A Shared Sense of Responsibility: Money versus Effort Contributions in the Voluntary Provision of Public Goods*

Jared C. Carbone†
Robert S. Gazzale‡

September 2011

Abstract

A frequently cited argument against the use of market-based instruments to provide public goods is that they diminish our sense of responsibility to be good citizens. In this paper, we report on the results of a laboratory experiment designed to explore the idea that this distrust stems from the ability of some members of society to contribute to the public good with money instead of time or effort. We look at how the personal effort exerted by subjects changes when their peers take advantage of an offer to buy out of their obligation to perform lab tasks that contribute toward carbon emission reductions. We find that on average subjects reduce their effort when their peers buy out. However, the aggregate result masks significant heterogeneity across individual responses. Those who choose not to buy out despite its expected profitability have no response to the treatment while those for whom it would simply not be profitable to buy out register large reductions in effort. The magnitude of these responses is increasing in the share of the group that accepts the buyout offer, suggesting that it is the act of peers buying out rather than the simple introduction of monetary incentives that is the source of the effect.

JEL Classification: C90, C91, H41, Q54

Key words: experimental economics, public goods, effort contribution, environment, climate change

*We gratefully acknowledge support from the Norwegian Research Council as part of the NORKLIMA project. The views expressed here and any errors are our own.

†Department of Economics & Institute for Sustainable Energy, Environment and Economy, University of Calgary, SS 454, 2500 University Drive NW, Calgary, AB T2N 1N4; and The Ragnar Frisch Centre for Economic Research, Oslo, Norway; j.c.carbone@ucalgary.ca.

‡Department of Economics, Williams College, 24 Hopkins Hall Drive, Williamstown, MA 01267; and The Ragnar Frisch Centre for Economic Research, Oslo, Norway; rgazzale@williams.edu.

1 INTRODUCTION

A frequently cited argument against the use of market-based instruments to provide public goods is that they diminish our sense of responsibility to be good citizens. For example, many environmental interest groups oppose the use of emission permit trading systems (cap-and-trade) to control air pollution despite their cost effectiveness (Heal 2007). They argue that by changing pollution from a sin against nature, remedied only by personal atonement, into a commodity that can be bought and sold with no special social consequences, market-based instruments may weaken our resolve in dealing with environmental challenges. If these types of fears were to be realized, they could make achieving society's goals more difficult — either by making it more difficult to enact future government policies to provide public goods or by crowding out the voluntary efforts of civic-minded individuals.

In this paper, we report on laboratory experiments designed to explore the latter idea — that introducing markets may crowd out voluntary effort. Specifically, we ask whether the effort individuals devote to providing a public good is affected by the contribution vehicle — personal effort versus money — used by their peers. Our hypothesis is that people view monetary contributions to the public good as less of a personal sacrifice than direct effort contributions — even when they result in the same quantity of the good being provided. When people observe their peers buying out of their effort obligation by contributing money, they respond by reducing their own effort because they feel that their peers are not sharing in the sacrifice required to undertake the civic enterprise.

Two key assumptions underlie our hypothesis. The first is that people view money and effort contributions differently in the context of public goods provision. The second is that this difference translates into lower effort when peers contribute money. With respect to the first assumption, anecdotal evidence abounds. Environmental activist Al Gore was widely criticized in 2007 when a think tank revealed that Gore's personal estate required twenty times as much electricity as a typical household. Gore declared his lifestyle "carbon neutral" because he purchased offsets to his polluting activities but many viewed this gesture as insufficient, amounting to a double standard. The president of the think tank was quoted, "If he [Gore] is going to be a spokesman for global warming, he has to be willing to make the same sacrifices [as those unable to afford offsets]" (Humphrey 2007). The clear implication was that Gore would be a more sympathetic advocate for his cause if he "walked the walk" by making lifestyle changes that reduced the size of his carbon footprint directly rather than via financial transaction.[1]

[1]Similarly, the Mid-Atlantic Regional Council of Carpenters came under fire when it became known that they regularly outsource shifts on their picket lines to homeless people because of the high cost of missing work to the union's own members (Alexander 2007). At a more local scale, food cooperatives frequently require effort contributions from their members. For example, the Park Slope Food Coop, the oldest and largest member-owned food cooperative in the U.S. requires each household adult to contribute 2.75 hours every four weeks. Its website notes that while "volunteer" effort keeps prices low, "another goal accomplished when members are doing 75% of the work of the Coop is a feeling of being a member-owner that one cannot get from merely investing one's money."(`http://foodcoop.com/go.php?id=40`) There are also experimental studies on the general issue of whether people perceive differences between money and time or effort, though none conducted in the context of public goods provision to our knowledge. Brüggen and Strobel (2007) and Vilares, Dam and Kording (2011) find no difference between money and effort in reciprocity experiments. However, Ellingsen and Johannesson (2009) find a significant

With respect to the second assumption, a number of experimental studies have documented evidence of conditional cooperation in public goods experiments, whereby a subject's voluntary contribution to the public good is increasing in the contribution of others. (See Gächter (2007) for an overview of this literature.) Linardi and McConnell's (2011) study is notable for its focus on effort comparisons. They conduct a laboratory study in which subjects provided volunteer effort to a charitable organization and could leave as they wished. They find that the more subjects still volunteering, the lower the likelihood that a particular subject leaves. We are unaware, however, of any conditional-cooperation study in which some donate money and others effort. If, as we hypothesize, individuals effectively view monetary contributions as smaller than equivalent effort contributions, then observing effort reductions in our experiments could be interpreted a form of conditional cooperation.

There is also support for the idea that introducing markets may induce crowding out through its effect on the shared sense of responsibility to provide public goods. For example, Fehr and Falk (2002, p. 711) suggest that market mechanisms may undermine social norms of voluntary contributions, conjecturing that allowing "even only a tiny minority ... to free themselves, although at some cost, from obeying the social norm may trigger the unravelling of the social norm." This sentiment has also been expressed by political philosophers. Rousseau (1762) warned, "As soon as public service ceases to be the chief business of the citizens and they would rather serve with their money than with their persons, the state is not far from its fall." More recently, Sandel (1997) proposed that market mechanisms (and specifically cap-and-trade) may reduce the intrinsic motivations of others to contribute effort to the associated public goods, citing effects on moral considerations and social norms of cooperation.

In our experiment, subjects complete tasks to reduce carbon emissions in some rounds and complete tasks for money in others. In treatment sessions, we introduce the possibility of a buyout in emission-reduction rounds: subjects can pay a fee (used to purchase emission reductions) that relieves them of the responsibility to provide effort to reduce emissions and allows them to continue to work for money. We test our hypothesis by comparing effort levels of subjects who did not accept the buyout in treatment sessions to effort levels in control sessions in which no buyout was offered. Effort is measured by the number of lab tasks completed in a round. Thus we identify a causal effect of introducing the buyout option on the effort level exerted by our subjects.

We find that the aggregate effect of the treatment is to reduce subjects' effort. However, the aggregate result masks significant heterogeneity across individual responses. Most notably, those who choose not to buy out despite its expected profitability have no response to the treatment while those for whom it would simply not be profitable to buy out register large reductions in effort. The magnitude of these responses is increasing in the share of the group that accepts the buyout offer with an approximately 5-10% reduction in effort for every 10 percentage-point increase in the percentage of subjects who buy out (if the response is assumed to be linear.) Furthermore, it appears to be the *act* of peers buying out rather than the simple introduction of the buyout option that is the source of the effect. Thus groups in our experiments in which the buyout was offered

difference between time and money investments in a modified ultimatum bargaining game.

but no subjects accepted experienced no reduction in effort.

