Who free rides?
Experimental Evidence from an Investment Game

Matheus Albergaria de Magalhães[§]
(matheus.albergaria@usp.br)

Abstract

In this paper, I present novel evidence related to collective-action dilemmas. I run several small-scale public goods experiments in distinct settings (two business schools, a private university, a public university, and a public service school) using different types of subjects (undergraduates, MBA students, professors, and public service workers). Based on the results of these experiments, I build a Free-Rider Index (FRI), relating it to subjects' socioeconomic characteristics and group size. I do this in order to identify the main characteristics of those who act opportunistically in situations involving social dilemmas. My main findings are the following: (i) there are no significant differences among subjects in terms of gender, political orientation or school type; (ii) on average, undergraduates free ride less than MBA students and public service workers; (iii) economics students consistently free ride less than other majors; (iv) there is evidence suggesting the existence of an inverted "U-shaped" curve relating group size and free rider behavior; (v) free riding is usually higher in the last round of multi-stage experiments. These results are important for providing additional evidence related to social dilemmas, such as public goods provision and common pool resources' management.

JEL Classification: C72, C91, H41.
Key-words: collective action, experiments, public goods, common pool resources, free riding.

1. Introduction

Pure public goods have two distinct characteristics: they are non-rival (one individual's consumption of the good does not reduce other individuals' consumption) and non-exclusive (no individual can be excluded from consuming it). Examples of such goods are national defense, public education and organizational knowledge, just to cite a few (Samuelson, 1954; Stiglitz, 2000). Table 1 contains a brief description of four distinct types of goods: public goods, common pool resources, private goods and toll goods.

[§] Graduate student at Programa de Pós-Graduação em Administração da Universidade de São Paulo (PPGA-USP).

Table 1.
Public goods, common pool resources, private goods and toll goods. Difficulty of excluding potential beneficiaries (lines) and subtractability of use (columns).

		Subtractability of Use	
		High	Low
Difficulty of Excluding Potential Beneficiaries	High	Common-pool resources: groundwater basins, lakes, irrigation systems, fisheries, forests, etc.	Public goods: peace and security of a community, national defense, knowledge, fire protection, weather forecasts, etc.
	Low	Private goods: food, clothing, automobiles, etc.	Toll goods: theaters, private clubs, daycare centers.

Source: Adapted from Ostrom (2010).

The table contains four main cells, separated by difficulty of exclusion (represented by the table's lines) and subtractability of use (columns) of each type of good. In the figure, pure public goods are located in the upper right cell, since they present lower subtractability but higher difficulty of exclusion when compared to other types of goods (in the limit, they are non-exclusive and non-rival). On the other hand, common pool resources are located in the upper left, since they present high difficulty of exclusion (as public goods), but they are non-rival, which implies a high subtractability of use. Private goods are located in the lower left cell, having lower difficulty of exclusion but a high subtractability of use (one can easily exclude others from the use of his or her own private goods, such as clothes and cars, for example). Finally, toll goods are located in the bottom right cell. As the name suggests, these goods are characterized by a lower subtractability of use (as public goods), but lower difficulty of exclusion (theaters and country clubs are examples of this kind).

One important question related to public goods is the following: how much money are people willing to pay for their provision? Two other questions are: (i) will people take part in collective actions involving public goods if they notice that the provision will take place regardless of individual contributions?; (ii) will individual actions lead to social inefficient results?

The main goal of this paper is to present a novel characterization of free-riding behavior and test hypotheses related to group size and subjects' specific characteristics. In doing so, I present an empirical strategy based on three steps. First, I run several small-scale public goods experiments in distinct settings – two business schools, a private university, a public university, and a public service school – all located in Brazil. Second, based on the experiments' results, I build a Free Rider Index (FRI) (Leuthold, 1993) and relate it to subjects' socioeconomic characteristics, such as gender, age, political orientation, school type, occupation, and group size. Finally, I present econometric evidence where I try to obtain significant correlations between subjects' FRI and two specific variables: economics major and group size, where socioeconomic characteristics are used as controls in regressions. At first, it is expected that subjects' characteristics, as well as group size may affect free riding behavior in social dilemmas, such as public goods provision and common pool resources' management (more details

below). In general terms, I hope to contribute to a growing body of research related to the use of experimental methods as a means to uncover new results in Social Sciences (Kagel, 2009; Levitt & List, 2008; Smith, 1989)[1].

My main results can be summarized as follows: (i) there are no significant differences among subjects in terms of gender, political orientation and school type; (ii) on average, undergraduates free ride less than MBA students and public service workers; (iii) economics students consistently free ride less than other majors; (iv) there is evidence suggesting existence of an inverted "U-shaped" curve relating group size and free rider behavior; (v) free riding is usually higher in the last round of multi-stage experiments. In my view, these results are important not only for the questions they raise, but also for providing additional evidence related to behavior in collective-action situations.

At the moment, there is well-established literature in Business and Economics related to public goods as well as opportunistic behavior in laboratory and field experiments[2]. The present paper brings additional contributions to this literature. First, it presents a profile of individuals who present opportunistic behavior in collective-action dilemmas. While most of the previous literature has focused on detecting behaviors of this kind, few contributions have actually analyzed the characteristics of free riders. It seems important to know if there are a set of characteristics of individuals who typically free ride in certain situations. For instance, authors such as Ostrom (2000, 2010) and Wilson, Ostrom, and Cox (2013), when studying common pool resources, designed a set of principles and characteristics related to success cases in managing these resources. In this context, it seems natural to ask what are the main characteristics related to opportunistic behavior, given its importance to several fields today (Cabrera & Cabrera, 2002; Williamson, 1993, 2002).

Second, this paper can be seen as an empirical test of some of the hypotheses contained in Olson's (1965) classical study of public goods and the theory of groups. Specifically, I am able to test some of the main insights contained in Olson (1965), who established important theoretical regularities related to group behavior in collective-action situations. A preliminary result that I find is that there seems to exist an inverted 'U-shaped' pattern between mean FRI values and group size. At first, this could suggest the existence of an "optimal" group size in collective-action dilemmas (more details below).

Finally, given some of the results reported above, they represent novel evidence related to the behavior of economists in the laboratory. While previous research found that economists behaved in an opportunistic manner in distinct settings (Carter & Irons, 1991; Frank, Gilovich, & Regan, 1993; Marwell & Ames, 1981), I present an opposite result, where economics majors tend to free ride less than other subjects, such as MBA students and public service workers[3].

This paper is divided in six sections. The second section presents the analytics related to linear public goods games and its main theoretical implications, as well as a partial account of previous contributions to the literature of the behavior of economists

[1] Experiments can also serve an important pedagogical device. For more information on this, see Emerson and Taylor (2004), Holt and McDaniel (1998), Leuthold (1993), Murphy (2001), Murphy and Cárdenas (2004) and Nelson and Beil (1994).

[2] Andreoni (1988), Fehr and Gächter (2000), Fosgaard et al. (2013), Leuthold (1993) and Marwell and Ames (1981) correspond to examples of experiments related to public goods provision in distinct settings.

[3] For detailed accounts of the behavior of economists, based on extensive interviews with graduate students, see Colander and Klamer (1987) and Colander (2007).

in experiments. The third section contains details related to data construction and the experimental design employed in the analysis, while the fourth section describes the main results obtained. The fifth section concludes and presents a brief discussion on future research topics.

2. Public Goods provision in experiments: analytics and experimental evidence

Public goods games have been extensively used in experiments over the last decades (e.g., Andreoni, 1988; Marwell and Ames, 1981). In such games, individuals are given a budget (*m*), which can be invested either in a private (*x*) or public good (*g*), with x + g = m.

