. 16, 26, 93), who switched together to form a new group, are apparently leaving behind a shirker. Accordingly, we observe one group with a misfit and one group with a shirker, which amounts to a misfit-and-shirk rate of 1.46% of the population and a troubled-by-free-riding rate of 6.90% of the 29 multi-person groups, significantly less than Hornaday's (2001) 27%, χ^2 (1) = 3.891, *p* = .049.

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Table 6
Students Who Switched Groups

Location	Student	Preferred size	Assigned-to group		Switched-to group	
			Group	Size	Group	Size
Hong Kong	152	1	0U	1	0L	5
	122	1	0V	1	0D	5
	21	4	0B	4	0I	4
U.S.A.	108	3	6M	1	6H	2
	61	4	1P	2	1H	3
	53	4	1H	3	1V	1
	16	4	5P	4	5E	3
	26	4	5P	4	5E	3
	93	4	5P	4	5E	3

To see if the different in the proportion of groups troubled by free riders might be due to differences in group sizes between our groups and Hornaday's groups, we compared the size distribution of our multi-person groups with those of Hornaday's (2001), as shown in Table 7. About 38% of our groups consist of four or more members, significantly greater than Hornaday's, at 10%, χ^2 (1) = 8.958, p = .003. Considering that larger-sized groups should be more likely to be troubled by free riding than smaller-sized groups, our lower troubled-by-free-riding rate affirms H4, that the percentage of our groups troubled by free riding will be less than 27%.

Table 7
Size Distribution of Multi-Person Groups

Size of group	Hornaday	Hong Kong and U.S.A.
2	4	7
3	59	11
4	7	9
5	0	1
6	0	1

CONCLUSION

This study showed that when students were told that they will be assigned to groups based on preferred group size alone, the students expressed group-size preferences that reflected their cultural milieu and distributed their indicated size preferences bimodally, reflecting their wariness of shirkers. Yet, those who were assigned to groups whose size differed from their preferred size were not more dissatisfied than those who received uncompromised group assignments, attesting to the students' acceptance of the procedure as fair. The observed rate of groups troubled by free riding is about 6.9%, much lower than the previously reported rate of 27% that is used as a benchmark, so our procedure appears to be more effective than the benchmark procedure, which relies on peer evaluations.

We cannot discount the possibility that our lower troubled-by-free-riding rate may be an artifact of measurement. Hornaday (2001) used a cognitive instrument; we used a behavioral one. Explicating the relationship between the two instruments will require additional research.

Previous studies have shown reduction in free riding when a procedure makes use of independent information about members, so we attribute much of the apparent effectiveness of our procedure to the same reason. Our procedure tracks the actions of each participant and gives credit for individual performance, thereby gathering and using independent information about group members. Our procedure also causes participants to be sorted such that groups tend to be composed of members roughly equal in their propensity to shirk. If it takes a thief to know a thief and it takes a shirker to know a shirker, then our procedure causes higher-propensity shirkers to come under more scrutiny from their like-minded colleagues than lower-propensity shirkers, which should help to reduce the overall incidence of shirking.

The belief that peer evaluations resolve the free-rider problem may arise from the thinking that free riding is rare, because the great majority of students are prosocial, and that the threat of peer evaluations will inhibit free riding. To the contrary, Hornaday's (2001) observed 27% troubled-by-free-riding rate suggests that free riding is not rare at all, and that the threat of peer evaluations is evidently ineffective.

Reducing the incidence of free riding should improve the functional and social aspects of groups, as suggested by Markulis and Strang (1995). This study does not have the data to confirm or refute that expectation, so we leave it to be addressed in future work.

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