There is a large literature (described in the next section of the paper) in psychology and economics focused on measuring crowding out of intrinsic motivation when explicit rewards for performance are introduced. Our experiments complement these studies by identifying a different behavioral mechanism that may be active in many of the same domains.

Section 2 discusses related literature and our hypotheses. Section 3 describes the design of the laboratory experiments and Section 4 describes the results. Section 5 describes robustness checks of our main results. Section 6 discusses some of the broader implications of our findings and offers suggestions for future research.

2 Related Literature and Hypotheses

Many people provide significant amounts of time and effort for charities and public goods, effort that is not directly compensated. In some cases, people receive other external rewards such as social approval or reputation from their participation in these activities. However, much of this "prosocial" effort is what psychologists would call intrinsically motivated. That is, it is offered voluntarily without any expectation of external reward. There is significant evidence that the introduction of market-based mechanisms and incentives can have adverse consequences on voluntary or intrinsically motivated effort (Frey and Jegen 2001).

Titmuss (1970) was one of the first to hypothesize that the introduction of payment might decrease supply. He conjectured that paying for blood donations would decrease overall supply.[2] A number of subsequent studies have documented similar perverse relationships between payment and supply. Frey and Oberholzer-Gee (1997) find that introducing a scheme to compensate individuals for the placement of a hazardous waste disposal site close to their homes made people *less* willing accept such sites than when they received no compensation. They attribute this finding to the reduced sense of civic duty with the the introduction of compensation. Gneezy and Rustichini (2000a) find that parents of children enrolled at a daycare center increased late pickup frequency after introduction of a late pickup fine. Similarly, Gneezy and Rustichini (2000b) conduct a series of between-subject experiments in which they compare effort across various levels of piece-rate compensation. While effort is increasing in piece rate when offered, effort for the lowest piece rate was less than for the condition in which no piece rate was mentioned or offered.

Broadly, authors have offered two types of explanations for these results.[3] First, introducing monetary rewards may decrease other *external* rewards such as social approval by making prosocial effort appear less virtuous. For example, Bénabou and Tirole (2006) develop a model showing that the introduction of rewards for a desired behavior may make it more difficult to discern the

[2] Mellström and Johannesson (2008) provide experimental support, at least for women.

[3] There are other proposed mechanisms but they are more relevant to a principal-agent scenario. Bénabou and Tirole (2003) develop a model in which the incentives chosen by the principal conveys her information about agent and task characteristics, which may influence the latter's intrinsic motivation to complete the task. Gneezy and Rustichini are actually at least as persuaded by incomplete-contract explanations for their results. For example, the introduction of a late pickup fine causes daycare parents to update beliefs about the consequences of especially repeated late pickups.

agent's underlying motives, thus reducing social approval for this effort and possibly the desire to expend this effort.

Second, the introduction of monetary rewards may crowd out *intrinsic* motivations for prosocial effort.[4] Within this category, a number of different specific mechanisms have been proposed. Self-perception theory (Bem 1965, Bem 1967) posits that the introduction of a salient external reward causes an individual to attribute task performance to external motivations. In a sense, the individual substitutes her intrinsic marginal benefit curve with the external marginal benefit curve. More generally, salient incentives to "do the right thing" reduce one's satisfaction from doing the right thing. One can also interpret the model of Bénabou and Tirole (2006) as one in which rewards impact intrinsic rewards like self-image and self-respect rather than external rewards like social approval. Likewise, a person might believe the prosocial action moral (Sugden 1984). Brekke, Kverndokk and Nyborg (2003) develop a theory of moral motivation, where (some) intrinsic motivation derives from a desire to do the moral action. They show that market incentives can have deleterious effects on the warm glow associated with the moral action and, as a result, reduce prosocial effort even when the market is believed to be sufficient to replace effort.

Common to all of the mechanisms discussed in this literature is the idea that the introduction of markets operates *directly* on a person's motivation — changing how she views the public good and her willingness to contribute to it. In contrast, our focus in this paper is on studying how the behavior of *peers* — specifically their decision to buy out of effort contributions to public goods — affects a person's motivation. Thus no change in the intrinsic or external rewards that a person associates with contributing to the public good *per se* would be required to activate the crowding mechanism we have described. To our knowledge, there is no study in the motivation crowding literature that follows up on this insight.

2.1 Hypotheses

Our working hypotheses are that:

1. Distrust of market mechanisms may arise from the ability of some to "buy out" of an obligation to contribute time or effort to the provision of a public good, and that the decision of peers to buy out adversely affects the performance of a subject who does not or can not buy out.

2. The degree to which performance is adversely affected is increasing in the degree to which peers buy out, measured by the number or fraction of the group that elect to accept the buyout.

The mechanism we propose is not only conceptually different from the existing literature on motivational crowding, it has identifiably different implications for the type of behavior we should

[4]Note that in considering intrinsic motivations for prosocial effort, we are taking a broader view of intrinsic motivation than Fehr and Falk (2002) who consider intrinsic motivation to complete the task itself. For example, while we consider a person's intrinsic motivation to help the environment by sorting recyclables, their definition of intrinsic motivation considers how much this agent enjoys sorting recyclables absent any environmental benefit.

expect to see in our experiments. Unlike with the mechanisms proposed in that literature, we would not expect the mere introduction of markets to cause crowding out in our setting. Here activation requires that subjects actually observe their peers accepting the buyout offer in our experiments. Thus observing no crowding out of effort in sessions in which no subjects accept the buyout offer or finding that effort crowding is a function of the degree to which peers buy out would support our hypothesis.

3 Experiment Design

Experiment sessions proceeded in a series of five-minute rounds in which subjects had the opportunity to complete computer-based tasks. In **Earning Rounds**, the subject earned a piece rate for each task completed. In **Environment Rounds**, we presented each subject with a second task, and purchased and retired one ton of carbon emissions for a set number of tasks completed. In **Buyout Sessions**, we introduced a buyout option in the final two environment rounds. Subjects accepting the buyout paid a fee, used to purchase as many carbon permits as possible, and were then presented with earning tasks. Our main comparison is the number of environment tasks completed by those in the Buyout Sessions who did not buy out with the baseline sessions in which we offered nobody a buyout option.

We used two tasks: an encryption task and a counting task. Whether a task was earning or environment varied between sessions, but was fixed within a session. For the encryption task, for the entire round a subject's computer screen displayed a table translating each letter of the alphabet into a unique 2-digit number.[5] For each task, the subject's screen displayed 2 letters. The subject successfully completed the task by translating the letters into their numeric equivalent and entering the correct 4 numbers. For each counting task, a subject's computer screen displayed a table with 4 rows and 4 columns with either a 0 or 1 (determined randomly) in each position. The subject successfully completed the task by correctly entering the number of zeros. For both task types, the subject received the next task only after completing the current task.

The subject received 10 cents per completed encryption task when it was the earning task, and when it was the environment task we retired 1 permit per 150 completed tasks. When the counting task was the earning task, the subject received 7.5 cents per completed task, and when it was the environment task we retired 1 permit per 200 completed tasks.

At the start of each session, we randomly allocated each subject to a computer whose screen displayed a z-Leaf window for interacting with the experiment as well as an Internet browser. Each subject received a written copy of the instructions (Appendix B), which were then read aloud. These instructions mentioned the internet browser to ensure common knowledge of its shirking potential. They also included information about the link between greenhouse-gas emissions and global warming, how we would purchase greenhouse-gas permits on the European Union Emission Trading System based on the number of completed environment tasks, and how to subsequently verify their purchase.

[5] We randomly generated one encryption key each round for all subjects.