Individual payoffs (P_i) are determined by the following formula:

$$P_i = x_i + \alpha \sum^{n}_{j=1} g_j \qquad (1),$$

where *n* is the number of group members. The parameter α is chosen such that $0 < \alpha < 1$.

Given the payoffs of the linear public goods game described, investing US$ 1.00 in the public good has a private return of US$ 1.00, while it has a social return of US$ 2.50 (in the case of a group composed by five members, for instance). Therefore, it is Pareto efficient for subjects to invest all of their money in the public good. However, since the private return from the private good exceeds the private return from the public good, the Nash equilibrium of this game is to invest zero in the public good (to free ride). In fact, it can be shown that investing zero in the public good is a dominant strategy for each player in this game[4].

The last conclusion corresponds to the formalization of an argument originally advanced by Olson (1965). According to this author:

> … unless the number of individuals in a group is quite small, or unless there is coercion or some other special device to make individuals act in their common interest, rational, self-interested individuals will not act to achieve their common or group interests. In other words, even if all of the individuals in a large group are rational and self-interested, and would gain if, as a group, they acted to achieve their common interest or objective, they will still not voluntarily act to achieve that common or group interest. The notion that groups of individuals will act to achieve their common or group interests, far from being a logical implication of the assumption that the individuals in a group will rationally further their individual interests, is in fact inconsistent with that assumption. (p. 2).

This argument later became known as the "zero contribution thesis" (Ostrom, 2000). In fact, its logic was extended to other settings – such as those involving common pool resources (Hardin, 1968) – which generated a large literature aimed at qualifying some of its main related results[5]. For instance, when describing the evidence

[4] For more information on linear public goods games and related experimental evidence, see Andreoni and Croson (2008).

[5] Today there is a consolidated literature related to field experiments and common pool resources. In the case of a few related examples, see Cárdenas and Ostrom (2004), Cárdenas (2003), Fehr and Leibbrandt (2011), Ostrom (1999, 2000, 2007, 2010), Vollan and Ostrom (2010) and Wilson et al. (2013).

related to collective-action experiments in the 1990s, Ostrom (2000) listed the following results:

1. Subjects contribute between 40 and 60 percent of their endowments in one-shot games (or in the first round of finitely repeated games).
2. After the first round, contributions tend to decay downward, although remaining well above zero.
3. Subjects who believe that others will cooperate in social dilemmas are more likely to cooperate themselves.
4. Learning the game tends to lead to more cooperation, not to less.
5. Face-to-face communication produces substantial increases in cooperation which are sustained across all periods (including the last one).
6. When allowed by the game structure, subjects expend personal resources to punish those who make below-average contributions to a collective benefit.
7. The rate of contributions is affected by several contextual factors.

These results are important for constituting a set of core facts related to social dilemmas' experiments. Given the type of information I have collected from the experiments, I am able to test the empirical adequacy of some of them.

Over the last decades, several studies attempted to analyze the provision of public goods using the experimental approach. Marwell and Ames (1981) correspond to one of the first attempts to test economists' behavior in collective-action experiments. The authors report the results of twelve experiments related to testing two versions ('weak' and 'strong') of the free rider hypothesis. Table 2 contains a summary of their findings:

Table 2.
Summary results for public goods experiments

Public Goods Experiment	Mean % of Resources Invested
1. Basic Experiment	42
2. Skewed Resources and/or Interest	53
3. Provision Point	51
4. Small Groups w/ Provision Point	60
5. Experienced Subjects	47
6. High Stakes (Experienced Interviewers)	35
7. High Stakes (All Interviews)	28
8. Feedback (No Changing Initial Investment)	46
9. Feedback (Initial Investment Change)	50
10. Feedback (Initial Investment Change – College Students)	49
11. Manipulated Feedback (Low)	43
12. Manipulated Feedback (Medium)	50
13. Manipulated Feedback (High)	44
14. Non-Divisibility (Control)	43
15. Non-Divisibility (Treatment)	84
16. Economics Graduate Students	20
Mean	46.56
Median	46.50

Adapted from Marwell and Ames (1981).

The table's second column reports the percentage of resources invested by subjects in different versions of public goods games. According to these results,

resources invested are in the 40%-50% range (mean and median contributions of 46.56% and 46.50%, respectively), refuting the 'strong version' of the free rider hypothesis (where subjects should not contribute at all to the provision of public goods). The results in the last rows of the table are somewhat surprising: they correspond either to very large (84%) or very low (20%) contributions. While the first number refers to a special version of the public goods game, where the good is non-divisible, the second refers to an experiment involving graduate students in economics.

The authors also reported a somewhat surprising result at the time: economists tended to provide considerably smaller amounts for the provision of public goods (around 20%). Specifically, in the latter case, contributions to the provision of public goods were half the magnitude of the contributions from other experiments. Marwell and Ames (1981) concluded that economists would free ride significantly more than other subjects did. According to the authors, there were two possible explanations for this result: first, students worried about economic incentives might self-select in economics; second, as time went by, economics students would adapt their behavior to the theories they study.

When summarizing the available evidence in the 1980s, Andreoni (1988) reported three consistent results: (i) there was no significant evidence of free riding behavior in single-shot games; (ii) in experiments involving repeated games, subjects' provisions for public goods tended to decay with each repetition; (iii) free riding was often approximated after several trials, although exact free riding was seldom realized. Because of these possibilities, Andreoni (1988) also tested two hypotheses related to public goods provision: 'learning' (where repeated play allowed subjects to learn the rules of the games they were playing) and 'strategies' (where repetition allowed subjects to signal future moves to each other). After finding mixed support for free riding behavior, the author concluded his study by pointing the need for theories of non-standard behavior[6].

Carter and Irons (1991) explored the robustness of Marwell and Ames' (1981) original study by implementing a simple ultimatum bargaining game experiment to test whether economics students behaved in accordance with the predictions of rational choice models. They found that economics students, when playing the role of 'responders' in ultimatum games, tended to accept less money offers, while keeping more when playing the role of 'proposers'. The authors also presented some econometric evidence trying to disentangle 'selection' and 'learning' effects among the experiment's subjects. In this case, results were mixed: while self-selection seems to play a role in the choices reported, the same is not true for learning economic topics. Overall, they concluded that, although evidence was not conclusive, "(…) *economists are different*" (p. 177).

Frank, Gilovich and Regan (1993) investigated if exposure to self-interest models commonly used in economics could affect students. In doing so, the authors presented extensive evidence related to situations where economics students might display opportunistic behavior when compared to students from other areas. For instance, in one occasion, they mailed questionnaires to over a 1,000 professors of 23 disciplines asking for charity contributions. Based on the responses received, the authors uncovered a result where the proportion of free riders (those who reported giving no money to any charity) was significantly higher among economics professors (9.3%) when compared to other disciplines, whose percentage was between 3% and 4%.

[6] In the case of themes related to cooperation in laboratory experiments, see Andreoni et al. (2007) and Dawes and Thaler (1988).

In other occasion, they conducted 267 experiments related to prisoners' dilemma games involving both economics majors and nonmajors. When comparing defection rates between the two groups, they reported a 60.4% defection rate for economics majors, which was considerably higher than the value reported for nonmajors (38.8%). Interestingly, they also noticed that the overall defection rate declined significantly, as students progressed through college (that is, upper-level students would free ride less than freshmen). Additionally, they presented the results of an honesty survey related to freshman students in microeconomics and astronomy classes. The results from this survey showed that the proportion of 'less honest' responses rose after students spent one semester having classes of introductory economics courses. The authors concluded that: (i) there were large differences in the extent to which economists and non-economists behave self-interestedly; (ii) however, there could be occasions where economists behaved in traditionally communitarian ways; and (iii) there was some evidence suggesting that differences in cooperativeness were caused in part by economics' training.