Prior to environment and earning rounds, sessions started with a one-minute practice round for each task. Subjects were then evenly and randomly allocated to either the Blue or Purple group. We did so for two reasons. First, we hypothesize that even weak group identity may make the actions of others—effort and buyouts in environment rounds—more salient (e.g., Chen and Li 2009). Second, in-group uncertainty may make a neighbor's audible keyboard effort less relevant. This may reduce the likelihood that a subject conditioned effort on her neighbor's *current* effort, as opposed to the buyout option and the number accepting.

At the beginning of each five-minute round, subjects were informed whether the round was an earning or an environment round. Subjects did not know the total number of rounds, nor the number of each type of round. In practice, all sessions lasted five rounds and started with an environment round, with rounds alternating between environment and earning. This means that when offered, buyouts were available in rounds 3 and 5.

At the end of each earning round, the subject's screen displayed the number of tasks she completed, as well as her earnings for the round. At the end of each environment round, her screen displayed the number of tasks she completed, as well as the number of tons of carbon emissions both she and her group averted. At all points in the experiment, a subject has access to a history box containing all previously revealed information.

3.1 Buyout Sessions

In Buyout Sessions, we surprised subjects with a Buyout Option at the start of the second environment round (round 3) (see instructions in Appendix B.1). The Buyout Option enabled a subject to pay a Buyout Fee and complete earnings tasks (and thus earn money) in lieu of completing environment tasks. We took a number of steps to make the buyout seem reasonable to the subject not buying out. We truthfully informed subjects that the buyout was available to all on the same terms and that the fee largely replaced lost effort.

At each buyout opportunity, we set the Buyout Fee to exactly offset the average number of permits produced in the first environment round. We also set the earning-task piece rate so that only half of the subjects in a group would find the buyout profitable assuming subjects replicated the number of tasks completed in the previous earning round. All subjects in an 8-subject group faced the same Buyout Fee and piece rate. The environment round proceeded as normal for those subjects not accepting the buyout. Subjects were also offered the Buyout Option in the final environment round (round 5), with the only difference being that the earning-task piece rate was calibrated so that median round-4 earning task performance broke even with respect to the buyout fee.

When deciding whether to accept the buyout, each subject's monitor displayed information about the expected profitability of accepting the buyout option: the buyout fee; the piece rate if she accepts the buyout; the number of tasks she completed in the previous earning round; and her net earnings if she accepts the buyout and completes the same number of tasks as in the previous earning round (expected task earnings minus buyout fee). In addition, the subject receives information about the expected effect of her buyout on the number of greenhouse gas permits retired.

Her screen displays the exact number of permits that will be purchased with her buyout fee, as well as the exact number of permits retired as a direct result of the number of tasks she completed in the first environment round.

After all subjects have decided whether or not to accept the buyout option for that round, a subject learns the number of group members accepting the option. She also learns the expected impact of the buyouts on total contributions: the number of greenhouse-gas permits that will be bought with the buyout fees and the number of greenhouse-gas permits produced in the first environment round by subjects accepting the buyout.

After the final round (round 5), subjects completed a brief demographic questionnaire. We also asked questions taken from the Pew Research Center For The People & The Press, January 2009 Political Survey in which subjects rated the importance of various issues (including global warming) facing the U.S. Government.

3.2 Summary

We conducted sessions at Williams College. Approximately 16 students participated in a session, without duplication.[6] Table 1 details the treatments and subject participation. The experiment was programmed and conducted with z-Tree (Fischbacher 2007). Subjects earned $16.61 on average, which includes a $5 show-up fee. Sessions lasted approximately 60–75 minutes.

Task Assignment:	**Buyouts Offered**	
{Earning; Environment}	**No**	**Yes**
{Counting; Encryption}	13	32
{Encryption; Counting}	16	32

Table 1: Number of Subjects per Treatment

3.3 Identification

In testing our hypotheses, we are mindful of a couple of potential confounding factors. First, unless the buyout fee is personalized to exactly replace an individual's (expected) contribution, even a relatively fair buyout will alter the contributions of those accepting the buyout. Given that an agent's optimal effort contribution may depend on the contributions of other subjects, we must disentangle the change due to the aggregate level of contributions by others from the change arising from the manner in which others contribute (effort versus money). In our main treatment, we informed subjects of the expected change in permits retired as a consequence of subjects accepting the buyout. Thus we control for changes in aggregate contributions by including the expected change in permits as an explanatory variable in our regression analysis.

Second, the appropriate counterfactual is comparing the effort contribution of those who do not accept the buyout option with those who were not offered the option *and* would not have accepted it were it offered. In our between-subject experiment, our baseline sessions (without a

[6]Subjects were recruited through the online recruitment system ORSEE (Greiner 2004).

buyout option) will include both those who would and would not have accepted the offer. It is easy to see that effort differences across these two groups may bias comparisons with those who do not buy out in the treated group. Thus, we must take care to control for those in the baseline session who might have accepted the buyout option. We take two basic approaches to addressing this concern. First, we identify subject characteristics which predict buyout acceptance and test whether these characteristics are correlated with high environment-task effort in later rounds in the baseline sessions. Second, we run an alternate formulation of the buyout session in which a random sample of only half of the subjects in a treatment group are offered the buyout option, ensuring that there is always a random sample of subjects who receive the treatment and can not buy out. The results of these robustness checks are described in Section 5.

The selection problem here clearly arises because we allow all subjects in our main treatment sessions to choose whether or not to accept the buyout and the alternate formulation clearly solves that problem. However, it also introduces the possibility that subjects who do not receive buyout offer in treatment sessions reduce their effort because they feel that it is unfair they did not receive an offer. Thus there is trade off between confounding the behavior of interest with selection effects on one hand and a treatment that may not capture exactly what we hope to measure on the other. Our strategy is to describe our main findings based on the formulation that is vulnerable to selection effects and then present evidence (of which the results from the alternate formulation represent one piece) demonstrating that these effects are unlikely to be driving our results.

4 RESULTS

Our key outcome measure is $\delta_{t,i}$: for subject i, environment tasks completed in round $t \in \{3, 5\}$ minus the number completed in round 1, defined for all subjects who do not buyout in round t. As we find no evidence of round-1 shirking, this output measure is a good estimate of round t effort.[7] We average across all non-buyout subjects in a treatment, and compare this average in our buyout sessions with the baseline session. We first summarize the buyout behavior in the sessions. We then examine the average treatment effect for these subjects as a whole and as well as for select sub-populations. This is followed by a formal regression analysis of the same outcomes.

Table 2 describes the pattern of buyouts in rounds 3 and 5 of the treatment sessions. For each 8-subject group, the second column identifies the task subjects performed to earn permits. The next two columns indicate the number accepting the buyout in each of the buyout rounds. In the final column, we indicate the difference between the number of permits purchased with buyout fees and the number of permits produced in the first environment round by subjects accepting the buyout option in round 5.

The typical group registered more than one buyout per buyout round with buyouts ranging between zero and four subjects. There is no discernible difference in the number of buyouts by

[7] For each task, we compare the number completed in the first round when it is the environment tasks to the number completed in the second round when it is the earning task. p-values for the Wilcoxon rank-sum test, testing the hypothesis that samples are drawn from the same distribution, are 0.452 for the counting task and 0.093 for the encryption task. Unless otherwise indicated, all p-values we report are for Wilcoxon rank-sum tests.

Group	Environment Task	Buyouts Round 3	Buyouts Round 5	Round 5 E[Δ Permits]
1	Encryption	4	3	0.13
2	Encryption	2	1	-0.04
3	Encryption	2	1	0.02
4	Encryption	4	3	-0.05
5	Counting	2	0	0.00
6	Counting	2	2	-0.13
7	Counting	3	3	0.10
8	Counting	2	1	-0.08

Table 2: Treatment Sessions: Number of subjects (out of eight) accepting buyout offer and expected permit change as a result of buyouts, per group.

environment task. Slightly fewer subjects chose to buy out in Round 5 than in Round 3.[8] In summary, our experimental manipulation was successful in generating buyouts and variation in the number of buyouts across groups while not greatly affecting the expected number of permits these subjects may have provided.[9]

E(Profit)>0:			**N**	**Y**
Buyout Accepted:	**Y**	**N**	**N**	**N**
Environment Task Index	1.040	1.014	0.994	1.039
	(0.359)	(0.141)	(0.141)	(0.140)
Earning Task Index	1.169	0.975	0.894	1.079
	(0.238)	(0.122)	(0.078)	(0.082)
E(Profit) if buyout	0.845	-0.136	-0.547	0.387
	(1.096)	(0.567)	(0.325)	(0.323)
Proportion E(Profit)>0	0.786	0.440	0.000	1.000
	(0.426)	(0.501)		
Buyout in Round 3	0.929	0.160	0.143	0.182
	(0.267)	(0.370)	(0.356)	(0.395)
n	14	50	28	22
Global Warming Importance	2.154	2.333	2.333	2.182
	(0.801)	(0.724)	(0.961)	(0.733)
n	13	48	27	22

Table 3: Treatment Sessions: Subjects characteristics (means and standard deviations) by round-5 buyout status. Global warming importance, on a 0–3 scale, and excludes subjects choosing "I don't know."

In Table 3, we present various subject characteristics by round-5 buyout status. We compare

[8]Only 1 round-5 buyout did not buy out in round-3. This means 8 round-3 buyouts chose not to buyout in round 5. Only 2 of these 8 lost money in round 3.

[9]For the sake of comparison, in buyout sessions average round-1 performance was 50.9 encryption tasks (.34 permits) or 63 counting tasks (.32 permits).

those who buyout with those who do not. We further distinguish in this latter group between those whose earnings would have (and would not have) been positive conditional on paying the buyout fee and replicating earning-task performance from the previous round. We focus on this distinction because one might expect that those subjects who refused the buyout and "left money on the table" by doing so might have different motives than those for whom the buyout was not profitable. In order to group together subjects completing different environment tasks, we create an index equal to the number of round-1 tasks completed divided by the median number of round-1 tasks completed amongst subjects faced with the same task. We construct a similar index for earning-task performance using round-4 output.

We make a few observations. In terms of performance in the first environment round, there are no significant differences across the populations. Unsurprisingly, there is a significant difference in round-4 earning-task performance between those who do and do not buyout in round 5 ($p = 0.002$). Perhaps surprisingly, the ranked importance of global warming (both in absolute terms and relative to other concerns) does not predict buyout acceptance.

4.1 Effect of Buyouts on Effort Contributions

We find no difference between the first buyout round (round 3) and round 3 in the baseline sessions. We therefore focus on the second buyout round (round 5) and $\delta_i = \delta_{5i}$, subject i's increase in environment tasks completed from round 1 to 5. Furthermore, within each treatment, we cannot reject the hypothesis that the distribution of δ_i is the same regardless of environment task. ($p = 0.218$ for the baseline sessions, $p = 0.735$ for the treatment sessions.) We therefore group counting and encryption tasks.

In Figure 1, we depict, by treatment, cumulative distribution functions of the percent change in tasks completed relative to round 1 ($\delta_i/\text{Tasks}_{1i}$). First, we see continued and near-uniform provision of effort contributions in the baseline session. Second, in both the baseline and treatment, a significant proportion of subjects increase round-5 output relative to round 1, consistent with learning and continued effort. (38% of baseline subjects and 28% of non-buyout treatment subjects increase output by over 10%.) However, the fraction of subjects decreasing output is markedly larger in the treatment group than in the baseline (48% versus 14%).

We present in Table 4 the average change in performance on the environment task from Round 1 to 5 by treatment and control groups. The rows identify the cohort. The first two columns identify the treatment and control groups, with each cell identifying the performance change ($\bar{\delta}$) and number of observations (n). The third column reports the p-value of the Wilcoxon rank-sum test of equal distributions. The final column calculates the difference in the change in average performance across these groups as a percentage of the average tasks completed by baseline subjects in Round 5.[10]

Formal results echo Figure 1. Subjects in the treatment sessions who did not buy out decreased output, and presumably effort, relative to their Round-1 performance. Completed tasks did not,

[10]Conceptually, we are calculating the number of Round-5 tasks completed by those not buying out if this group had the baseline's Round 1.

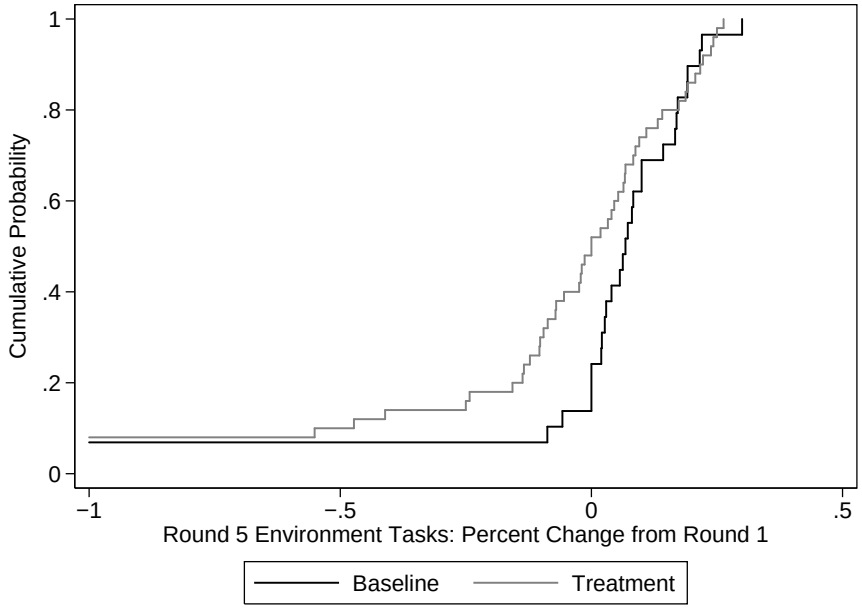

Figure 1: CDFs (by treatment) of percent change in Round 5 environment tasks. (Excludes subjects accepting Round 5 buyout.)

	Buyout Available			**Δ as % of Round-5**
	No	**Yes**	***p*-value**	**Baseline**
All Subjects	$\bar{\delta}$ = 0.3 n = 29	$\bar{\delta}$ = -3.5 n = 50	0.069	-6.5
Unprofitable Subjects	$\bar{\delta}$ = -3.9 n = 14	$\bar{\delta}$ = -7.9 n = 29	0.024	-8.0
Profitable Subjects	$\bar{\delta}$ = 4.2 n = 15	$\bar{\delta}$ = 2.6 n = 21	0.724	-2.5

Table 4: Mean Round 1 to 5 Change Change In Output by Treatment and Expected Profit: All non-buyout subjects. p-values for the Wilcoxon rank-sum test, testing the hypothesis that samples are drawn from the same distribution.

$\delta_i = \text{Tasks}_{5i} - \text{Tasks}_{1i},\ i \in$ subjects who do not accept buyout. $\bar{\delta} = \sum_i \delta_i / n =$ Treatment average.

on average, change for baseline subjects. The difference between baseline and treatment subjects is weakly significant. Overall, this reduction in effort translates into a 6.5% reduction in effort contributions relative to the performance of control subjects in Round 5.