Yezer, Goldfarb and Poppen (1996) questioned the validity of Frank, Gilovich and Regan's (1993) study. According to the former authors, it was not obvious that exposure to economics would be expected to encourage less cooperative behavior. In particular, they emphasized the importance of drawing inferences based on subjects' behavior in actual (as opposed to hypothetical) situations. They presented an interesting experiment, where envelopes containing currency were dropped in classrooms before classes in economics or other subjects were scheduled to meet (the 'lost-letter experiment'). In this case, the return rate on lost letters was used as a measure of cooperation. The results of this experiment showed considerable differences in cooperation rates between economics and noneconomics majors. Contrarily to the evidence presented by Frank, Gilovich and Regan (1993) and other authors, Yezer, Goldfarb and Poppen's (1996) results indicated that economics students were far more cooperative than students from other disciplines.

A promising example of the use of experimental methods in the Brazilian context was Bianchi (1998). Inspired by Carter and Irons (1991), the author presented results of an experiment related to an ultimatum game, where each subject was asked to divide R$ 10 (US$ 9.70, in 1998) between him(her)self and another anonymous subject. The author reported a similar result to Carter and Irons (1993): subjects who were economics majors tended to accept less money offers when playing the role of 'responders' in ultimatum games, while keeping more money when playing the role of 'proposers'. She emphasized that, in the Brazilian context, fairness considerations might play a significant role in determining negotiations' outcomes. In terms of econometric evidence, contrarily to Carter and Irons' (1991) original conclusions, self-selection did not seem to play a relevant role in the reported results. In addition, the regression results did not support the hypothesis of a learning effect, either[7].

3. Experimental Design

The empirical strategy followed through this paper is based on three steps. First, I run several small-scale public goods experiments in distinct settings. Specifically, experiments were performed in two business schools, a private university, a public

[7] One common point between this paper and Bianchi's (1998) is that both deal with Brazilian students in social dilemma experiments. In general terms, I see our approaches as complementary. See also Antiqueira et al. (2007) and Mesquita et al. (2011) for additional examples of experiments applied to the Brazilian context.

university, and a public service school, all located in two Brazilian cities, Vitória and São Paulo[8]. All experiments took place in different dates of the 2013-2014 academic year. Table 3 contains related information on the experiments' sites:

Table 3.
Experiments' sites information.

Site	Experiments' Dates	Location
Business School 1	February, 2013 – July, 2014	Vitória, Brazil
Business School 2	April, 2013 – July, 2013	São Paulo, Brazil
Private University[a]	April, 2013	São Paulo, Brazil
Public University[a]	November, 2013	Vitória, Brazil
Public Service School	May, 2013 – October, 2013	Vitória, Brazil

Source: author's calculations. [a] Locations where the author ran experiments during one occasion, only. In all other cases, more than one experiment was ran in different dates.

Second, based on the experiments' forms, I am able to collect subjects' socioeconomic characteristics, such as gender, age, undergraduate major, whether they went to a public or private school before entering college, and political orientation. Table 4 presents a brief summary containing descriptive statistics for the total sample used in the experiments.

Table 4
Subjects' socioeconomic characteristics (total sample).

Statistic	Gender[a]	Age[b]	Major[c]	Public School[d]	Political Orientation[e]
Mean	0.51	30.67	0.43	1.16	0.91
Median	1.00	28.00	0.00	2.00	1.00
Maximum	1.00	67.00	1.00	2.00	2.00
Minimum	0.00	18.00	0.00	0.00	0.00
Std. deviation	0.50	11.36	0.50	0.96	0.68
# observations (N)	313	298	218	311	296

Source: author's calculations. [a] 'Gender' corresponds to a dummy variable that assumes the value of 1 for male subjects and 0 for female subjects. [b] 'Age' corresponds to each subject's age at the date of the experiment. [c] 'Major' corresponds to a dummy variable that assumes the value of 1 for subjects majoring in Economics and 0 otherwise. [d] 'Public School' corresponds to a dummy variable that assumes the value of 0 for subjects who went to private school before college, 2 for subjects who went to public school before college, and 1 for those who went to both types of school. [e] 'Political Orientation' corresponds to a dummy variable that assumes the value of 0 for subjects who declared themselves as left wing, 1 for those who declared center, and 2 for those who declared right wing.

As mentioned above, my sample is composed by undergraduate students from a business school. The results in the table show that 51% of the subjects are male students, with the mean age being around 31 years old. At the time of the experiment, 43% of the subjects were majoring in economics, while most went to a public school before entering college. In terms of political orientation, most subjects identified themselves as oriented towards the center of the political spectrum. While there is

[8] The choice of these two cities was based on the locations where the author would teach classes during the 2013-2014 period. There was no identification of subjects and no payment of monetary sums during the experiments. Basically, at the beginning of each class in a different setting, the experimenter would handle subjects with a printed version of the experiment's instructions and give them time to respond (between 5 and 10 minutes). For more details, see the Appendix.

considerable variation in the data (given by the standard deviation values reported), I see these results as a useful description of subjects' socioeconomic characteristics.

One advantage of the current approach is that, contrarily to most of the contributions related to laboratory experiments, the subjects used in this paper's experiments are not limited to university students, only. In fact, a fraction of the total sample is composed by professors from a private university in São Paulo and public service workers from distinct organizations in Vitória.

Third, based on the experiments' results and their subjects' socioeconomic characteristics, I am able to correlate variables, such as FRI, undergraduate major, and group size in econometric regressions where socioeconomic characteristics are used as controls. At first, it is expected that subjects' characteristics, as well as group size might affect free riding behavior in social dilemmas, such as public goods provision and common pool resources' management (more details below).

In terms of experimental design, I initially ran a one-round experiment where subjects filled a form deciding how to (hypothetically) divide R$ 100 (R$ 1.00 = US$ .44, in August, 2014) between a private and a public good (for simplicity, the private and public goods were named *A* and *B*, respectively). For each R$ 1.00 invested in the private good, subjects would receive R$ 1.00 individually. On the other hand, for each R$ 1.00 invested in the public good, the group's members would receive R$ 0.50. in a second occasion, dealing with a smaller sample of undergraduates, I also ran five-rounds experiments with the same structure as the one described above. This is a typical social dilemma game: although it is Pareto efficient for subjects to invest all of their money in the public good, they have a private incentive to invest in the private good (that is, the Nash equilibrium of this game is to invest zero in the public good; i.e., to free ride)[9].

In order to measure opportunistic behavior, I constructed a simple index, named 'Free Rider Index' (FRI) (Leuthold, 1993). This index is based on the following formula:

$$\text{FRI} = (\text{Amount Invested in A}) / \text{R\$ } 100 \qquad (2)$$

The FRI corresponds to a ratio between the amount invested in the private good (A) and the total amount available for each subject. I employ this index as a means to capture free riding behavior in the experiments involving public goods provision.

5. Results

Figures 1 to 5 contain graphs relating subjects' socioeconomic characteristics (horizontal axis) and FRI values (vertical axis). By doing this, I want to test for the existence of significant differences among subjects, based on their characteristics. Results are displayed below:

[9] When designing this experiment, I followed mainly the guidelines contained in Andreoni (1988). The investment form employed during in the experiment is in the Appendix. All the data used in this paper is available from the author upon request.

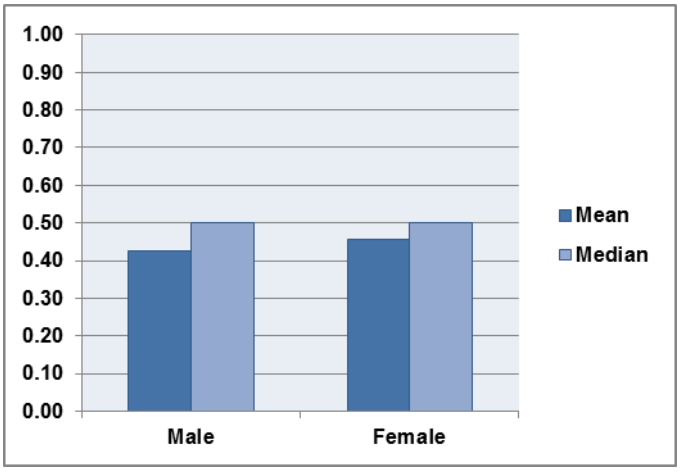

Figure 1. FRI mean and median values, by gender.

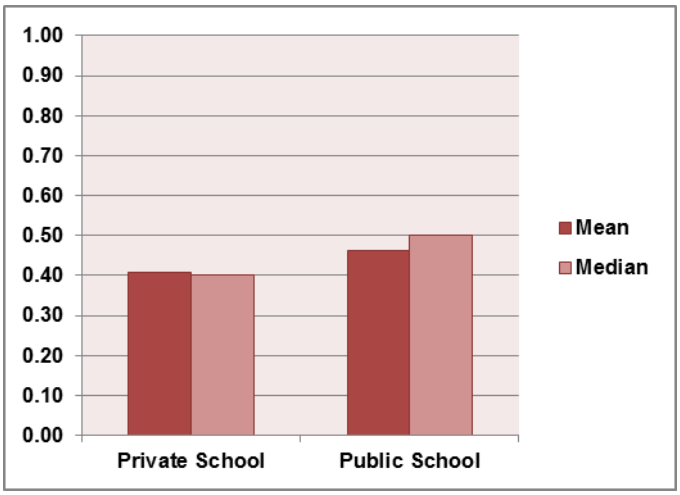

Figure 2. FRI mean and median values, by school type.

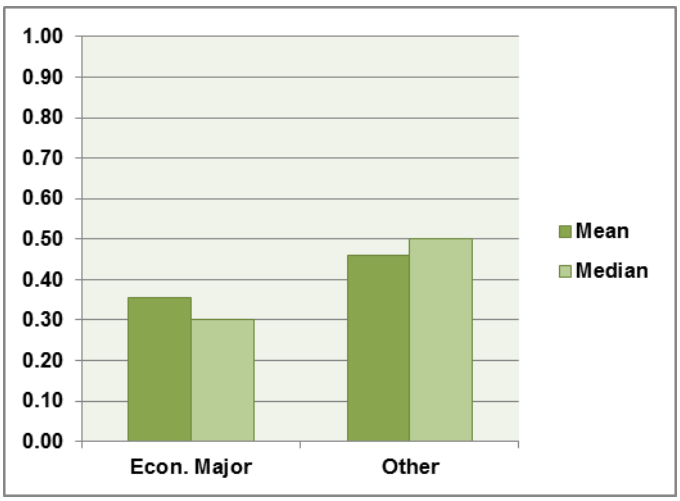

Figure 3. FRI mean and median values, by undergraduate major.

Figure 4. FRI mean and median values, by political orientation.

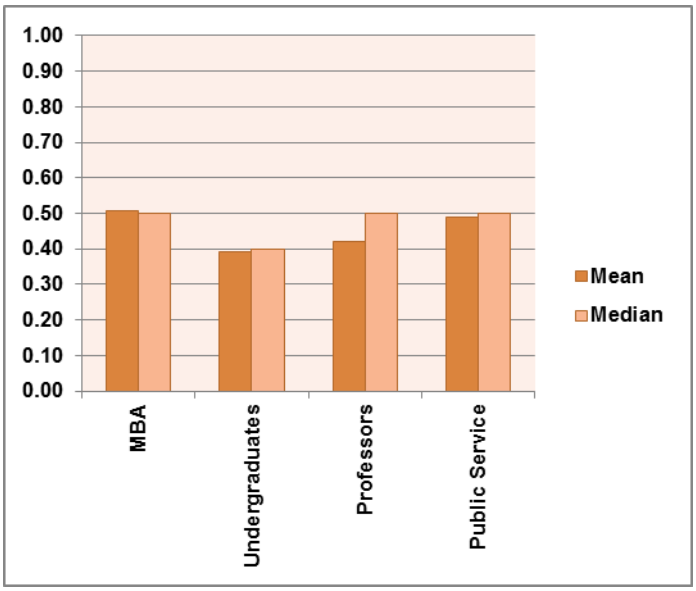

Figure 5. FRI mean and median values, by occupation.

When analyzing these results, one can notice that, in the case of the one-shot experiments described here, contributions are between 40 and 60%, since the reported values for the FRI are around 50% in all graphs. Table 6 contains the results of several tests for the equality of means among distinct pairs of variables:

Table 5
Difference of Means Tests (subjects' selected characteristics)

Mean Difference	Two-tailed t-test (p-value)[a]
Male (N = 161) x Female (N = 152)	.40
Private School (N = 122) x Public School (N = 171)	.15
Economics Major (N = 93) x Other Courses (N = 125)	.02**
Left Wing (N = 56) x Center (N = 156)	.17
Left Wing (N = 56) x Right Wing (N = 84)	.25
Center (N = 156) x Right Wing (N = 84)	.52
MBA (N = 63) x Undergraduates (N = 123)	.02**
MBA (N = 63) x Professors (N = 44)	.16
MBA (N = 63) x Public Service Workers (N = 71)	.73
Undergraduates (N = 123) x Professors (N = 44)	.60
Undergraduates (N = 123) x Public Service Workers (N = 71)	.02**
Professors (N = 44) x Public Service Workers (N = 71)	.20

Source: author's calculations. [a] p-values associated with each test's null hypothesis (equality of means). Some tests considered equivalent variances while others did not. F-tests were performed to test the null of variances' equality (not reported).

The results displayed in the table suggest that most of the differences – in terms of socioeconomic characteristics – contained in the graphs are not statistically significant. However, a few important results can be highlighted in this case. First, there is a significant difference (t-test's p-value of .02) between economics majors and other majors in terms of free-riding. This suggests that economists actually tend to present opportunistic behavior less than students from other specializations, a result that contradicts most of the literature related to the theme (Carter & Irons, 1991; Frank et al., 1993)[10]. Additionally, there are significant differences between reported FRI values between MBA students and undergraduates (the former tend to free ride more often than the latter, with reported mean values of .51 and .39, respectively) and between undergraduates and public service workers (mean values of .39 and .49, respectively). Although these initial results deserve a more detailed empirical analyzes, they call attention for different responses among distinct groups in terms of observed behavior in social dilemmas.

Table 6 contains results related to contributions in the public goods games considered. In this case, contributions are expressed as the mean percentage of resources invested in public goods in each experiment.

[10] On the other hand, this result is in accordance with Yezer, Goldfarb, and Poppen (1996). One possibility (not explored in this paper) is that, when compared to other business students, economists tend to display less opportunistic behavior. See Frey and Meier (2005), who explore this possibility. Most of the literature focuses its attention on the Humanities (Carter & Irons, 1991; Frank et al., 1993). I thank Ana Maria Bianchi for pointing this out.

Table 6
Contributions to Public Goods (selected samples)

Location	Mean % of Resources Invested in Public Goods
Business School 1	53.73
Business School 2	58.08
Private University	65.00
Public University	65.33
Public Service School	50.92
Mean	50.92

Source: author's calculations.