4.2 Profitable versus Unprofitable Subjects

The averages reported in the first row of Table 4 masks the significant individual-level heterogeneity shown in Figure 1. We distinguish in the final two rows between the subjects who would and would not have expected the buyout to be profitable based on round-4 earning task performance. We focus on this distinction because we informed each subject of her expected earnings from accepting the buyout, and subjects who refused the buyout and "left money on the table" by doing so might have different motives than those for whom the buyout was not profitable. We construct these groups *ex post* for the baseline using the same rule: subjects above the median performance in the preceding earning round are designated profitable.

In both the baseline and the treatment sessions, subjects below the median in earning tasks (those who might have reasonably expected the treatment buyout to be unprofitable) decreased their output relative to round 1. This decrease is significantly larger, however, for those who were actually offered and did not accept the buyout. This effect is large economically as well. We estimate that had we offered the buyout to unprofitable baseline subjects, they would have decreased output by approximately 8% on average. While the increase in tasks completed is slightly smaller in the cohort who actually turned down a buyout than in the cohort who would have found it profitable if offered, we cannot reject the hypothesis that this difference is zero. Thus, the aggregate results presented in the first row mask substantial heterogeneity across individuals, as the treatment effect appears to be isolated amongst those who (rationally) could not buyout.

Profitable subjects who rejected the buyout offer may be revealing a strong preference for contributing to the environment good or, perhaps, rejecting the idea of the buyout offer itself. It is worth noting that we find that these subjects do not report a higher importance on global warming in a post-experiment survey.

4.3 Regression Analysis

We now present a formal regression analysis of the data. This allows us to decompose the results along other dimensions and to introduce additional control variables. It also allows us to look at how the rate at which group members accept the buyout affects the performance of non-buyout subjects. Table 5 shows the results of this analysis. The dependent variable in all of the regressions is δ_i, the change from Round 1 to 5 in environment tasks completed. We present three different specifications of an ordinary-least-squares model in which we successively add more explanatory variables.

Our base model includes controls for the pattern of buyouts and whether the subject would have found the buyout profitable. In the first category, we have **Buyout Session**, an indicator variable equal to 1 for subjects participating in a buyout session, and **Buyout Rate**, the fraction of group members accepting the buyout. To capture expected buyout profitability, we include

	(1)	(2)	(3)
Count Round	-0.726	-0.209	-0.382
	(3.941)	(4.057)	(4.458)
Buyout Session	6.271	7.653	7.239
	(7.744)	(7.548)	(8.683)
Buyout Rate	-0.512**	-0.561***	-0.562***
	(0.209)	(0.202)	(0.203)
E[Profit]>0	8.029	8.049	6.946
	(6.762)	(6.796)	(10.20)
Buyout Session X E[Profit]>0	-7.736	-8.261	-7.164
	(8.954)	(8.798)	(11.38)
Buyout Rate X E[Profit]>0	0.504**	0.519**	0.512**
	(0.240)	(0.231)	(0.230)
Expected Permit Change		25.36	24.17
		(31.44)	(31.37)
Round 1 Performance			3.916
			(16.25)
Constant	-3.442	-3.738	-7.144
	(7.239)	(7.302)	(10.95)
Observations	79	79	79

Table 5: OLS models of $\delta_i = \text{Tasks}_{5i} - \text{Tasks}_{1i},\ i \in$ subjects who do not accept buyout, robust standard errors in parentheses.

Independent Variables: **Count Round** $= 1$ if counting is environment task, else 0; **Buyout Session** $= 1$ if buyout is offered this session, else 0; **Buyout Rate** $=$ percentage of group that accepted the buyout this round; **E[Profit]>0** $= 1$ if subject expected to profit from buyout based on round 4 Earning Task performance, else 0; **Buyout Session X E[Profit]>0** $=$ interaction of **Buyout Session** and **E[Profit]>0**; **Expected Permit Change** $=$ expected change in the aggregate permits retired this round based on round 1 performance and buyout pattern; **Buyout Rate X E[Profit]>0** $=$ interaction of **Buyout Rate** and **Expected Buyout Profitability**; **Round 1 Performance** $=$ subject's round 1 performance relative to the median performance across all sessions.

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

E[Profit]>0, an indicator variable equal to 1 if the number of tasks completed in the preceding earning round was greater than the group's median.[11] Importantly, because this variable is defined for subjects in the baseline sessions, it captures the effect of high earnings independent of any buyout-option effect. We therefore interact **E[Profit]>0** with both **Buyout Session** and **Buyout Rate**. With this specification, **Buyout Session** and **Buyout Rate** capture the treatment effect on those "unable" to buyout.

The coefficients we estimate for our base model suggest that the treatment effect does not arise from the buyout offer per se, but rather from the number accepting the offer. When including buyout rate variables in the model, the **Buyout Session** indicator variable captures the effect of the buyout offer on subjects assuming none of the subjects actually accept the buyout. We find no effect here, but do find a strong effect from the buyout rate. Looking at the subjects who expected the offered buyout to be unprofitable, we estimate greater than 5% reduction in effort for every 10 percentage-point increase in the fraction of subjects who buy out (assuming a linear response.) The equal in magnitude but positive coefficient on **Buyout Rate X E[Profit]>0** is consistent with no treatment effect on those who decided not to buy out despite its expected profitability.

The expected net change in retired emission permits due to buyouts might have an influence on the effort chosen by non-buyout subjects. We provided subjects with this information prior to their completing tasks. Suppose, for example, that aggregate permits are expected to fall based on the buyout pattern. Assuming marginal utility decreasing in pollution abated and optimally chosen effort, this change would result in increased effort and thus number of tasks completed.[12] Alternatively, a decrease in the permits provided by others might discourage a subject, inducing her to reduce her effort. In either case, we would be confounding the effect of the buyout itself with its effect on the expected level of public good provided by others. Specification (2) controls for this possibility by including the expected change in aggregate permits (**Expected Permit Change**). Including it in the model makes no difference to our results.

The estimated coefficients from the OLS models are consistent with the *average* change in performance decreasing in the number accepting the buyout. Figure 1 suggests that while the treatment does not greatly affect the likelihood of an increase in output, treatment increases the likelihood of more extreme output drops. As a robustness check we estimate probit models of decreases of 0% and 10% relative to round 1. For each dependent variable, we present in Appendix A estimates for 2 models: one controlling only for environment task and an indicator for the availability of buyouts, and a second with a full suite of controls (Table 9). Coefficient estimates for the first model show that the likelihood of a decrease in environment tasks completed is significantly larger in the treatment sessions than in the baseline. The addition of buyout rate controls offers a nuanced picture. While the likelihood of a large output decrease ($> 10\%$) operates independently of the buyout rate, the likelihood of any decrease in performance depends on the number accepting the buyout. In either case, the increase in shirking likelihood is limited to those in the treatment session who could not afford the buyout.

[11] Estimation results do not qualitatively change when we use continuous measures of expected buyout profitability.

[12] The subject motivated by impure or "warm-glow" altruism (Andreoni 1989) would not necessarily adjust her effort.

5 Robustness Checks: Ruling Out Selection Effects

Our results, which we interpret as a treatment effect, rely on comparing those in the treatment sessions who do not buy out, and especially those who cannot buyout, with subjects in the baseline sessions. The latter cohort, however, includes both those who would and would not have accepted the buyout if offered. If those baseline subjects who would have accepted the buyout were more likely to have larger performance increases (larger δs), then some of what we are attributing to treatment could instead be a result of composition. We now provide evidence suggesting that composition is not driving our results in the current treatment, and then present results from an alternate treatment in which ability to buyout is exogenously determined.