Based on the table's results, I conclude that contributions were significantly above 0, as originally enunciated by Marwell and Ames (1981) and Ostrom (2000). In particular, subjects from private and public universities were among the ones that provided larger sums for public goods (around 65%, in both cases).

Figure 6 displays a scatterplot relating group size (horizontal axis) and average FRI (vertical axis) for all the experiments that I ran. My intention here is to uncover some type of statistical association between these variables, along the lines originally proposed by Olson (1965):

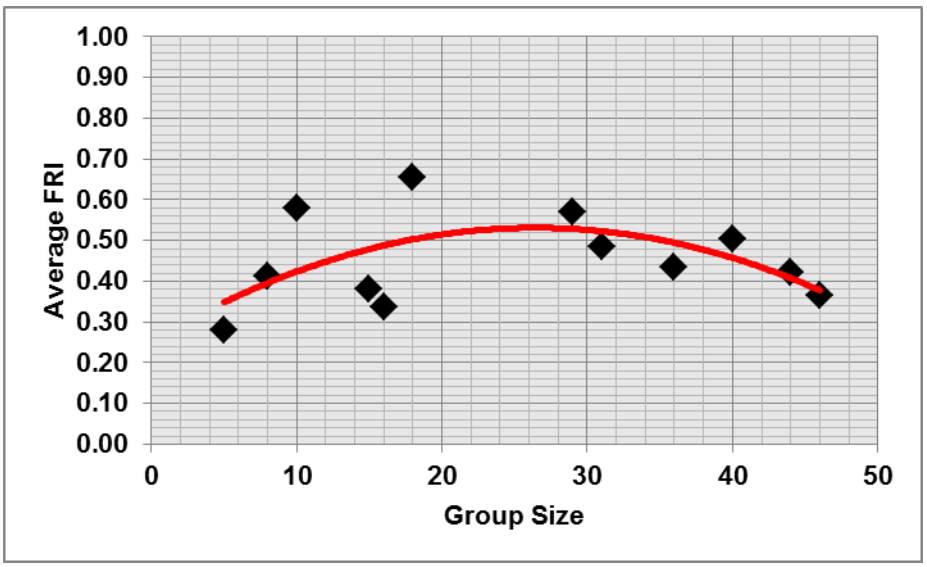

Figure 6. Group size and average FRI.

Analyzing the figure and its regression output (not reported), I cannot uncover any type of linear association between group size and free rider behavior. At first, as originally stated by Olson (1965), it would be expected that this kind of behavior would be present in groups of larger sizes, denoting a positive relation between the two variables displayed in the graph. However, the data collected does not support this claim. In fact, it suggests the existence of a non-linear relation between group size and free-rider behavior[11]. If this is the case, then one could argue that there is the possibility

[11] When considering alternative specifications relating FRI, group size and (group size)^2 (as well as additional controls), I find statistically significant coefficients, a result that suggests the existence of a

of having an "optimal" group size for free-riding: in small groups, this kind of behavior would not be a dominant strategy, but it could be for larger groups, becoming non-dominant again in the case of even larger groups[12].

Interested in testing the same predictions as Carter and Irons (1991) and Bianchi (1998), Table 7 presents econometric results related to the experimental data collected in the experiment. This table contains the results of specifications of the following form:

$$FRI_i = \alpha + \beta_1 * \text{'Major'} + \beta_2 * \text{Controls} + \varepsilon_i \qquad (3),$$

where 'FRI_i' stands for the FRI calculated for each subject in the sample, while 'Major' corresponds to a dummy variable that assumes the value of 1 for subjects who were economic majors and 0 otherwise. I regress FRI on this dummy and use subjects' social characteristics as controls, while attempting to capture some correlations among these variables. All regressions were run through Ordinary Least Squares (OLS).

Table 7
Free Rider Index (FRI) and Selected Socioeconomic Characteristics: econometric results

	Dependent Variable: FRI			
	(1)	(2)	(3)	(4)
Major[a]	-.11**[e]	-.11**	-.10*	-.10**
	(.04)[f]	(.04)	(.05)	(.05)
Gender[b]		-.02	-.01	-.01
		(.04)	(.04)	(.04)
Age[c]			.00	.00
			(.00)	(.00)
Public School[d]				.02
				(.02)
Constant	.46***	.47***	.45***	.44***
	(.03)	(.03)	(.08)	(.08)
R^2	.03	.03	.03	.03
Adj. R^2	.02	.02	.02	.01
N	218	217	212	210

Source: author's calculations. [a] 'Major' corresponds to a dummy variable that assumes the value of 1 for subjects majoring in Economics and 0 otherwise. [b] 'Gender' corresponds to a dummy variable that assumes the value of 1 for male subjects and 0 for female subjects. [c] 'Age' corresponds to each subject's age at the date of the experiment. [d] 'Public School' corresponds to a dummy variable that assumes the value of 0 for subjects who went to private school before college, 2 for subjects who went to public school before college, and 1 for those who went to both types of school. [e] The terms *, ** and *** denote statistical significance at the 10%, 5%, and 1% significance levels, respectively. [f] Standard errors are reported in parenthesis.

Several interesting patterns emerge from the econometric results above. First, contrarily to most available evidence (e.g., Marwell and Ames 1981), subjects majoring in economics seemed to free ride less often than others in this context. This is a particularly surprising result, since previous studies usually found the opposite pattern,

quadratic trend relating FRI and group size. Results of these estimations were not reported due to space constraints.

[12] At the moment, I see this as an exploratory hypothesis, given the limited sample size used in this paper. I leave it as a suggestion for future research.

where economics majors would free ride more often than not[13]. Although most specifications present low explanatory power (given by R^2 and its adjusted version), this result is robust to all specifications considered above (coefficients around -.1, and statistically significant). Second, subjects' gender did not seem to exert a significant effect on free riding. If anything, the sign of the estimated coefficients suggests that male subjects tended to free ride less often than female subjects, albeit its lack of statistical significance.

Finally, when considering the effects of subjects' age in free riding behavior, I could not find any significant evidence (the same is true when age^2 is included in the specifications). That is, age did not seem to be a relevant factor for this type of behavior in the experiment. A similar pattern happens for the variable 'public school', which indicates that subjects' type of school does not exert significant effects over free riding.

One limitation related to the experiments presented until this moment is its static nature. Since these are all one-shot linear public goods games, they say nothing about the evolution of cooperation over time, an important point stressed in the literature (Andreoni, Harbaugh, & Vesterlund, 2007; Dawes & Thaler, 1988; Ostrom, 2000, 2010; Vollan & Ostrom, 2010). Because of this limitation, I present the main results related to a multi-round experiment involving public goods. Specifically, I ran the former experiment with a smaller sample, but considering five rounds (instead of one). This procedure allows me to track the evolution of free riding behavior over time. Figure 7 displays results related to the FRI during all rounds of the experiment[14]:

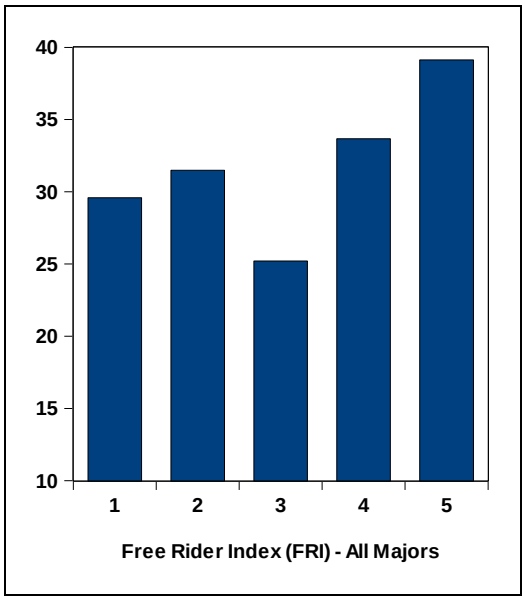

Figure 7. FRI in a 5-round experiment.