5.1 Buyout Status and Environment-Task Ability

If buyout status is correlated with environment-task ability, then we might observe lower-than-average-ability subjects in the pool of non-buyout subjects.[13] As a result, we may see a larger effort reduction the non-buyout treatment group not because they are responding to the introduction of the buyout by reducing their effort, but because low-ability subjects reduce their effort more than the average subject. To control for this possibility, we include in specification (3) from Table 5 a subject's round-1 performance relative to median round-1 performance. The coefficient on this variable is statistically insignificant and has little effect on the point estimates of the key explanatory variables in the model.

5.2 Subject Characteristics, Buyout Status and Performance

We now investigate whether baseline subjects who might have accepted an offered buyout are more likely to be the baseline subjects who had larger increases in environment tasks completed. In Table 6, we present regression evidence that subject characteristics predicting the acceptance of the buyout in the treatment sessions do not predict performance improvement in the baseline sessions. In models (1) and (2), we look at the buyout decision in treatment sessions. Whether we use the continuous measure of performance in the earning task or the indicator for expected buyout profitability, high earning-task performance increases the likelihood of buying out. Males are more likely to buy out, but no other demographic variable has predictive power. In models (3) and (4), we use the same explanatory variables in probit models of δ_i in the baseline treatment. All coefficients are small and imprecisely estimated.

While the limited number of observations in models (3) and (4) may contribute to insignificance, the results do support the hypothesis that high δs are not more likely to be found in the cohort that would have bought out. Of course, the potential selection problem stems from the fact that subjects in the treatment sessions choose whether to buyout. In the next section, we discuss the results from a second buyout treatment in which some subjects were not offered the buyout option.

[13] Buyouts are highly correlated with earning task performance, and (first) earning task performance is positively correlated with (first) environment task performance (Spearman's $\rho = 0.4285$, $p = 0.000$).

	(1) isBuyout	(2) isBuyout	(3) δ_i	(4) δ_i
Count Round	-0.018	-0.017	4.644	5.952
	(0.112)	(0.102)	(7.459)	(7.508)
Male	0.188*	0.245**	-6.205	-4.952
	(0.108)	(0.095)	(6.654)	(5.612)
Round 1 Performance	0.075	0.177	-26.543	-17.642
	(0.291)	(0.240)	(22.728)	(18.206)
Round 4 Performance	1.115***		31.110	
	(0.327)		(26.002)	
E[Profit]>0		0.243***		12.705
		(0.093)		(10.151)
Observations	64	64	29	29

Table 6: Probit models of (1–2) Buyout in treatment sessions; (3–4) δ_i in baseline sessions.

Independent Variables: **Count Round** = 1 if counting is environment task, else 0; **Male**= 1 if male, else 0; **Round 1 Performance** = subject's round 1 performance relative to the median performance across all sessions; **Round 4 Performance** = subject's round 4 performance relative to the median performance across all sessions. **Buyout Rate X E[Profit]>0** = interaction of **Buyout Rate** and **Expected Buyout Profitability**

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

5.3 The Alternate Buyout Treatment

Our goal in designing the main-treatment buyout was to make the buyout seem fair and reasonable to subjects. Towards this end, we made the buyout available to all subjects, and informed subjects that the monetary contribution of those accepting the buyout largely replaced their effort contribution. We also created an alternate buyout treatment that was designed to seem somewhat unfair.[14] From the perspective of testing for selection effects, the key difference between our main buyout treatment and this alternate design is that we only offered the option to one half of each treatment group chosen at random, with the same subjects offered the option in the two buyout rounds. As a result, while those offered the option have a choice, we do not need to worry about selection when looking at the cohort not offered the option.

Buyout Accepted:			**N**	**Y**
Buyout Offered:	**N**	**Y**	**Y**	**Y**
Environment Task Index	1.045	1.042	1.036	1.043
	(0.236)	(0.164)	(0.162)	(0.168)
Earning Task Index	1.034	0.962	1.050	0.937
	(0.170)	(0.168)	(0.154)	(0.167)
Buyout in Round 3	0.000	0.677	0.286	0.792
	(0.000)	(0.475)	(0.488)	(0.415)
n	30	31	7	24

Table 7: Alternate Treatment: Subject characteristics (means and standard deviations) by round-5 buyout status.

Sixty-one subjects participated in the alternate treatment. Table 7 details subject characteristics by buyout status. First, those offered the buyout do not significantly differ from those who do not receive the option. Comparing the offered and not-offered groups, there is no significant difference in either task index (p=0.574 and p=0.160). Further, amongst those offered the buyout, those accepting the buyout do not significantly differ from those who do not accept it in terms of task performance. Comparing the accept and not-accept groups, there is no significant difference in either task index (p=0.795 and p=0.150). However, compared to those who did not buy out in round 5, those who bought out in round-5 were more likely to have bought out in round 3 (p=0.013). We also note that, as in the main treatment, there is heterogeneity between groups in the number who buyout, with round-5 buyout rates ranging from 12.5% to 57.1%.[15]

5.3.1 Effect of Buyouts on Effort Contributions

In Figure 2, we present, for the baseline and both buyout treatments, cumulative distribution functions of the percent change in tasks completed relative to round 1 ($\delta_i/\text{Tasks}_{1i}$). Like the baseline

[14]The treatment differs in a number of ways. In lieu of a fixed buyout fee, the fee in alternate treatment was one-half of subject earnings. As a result, the buyout fee did not replace the effort contribution of those accepting the buyout.

[15]Four subjects bought out in a group of 7.

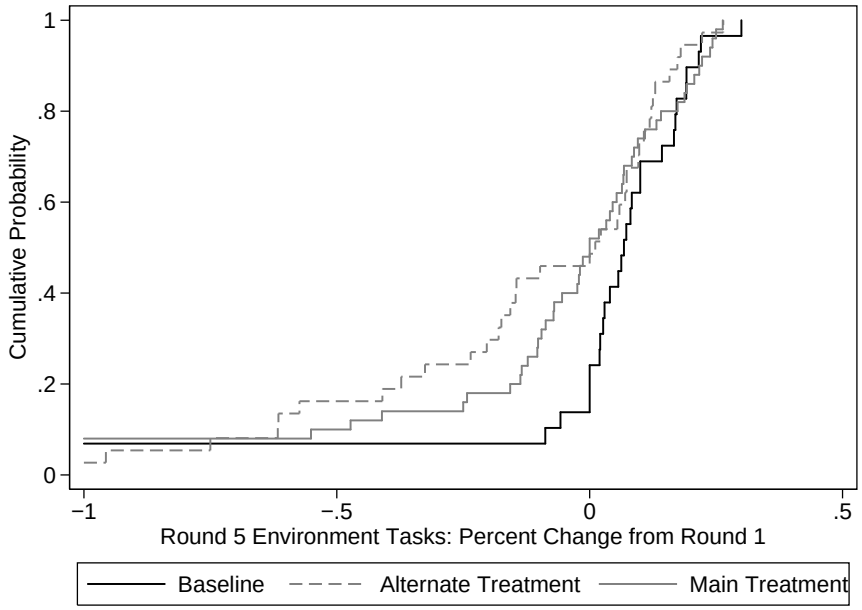

Figure 2: CDFs (by treatment) of percent change in Round 5 environment tasks. (Excludes subjects accepting Round 5 buyout.)

and main-treatment sessions, we see a significant portion of alternate-treatment subjects increasing output from round 1 to 5, with 27% increasing by 10%. However, we see an even more pronounced treatment effect, with over 43% of non-buyout subjects registering output decreases of at least 10%.