The figure displays two main patterns: (i) the FRI increased between the first and final round of the game (average values range from 30% to 40%); (ii) although the FRI presented a lower value in the third round, it raised again in the fourth round, reaching its peak by the end of the game. This last pattern is in accordance with most

[13] See, for instance, Marwell and Ames (1981) and Carter and Irons (1991). On the other hand, Frey and Meier (2005) and Yezer et al. (1996) provide results supporting the claim that subjects who major in economics actually tend to cooperate more often in collective-action experiments.

[14] This section is partially based on previous coauthored research related to the effects of random rematching on public goods experiments (Magalhães & Oliveira, 2014).

predictions from game-theoretic models with a finite number of repetitions[15].

Figure 8 plots the FRI index and its components, segmented by major. In this case, I divided my sample in two categories: 'Majors', representing subjects who major in economics, and 'Others', representing subjects majoring in other fields (such as accounting and business administration).

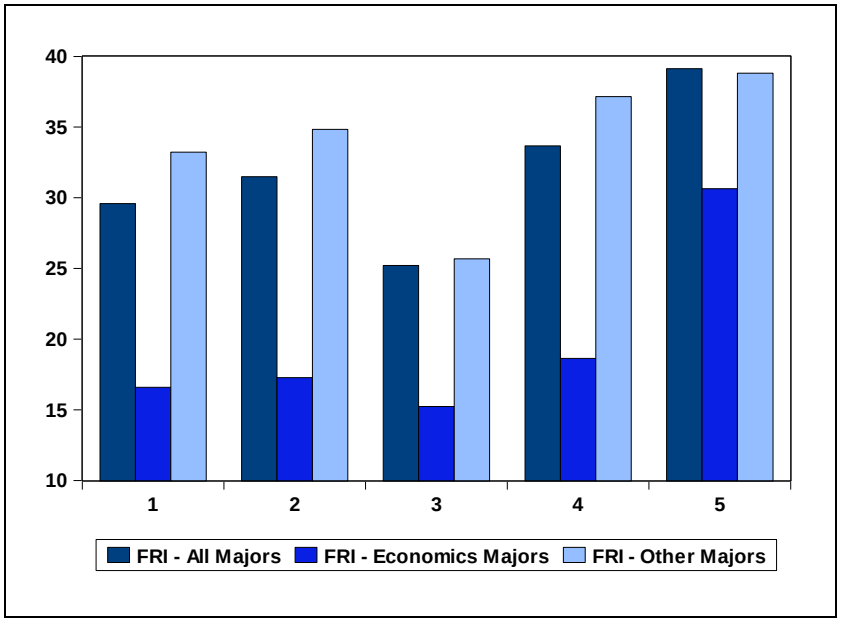

Figure 8. FRI in a 5-round experiment, distinct majors.

A clear pattern in the figure is that the results for economics majors are significantly lower than for other majors, contrarily to what was previously expected. This is confirmed when I consider the FRI values for each round of the experiment, as reported in Table 8:

Table 8
Free Rider Index (FRI) for distinct rounds (5-round experiment)

	Round 1	Round 2	Round 3	Round 4	Round 5
Economics Major	16.59	17.27	15.23	18.64	30.64
Other Majors	33.23	34.84	25.68	37.16	38.81
Difference	-16.64	-17.57	-10.45	-18.52	-8.18

Source: author's calculations.

These results confirm that subjects who are economics majors tend to free ride significantly less often than those who are not. The reported differences between the two groups are in the 17-18% range. Interestingly, such differences drop to half these values (-8.18%) once the experiment reaches its final round.

Figure 9 contains the evolution of cooperation among group members during the rounds of the experiment. In this case, subjects were divided in two groups: 'Partners' (groups with fixed composition during all rounds of the experiment) and 'Strangers' (groups with random composition in each round). Individual contributions (*Ci*) were calculated through the formula Ci = R$ 100 – FRI.

[15] See Gibbons (1992) for related details.

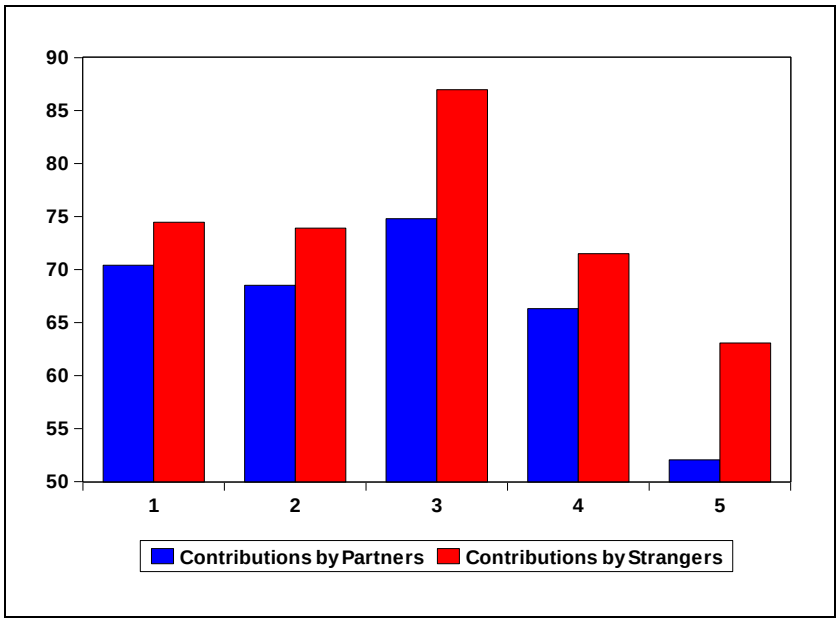

Figure 9. Contributions to public goods provision ('Partners' and 'Strangers').

These graphical results confirm two interesting patterns: first, contributions by 'Strangers' were larger than contributions for 'Partners' during all rounds of the game, reaching a peak in the third round; second, both groups' contributions were significantly lower in the last round of the experiment, as predicted by game-theoretic models with finite duration.

In general terms, these results are interesting for the possibilities suggested, rather than representing definitive evidence related to opportunistic behavior. In this sense, it is important to notice that the limited sample size, as well as the simple structure of the experiments presented, is probably related to the specifications' low explanatory power. Overall, I see these results as suggestive, rather than representing definitive evidence related to opportunistic behavior.

4. Conclusions and Limitations

In this paper, I presented an attempt to describe the main characteristics of subjects who present opportunistic behavior in collective-action dilemmas. In doing so, I ran several one-shot public goods' experiments in distinct settings and tried to relate the results with subjects' socioeconomic characteristics and group size.

The main results obtained were the following: (i) there are no significant differences among subjects in terms of gender, political orientation and school type; (ii) on average, undergraduates free ride less than MBA students and public service workers; (iii) economics students consistently free ride less than other majors; (iv) there is evidence suggesting existence of an inverted "U-shaped" curve relating group size and free rider behavior; (v) free riding is usually higher in the last round of multi-stage experiments. In my view, these results are important not only for the questions they raise, but also for providing additional evidence related to behavior in collective-action situations.

One specific result was somewhat surprising: when deciding on how much to contribute for public goods provision, economics majors provided, on average, higher amounts than non-majors did. As presented above, these results are in stark contrast with other contributions previously reported in the literature (Bianchi, 1998; Carter & Irons, 1991; Frank et al., 1993). In this case, there is the possibility that, contrarily to

what most authors previously emphasized, economics majors tend to play experimental games in a strategic way. Because of that, subjects might contribute not because they are more altruistic than others, but because they are willing to receive higher payoffs in future rounds of the game. While this is an exploratory hypothesis, it would be interesting to test for the occurrence of strategic behaviors in public goods games, as originally proposed by Andreoni (1988), for instance.

In terms of limitations, one is related to the experiments' external validity, since most of its subjects are university students. At first, such a choice might invalidate the reported results in the case of extrapolation to other contexts, such as business firms, for instance (Kagel, 2009; Tabachnick & Fidell, 2007). However, one advantage of this paper, when compared to other contributions, was the use of other types of subjects, such as university professors and public service workers (Fréchette, 2009). Although these samples might display related biases, they represent a clear advance when compared to other contributions in the literature of experiments applied to the Brazilian context (Antiqueira, Lazzarini, & Saes, 2007; Bianchi, 1998; Mesquita, Saes, & Lazzarini, 2011).

Another limitation is related to the possibility that subjects present different behaviors in market and non-market contexts (Fosgaard, Fosgaard, & Foss, 2013). In this case, subjects might be more willing to contribute and perform in the latter context than in the former. Experiments related to organizational issues – such as agency and holdup problems – might represent a new form of addressing this limitation[16]. While I do not provide evidence related to this point, I see it as an important avenue for future research.

A final limitation is related to the inclusion of socioeconomic characteristics in the estimated regressions, only. Specifically, other factors, such as identity, trust and social ties could be included in specifications relating free riding behavior to group size and choice of major[17]. For instance, it would be interesting to test if the observed behavior of economists is related to identity issues, as originally proposed by Akerlof and Kranton (2000, 2005). In particular, the possibility of running experiments relating subjects' sense of identity derived from economics training might provide new insights in the study of economists' decisions, both in the laboratory and the field[18].

[16] In particular, it would be interesting to test some of the main insights contained in Williamson (1991, 2005, 2010) through the use of experiments. See Antiqueira et al. (2007), who report results from an experimental study related to holdup issues.

[17] On the increasing importance of each of these factors in socioeconomic analyses, see Akerlof and Kranton (2000, 2005), Alesina and Giuliano (2013), Glaeser, Laibson, Scheinkman, and Soutter (2000), Goeree, Mcconnell, and Mitchell (2010), Granovetter (1973, 1985, 2005), and Jackson (2014).

[18] For a few examples of experimental studies related to identity issues, see Benjamin, Choi, and Fisher (2010) – who relate religious identity to contributions in public goods games and other experiments – and Kranton, Pease, Sanders, and Huettel (2012), who study a social dilemma situation based on subjects' political identity (Democrats or Republicans).

5. References

Akerlof, G. A., & Kranton, R. E. (2000). Economics and identity. *Quarterly Journal of Economics*, *115*(August), 715–753. http://doi.org/10.1162/003355300554881

Akerlof, G. A., & Kranton, R. E. (2005). Identity and the economics of organizations. *Journal of Economic Perspectives*, *19*(1), 9–32. http://doi.org/10.1257/0895330053147930

Alesina, A., & Giuliano, P. (2013). *Culture and institutions* (No. 19750). Cambridge. Retrieved from http://www.nber.org/papers/w19750.pdf

Andreoni, J. (1988). Why free ride? Strategies and learning in public goods experiments. *Journal of Public Economics*, *37*(3), 291–304. http://doi.org/10.1016/0047-2727(88)90043-6

Andreoni, J., & Croson, R. (2008). Partners versus Strangers: random rematching in public goods experiments. *Handbook of Experimental Economics Results*, *1*(C), 776–783. http://doi.org/10.1016/S1574-0722(07)00082-0

Andreoni, J., Harbaugh, W. T., & Vesterlund, L. (2007). Altruism in experiments. *The New Palgrave Dictionary of Economics*, *2*(1), 1–16.

Antiqueira, J. R. M., Lazzarini, S. G., & Saes, M. S. M. (2007). Comportamento oportunista em negociações envolvendo investimentos específicos: um estudo com metodologia experimental. *Revista de Administração (RAUSP)*, *42*(4), 393–404.

Benjamin, D. J., Choi, J. J., & Fisher, G. W. (2010). Religious identity and economic behavior. *National Bureau of Economic Research*, *w15925*. Retrieved from http://www.nber.org/papers/w15925

Bianchi, A. M. (1998). Are Brazilian economists different? *Revista Brasileira de Economia*, *52*(July 1996), 427–439.

Cabrera, a., & Cabrera, E. F. (2002). Knowledge-sharing dilemmas. *Organization Studies*, *23*(5), 687–710. http://doi.org/10.1177/0170840602235001

Cárdenas, J. C. (2003). Real wealth and experimental cooperation: experiments in the field lab. *Journal of Development Economics*, *70*(2), 263–289. http://doi.org/10.1016/S0304-3878(02)00098-6

Cárdenas, J. C., & Ostrom, E. (2004). What do people bring into the game? Experiments in the field about cooperation in the commons. *Agricultural Systems*, *82*(3), 307–326. http://doi.org/10.1016/j.agsy.2004.07.008

Carter, J. R., & Irons, M. D. (1991). Are economists different, and if so, why? *Journal of Economic Perspectives*, *5*(2), 171–177. http://doi.org/10.1257/jep.5.2.171

Colander, D. (2007). *The making of an economist, redux*. Princeton: Princeton University.

Colander, D., & Klamer, A. (1987). The making of an economist. *Journal of Economic Perspectives*, *1*(2), 95–111.

Dawes, R. M., & Thaler, R. H. (1988). Anomalies: cooperation. *Journal of Economic Perspectives*, *2*(3), 187–197.

Emerson, T. L. N., & Taylor, B. A. (2004). Comparing student achievement across experimental and lecture-oriented sections of a Principles of Microeconomics course. *Southern Economic Journal*, *70*(3), 672–693.

Fehr, E., & Gächter, S. (2000). Cooperation and punishment in public goods experiments. *The American Economic Review*, *90*(4), 980–994. http://doi.org/10.1126/science.151.3712.867-a

Fehr, E., & Leibbrandt, A. (2011). A field study on cooperativeness and impatience in the Tragedy of the Commons. *Journal of Public Economics*, *95*(9), 1144–1155. http://doi.org/http://dx.doi.org/10.1016/j.jpubeco.2011.05.013

Fosgaard, M. R., Fosgaard, T. R., & Foss, N. J. (2013). *Consumer or citizen? Prosocial behaviors in markets and non-markets*. Copenhagen.

Frank, R. H., Gilovich, T., & Regan, D. T. (1993). Does studying economics inhibit cooperation? *Journal of Economic Perspectives*, *7*(2), 159–171. http://doi.org/10.1257/jep.7.2.159

Fréchette, G. R. (2009). *Laboratory experiments: professionals versus students*. New York. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1939219

Frey, B. S., & Meier, S. (2005). Selfish and indoctrinated economists? *European Journal of Law and Economics*, *19*(2), 165–171. http://doi.org/10.1007/s10657-005-5425-8

Gibbons, R. (1992). *Game theory for applied economists*. Princeton: Princeton University.

Glaeser, E. L., Laibson, D. I., Scheinkman, J. A., & Soutter, C. L. (2000). Measuring trust. *The Quarterly Journal of Economics*, *115*(3), 811–846. http://doi.org/10.1162/003355300554926

Goeree, B. J. K., Mcconnell, M. A., & Mitchell, T. (2010). The 1/d law of giving. *American Economic Journal: Microeconomics*, *2*(1), 183–203. http://doi.org/10.1257/mic.2.1.183

Granovetter, M. (1973). The strenght of weak ties. *American Journal of Sociology*, *78*(6), 1360–1380.