Formal testing of the differences between baseline and the alternate treatment sessions is similar to the results comparing baseline and main treatment. The average decrease environment tasks from round 1 to 5 was $\bar{\delta} = -7.1$. This is weakly different than the baseline session ($p = 0.062$). However, whereas the subject who did not accept the alternate-treatment buyout completed 6.1 more tasks, the subject not offered the alternate-treatment buyout completed 10.2 fewer tasks, significantly less than in the baseline ($p = 0.009$).

In Table 8, we present estimates of OLS models of δ_i. Observations include baseline sessions and subjects who do not buyout in round 5 of an alternate-treatment session. In model (1), in addition to **Count Round**, we include only indicator variables capturing whether the alternate-treatment subject was not able to buyout or chose not to buyout. We estimate that compared to baseline subjects, those not offered the buyout significantly decrease output, whereas those who complete environment tasks in round 5 because they turned down the offer weakly increase output. In the second model, we interact these variables with the buyout rate. The estimates suggest that while the increase amongst those who decline the buyout is independent of the number who accept the offer, the decrease amongst those not receiving the offer comes not from the offer *per se*, but similar to the main treatment it rather comes through the fraction accepting the offer.

	(1)	(2)
Count Round	1.744	4.211
	(4.489)	(4.454)
Buyout Not Offered	-10.40**	10.30
	(4.904)	(6.917)
Buyout Not Accepted	6.296*	9.652**
	(3.724)	(4.408)
Not Offered X Buyout Rate		-0.525***
		(0.183)
Not Accepted X Buyout Rate		-0.116
		(0.100)
Constant	-0.652	-2.013
	(4.319)	(4.364)
Observations	66	66

Table 8: OLS models of $\delta_i = \text{Tasks}_{5i} - \text{Tasks}_{1i},\ i \in$ subjects who do not accept buyout, robust standard errors in parentheses.

Independent Variables: **Count Round** $= 1$ if counting is environment task, else 0; **Buyout Not Offered** $= 1$ if subject not offered buyout, else 0; **Buyout Not Accepted** $= 1$ if subject did not accept offered buyout, else 0; **Round 1 Performance** $=$ subject's round 1 performance relative to the median performance across all sessions; **Round 4 Performance** $=$ subject's round 4 performance relative to the median performance across all sessions. **Buyout Rate X E[Profit]>0** $=$ interaction of **Buyout Rate** and **Expected Buyout Profitability**

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

6 Conclusion and Discussion

If the fact that Mr. Gore chooses to avail himself of market-based solutions to environmental problems results only in hurt feelings, then perhaps there is little to worry about. If these choices result in measurable changes in aggregate contributions to public goods, then they have the potential to alter the effectiveness of policy interventions.

We design an experiment to test the hypothesis that some of those providing effort contributions to a public good reduce their effort when others contribute money in lieu of effort. Our baseline environment without buyouts elicited continued effort contributions. While the surprise introduction of a buyout option did not have an immediate effect,[16] we find that our buyout treatment decreased output in the second buyout round. We find heterogenous effects, and their pattern supports our preferred explanation. First, while those who decline the buyout despite its profitability do not decrease effort contributions, many of those who cannot buyout respond by shirking. Second, the decreased effort contribution depends not on the availability of the option *per se*, but rather on the number of group members accepting the offer, a pattern of behavior that would be difficult to explain using existing theories in the motivational crowding literature.

While our experiment environment captures many of the salient aspects of real world buyout options, real-world environments will vary significantly, and we were thus forced to make a number of design choices. We consider how some of these differences between our environment and particular buyout opportunities might affect outcomes.

First, subjects likely felt little group identity and varied in their intrinsic concern for the public good. It is unclear whether changing these aspects would strengthen or weaken the effects found in the laboratory. For example, while increased group identity (or commitment to the public good) might increase the sting of others replacing effort with money, increased weight on the group's welfare might steel resolve despite this sting.[17]

Characteristics of the public-good effort task may well affect willingness to reduce effort contributions when others replace effort with money. Our laboratory tasks were solitary and separable (i.e., there was neither group-member interaction nor effort complementarities). Furthermore, subjects reported little intrinsic motivation to complete the tasks, and performance — both in terms of number of tasks and ultimate greenhouse-gas reduction — was measurable. Differences in any of these dimensions will plausibly affect willingness to continue to contribute an effort contribution to the public good while others contribute otherwise.

In many real-world opportunities for effort contributions to public goods, an individual's effort choice will be public. People may use public participation and effort choice to signal attributes such as caring for the environment (Bénabou and Tirole 2006). This signal may be more clear from a person who has publicly passed up an opportunity to buyout of the prosocial effort, which may somewhat mitigate the strong effect we find in the laboratory.

[16] Other studies (e.g., Cooper and Stockman 2002) also find that fairness concerns do not necessarily manifest themselves immediately, but rather may take experience to learn.

[17] In fact, Chen and Li (2009) find experimental evidence that subjects are less likely to punish in-group members for misbehavior.

Another aspect of our experiments that deserves further consideration is the fact that those accepting the buyout were able to earn money as the alternative activity. One possibility is that — to the extent that market-based mechanisms highlight or exacerbate pre-existing inequality — an aversion to income inequality might underlie objections to their use. The notion that people care about their relative consumption in addition to their absolute level of consumption has a long history in economics (Duesenberry 1949), and the public policy implications of this hypothesis have been well studied (e.g., Boskin and Sheshinski 1978, Layard 1980, Persson 1995, Carroll, Overland and Weil 1997). Thus, due to the increased earning inequality introduced by the buyout in our experiment, we cannot rule out the possibility that inequity aversion contributed to our treatment effect.[18] We note, however, the while concern for inequality is plausible as a reason to oppose the use of markets, why it should be linked to the crowding effect we observe is far less clear, as reduced effort does nothing to reduce inequality. Furthermore, there is evidence suggesting that wealth and income inequality need not adversely affect voluntary contributions to public goods (Buckley and Croson 2006).

A second possibility is that earning money in lieu of contributing effort to the public good might have a more direct effect: it may simply be aggravating to non-buyout subjects that some are earning money while others are expected to contribute their labors to the public good. In other contexts, someone accepting a buyout may be doing something "better" with his time, such as caring for a family member, which may mitigate the perceived injustice.

[18]While we did not share the earnings of those who did buyout, it is clear in the alternate-treatment sessions that subjects buying out made money. In the main-treatment sessions it would be reasonable for subjects to infer both that the higher earners were more likely to buyout and these already high earners would be making more money.

References

Alexander, Keith L., "Outsourcing the Picket Line," *The Washington Post*, July 24, 2007.

Andreoni, James, "Giving with Impure Altruism: Applications to Charity and Ricardian Equivalence," *The Journal of Political Economy*, December 1989, *97* (6), 1447–1458.

____ **and Lise Vesterlund**, "Which is the Fair Sex? Gender Differences in Altruism," *Quarterly Journal of Economics*, 2001, *116* (1), 293–312.

Bem, Daryl J., "An Experimental Analysis of Self-Persuasion," *Journal of Experimental Social Psychology*, August 1965, *1* (3), 199–218.

____ , "Self-Perception: An Alternative Interpretation of Cognitive Dissonance Phenomena," *Psychological Review*, May 1967, *74* (3), 183–200.

Bénabou, Roland and Jean Tirole, "Intrinsic and Extrinsic Motivation," *Review of Economic Studies*, July 2003, *70* (3), 489–520.