Granovetter, M. (1985). Economic action and social structure: the problem of embeddedness. *American Journal of Sociology*, *91*(3), 481. http://doi.org/10.1086/228311

Granovetter, M. (2005). The impact of social structure on economic outcomes. *Journal of Economic Perspectives*, *19*(1), 33–50. http://doi.org/10.1257/0895330053147958

Hardin, G. (1968). The tragedy of the commons. *Science*, *162*(3859), 1243–1248.

Holt, C. A., & McDaniel, T. (1998). Experimental economics in the classroom. In W. B. Walstad & P. Saunders (Eds.), *Teaching undergraduate economics: a handbook for instructors* (pp. 257–268). McGraw-Hill. http://doi.org/10.2307/1182396

Jackson, M. O. (2014). Networks in the understanding of economic behaviors. *Journal of Economic Perspectives*, *28*(4), 3–22. http://doi.org/10.1257/jep.28.4.3

Kagel, J. H. (2009). Laboratory experiments. In G. Fréchette & A. Schotter (Eds.), *The methods of modern experimental economics*. Oxford: Oxford University.

Kranton, R., Pease, M., Sanders, S., & Huettel, S. (2012). *Identity, group conflict, and social preferences*. Durham. Retrieved from http://econ.duke.edu/uploads/media_items/identity-groupconflict-may2012.original.pdf

Leuthold, J. (1993). A free rider experiment for the large class. *Journal of Economic Education*, *24*(3), 353–363.

Levitt, S. D., & List, J. (2008). Homo Economicus evolves. *Science*, *319*(5865), 909–910. http://doi.org/10.1126/science.1153640

Magalhães, M. A., & Oliveira, E. S. (2014). *Partners , Strangers and Free Riders: an experimental study on the importance of group composition for linear public goods games*. Vitória, FUCAPE Business School.

Marwell, G., & Ames, R. E. (1981). Economists free ride, does anyone else? *Journal of Public Economics*, *15*(3), 295–310. http://doi.org/10.1016/0047-2727(81)90013-X

Mesquita, L. F., Saes, M. S. M., & Lazzarini, S. G. (2011). *Holdup or differential competencies ? An experimental investigation on the determinants of vertical integration*. São Paulo, Insper Institute of Education and Research and Univerisade de São Paulo (USP).

Murphy, J. J., & Cárdenas, J. C. (2004). An experiment on enforcement strategies for managing a local environmental resource. *Journal of Economic Education*, *35*(1), 47–61.

Nelson, R. G., & Beil, R. O. (1994). When self-interest is self-defeating: the public goods experiment as a teaching tool. *Journal of Agricultural and Applied Economics*, *26*(2), 580–590.

Olson, M. (1965). *The logic of cooperative action: public goods and the theory of groups*. Cambridge: Harvard University.

Ostrom, E. (1999). Coping with tragedies of the commons. *Annual Review of Political Science*, *2*(1), 493–535. http://doi.org/10.1146/annurev.polisci.2.1.493

Ostrom, E. (2000). Collective action and the evolution of social norms. *Journal of Economic Perspectives*, *14*(3), 137–158.

Ostrom, E. (2007). *Developing a method for analyzing institutional change* (No. 07-1). *Workshop in Political Theory and Policy Analysis*. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=997837

Ostrom, E. (2010). Beyond markets and states: polycentric governance of complex economic systems. *The American Economic Review*, *100*(3), 641–672. http://doi.org/10.1257/aer.100.3.1

Samuelson, P. A. (1954). The pure theory of public expenditure. *The Review of Economics and Statistics*, *36*(4), 387–389.

Smith, V. L. (1989). Theory, experiment and economics. *Journal of Economic Perspectives*, *3*(1), 151–169. http://doi.org/10.1257/jep.3.1.151

Stiglitz, J. (2000). *Economics of the public sector*. New York: W.W. Norton.

Tabachnick, B. G., & Fidell, L. S. (2007). *Experimental designs using ANOVA*. New York: Thompson Brooks/Cole.

Vollan, B., & Ostrom, E. (2010). Cooperation and the commons. *Science*, *330*(November), 923–924. http://doi.org/10.1126/science.1197881

Williamson, O. E. (1991). Strategizing, economizing and economic organization. *Strategic Management Journal*, *12*(Special issue: Fundamental Research Issues in Strategy and Economics), 75–94. http://doi.org/10.1002/smj.4250121007

Williamson, O. E. (1993). Calculativeness, trust, and economic organization. *Journal of Law and Economics*, *36*(1), 453–486. Retrieved from http://www.jstor.org/stable/725485

Williamson, O. E. (2002). The theory of the firm as governance structure: from choice to contract. *Journal of Economic Perspectives*, *16*(3), 171–195. http://doi.org/10.1257/089533002760278776

Williamson, O. E. (2005). The economics of governance. *The American Economic Review*, *95*(2), 1–18. http://doi.org/10.1257/000282805774669880

Williamson, O. E. (2010). Transaction cost economics: the natural progression. *The American Economic Review*, *100*(3), 455–476. http://doi.org/10.1257/aer.100.3.673

Wilson, D. S., Ostrom, E., & Cox, M. E. (2013). Generalizing the core design principles for the efficacy of groups. *Journal of Economic Behavior and Organization*, *90*(Supplement), S21–S32. http://doi.org/10.1016/j.jebo.2012.12.010

Yezer, A. M., Goldfarb, R. S., & Poppen, P. J. (1996). Does studying economics discourage cooperation? Watch what we do, not what we say or how we play. *Journal of Economic Perspectives*, *10*(1), 177–186. http://doi.org/10.1257/jep.10.1.177

Appendix: Experimental Instructions

Hoje, realizaremos um pequeno experimento. Antes de iniciarmos, por favor, leia as instruções abaixo.

Após sua leitura das instruções, o professor as lerá em voz alta. Aproveite este momento para sanar eventuais dúvidas e vir com questionamentos, caso necessário.

*****

Experimento 01

Suponha que, a partir deste momento, você receba R$ 100,00 (cem reais) do professor e tenha a opção de dividir esta soma em apenas dois ativos financeiros, que chamaremos de *Ativo A* e *Ativo B*.

No caso de investir no *Ativo A*, você receberá um retorno fixo de 5% de seu investimento.

No caso de investir no *Ativo B*, você receberá um retorno fixo de 10% do investimento feito por todos os participantes do experimento.

Assim, por exemplo, se um grupo com 10 participantes decidir por investir um total de R$ 1.000,00 no *Ativo B*, cada participante receberá um retorno de R$ 10,00 (1/10 de 10% de R$ 1.000,00), independentemente do investimento que faça individualmente no *Ativo A*.

Você tem liberdade para dividir o total de dinheiro disponível (R$ 100,00) entre os dois ativos da maneira que quiser.

A partir destas instruções, responda às questões abaixo (não é preciso colocar seu nome nesta folha):

1. Quanto você quer investir em cada um dos ativos abaixo?

Ativo A:	R$
Ativo B:	R$

2. Adicionalmente, preencha as informações abaixo:

Idade	( ) Anos
Sexo	( ) Feminino ( ) Masculino
Escola	( ) Frequentou Escola Pública ( ) Frequentou Escola Privada
Curso	( ) É aluno de Economia ( ) Não é aluno de Economia
Orientação Política	( ) Esquerda ( ) Centro ( ) Direita