____ **and** ____ , "Incentives and Prosocial Behavior," *American Economic Review*, December 2006, *96* (5), 1652–1678.

Bolton, Gary E. and Axel Ockenfels, "ERC: A Theory of Equity, Reciprocity, and Competition," *American Economic Review*, March 2000, *90* (1), 166–193.

Boskin, Michael J. and Eytan Sheshinski, "Optimal Redistributive Taxation When Individual Welfare Depends upon Relative Income," *Quarterly Journal of Economics*, November 1978, *92* (4), 589–601.

Brekke, Kjell Arne, Snorre Kverndokk, and Karine Nyborg, "An Economic Model of Moral Motivation," *Journal of Public Economics*, September 2003, *87* (9–10), 1967–1983.

Brüggen, Alexander and Martin Strobel, "Real effort versus chosen effort in experiments," *Economics Letters*, 2007, *96* (2), 232–236.

Buckley, Edward and Rachel Croson, "Income and wealth heterogeneity in the voluntary provision of linear public goods," *Journal of Public Economics*, May 2006, *90* (4–5), 935–955.

Carroll, Christopher D., Jody Overland, and David N. Weil, "Comparison Utility in a Growth Model," *Journal of Economic Growth*, December 1997, *2* (4), 339–367. 10.1023/A:1009740920294.

Chan, Kenneth S., Stuart Mestelman, Rob Moir, and R. Andrew Muller, "The Voluntary Provision of Public Goods under Varying Income Distributions," *Canadian Journal of Economics*, February 1996, *29* (1), 54–69.

Chan, Kenneth, Stuart Mestelman, Robert Moir, and R. Muller, "Heterogeneity and the Voluntary Provision of Public Goods," *Experimental Economics*, August 1999, *2* (1), 5–30.

Charness, Gary and Matthew Rabin, "Understanding Social Preferences with Simple Tests," *Quarterly Journal of Economics*, August 2002, *117* (3), 817–869.

Chen, Yan and Sherry Xin Li, "Group Identity and Social Preferences," *American Economic Review*, March 2009, *99* (1), 431–457.

Cooper, David J. and Carol Kraker Stockman, "Fairness and Learning: An Experimental Examination," *Games and Economic Behavior*, October 2002, *41* (1), 26–45.

Duesenberry, James Stemble, *Income, Saving and the Theory of Consumer Behaviour*, Cambridge, MA: Harvard University Press, 1949.

Ellingsen, Tore and Magnus Johannesson, "Time is not money," *Journal of Economic Behavior & Organization*, October 2009, *72* (1), 96–102.

Fehr, Ernst and Armin Falk, "Psychological foundations of incentives," *European Economic Review*, May 2002, *46* (4-5), 687–724.

____ **and Klaus M. Schmidt**, "A Theory of Fairness, Competition, and Cooperation," *Quarterly Journal of Economics*, August 1999, *114* (3), 817–868.

Ferrer-i-Carbonell, Ada, "Income and well-being: an empirical analysis of the comparison income effect," *Journal of Public Economics*, 2005, *89* (5-6), 997 – 1019.

Fischbacher, Urs, "z-Tree: Zurich Toolbox for Ready-made Economic Experiments," *Experimental Economics*, June 2007, *10* (2), 171–178.

Frey, Bruno S. and F. Oberholzer-Gee, "The Cost of Price Incentives: An Empirical Analysis of Motivation Crowding-Out," *American Economic Review*, 1997, *87* (4), 746–755.

____ **and Reto Jegen**, "Motivation Crowding Theory: A Survey of Empirical Evidence," *Journal of Economic Surveys*, December 2001, *15* (5), 589–611.

Gächter, Simon, "Conditional Cooperation: Behavioral Regularities from the Lab and the Field and Their Policy Implications," in Bruno S. Frey and Alois Stutzer, eds., *Economics and Psychology: A Promising New Cross-Disciplinary Field*, CESifo Seminar Series, Cambridge, MA: MIT Press, 2007, chapter 2, pp. 19–50.

Gneezy, Uri and Aldo Rustichini, "A Fine Is a Price," *Journal of Legal Studies*, January 2000, *29* (1), 1–17.

____ **and** ____ , "Pay Enough or Don't Pay at All," *Quarterly Journal of Economics*, August 2000, *115* (3), 791–810.

Greiner, Ben, "An Online Recruitment System for Economic Experiments," in Kurt Kremer and Volker Macho, eds., *Forschung und wissenschaftliches Rechnen 2003*, Vol. 63 of *GWDG-Bericht*, Göttingen, Germany: Gesellschaft für wissenschaftliche Datenverarbeitung mbh, 2004, pp. 79–93.

Heal, Geoffrey, "A Celebration of Environmental and Resource Economics," *Review of Environmental Economics and Policy*, Winter 2007, *1* (1), 7–25.

Humphrey, Mark, "Group says Gore's home overuses electricity," *USA Today*, February 27, 2007.

Isaac, R. Mark and James M. Walker, "Communication and Free-Riding Behavior: The Voluntary Contribution Mechanism," *Economic Inquiry*, October 1988, *26* (4), 585–608.

Layard, R., "Human Satisfactions and Public Policy," *The Economic Journal*, 1980, *90* (360), 737–750.

Linardi, Sera and Margaret A. McConnell, "No excuses for good behavior: Volunteering and the social environment," *Journal of Public Economics*, June 2011, *95* (5-6), 445–454. Charitable Giving and Fundraising Special Issue.

Mellström, Carl and Magnus Johannesson, "Crowding Out in Blood Donation: Was Titmuss Right?," *Journal of the European Economic Association*, June 2008, *6* (4), 845–863.

Persson, Mats, "Why Are Taxes So High in Egalitarian Societies?," *The Scandinavian Journal of Economics*, 1995, *97* (4), 569–580.

Rousseau, Jean-Jacques, *The Social Contract* 1762.

Sandel, Michael J., "It's Immoral to Buy the Right to Pollute," *The New York Times*, December 15, 1997.

Sugden, Robert, "Reciprocity: The Supply of Public Goods Through Voluntary Contributions," *The Economic Journal*, December 1984, *94* (376), 772–787.

Titmuss, Richard Morris, *The Gift Relationship: From Human Blood to Social Policy*, London, UK: Allen & Unwin, 1970.

Vilares, Iris, Gregory Dam, and Konrad Kording, "Trust and Reciprocity: Are Effort and Money Equivalent?," *PLoS ONE*, 02 2011, *6* (2), e17113.

Younge, Gary, "Are you feeling cooperative?," *The Guardian*, 2006.

	(1) $\%\delta_i < 0$	(2) $\%\delta_i < 0$	(3) $\%\delta_i < -.1$	(4) $\%\delta_i < -.1$
Count Round (d)	-0.092	-0.045	0.003	-0.001
	(0.111)	(0.125)	(0.090)	(0.030)
Buyout Session (d)	0.341***	0.119	0.231***	-0.030
	(0.096)	(0.220)	(0.081)	(0.070)
Buyout Rate		0.019**		0.003
		(0.008)		(0.002)
E[Profit]>0 (d)		-0.018		-0.776***
		(0.262)		(0.082)
Buyout Session X E[Profit]>0 (d)		0.106		0.996***
		(0.364)		(0.002)
Buyout Rate X E[Profit]>0		-0.022**		-0.003
		(0.011)		(0.003)
Expected Permit Change		-0.715		-0.367
		(0.990)		(0.269)
Round 1 Performance		0.002		0.075
		(0.372)		(0.115)
Observations	79	79	79	79

Table 9: Probit models of output reductions, reporting marginal probabilities with robust standard errors in parentheses.

Dependent Variables: $\frac{\delta_i}{Tasks_{1i}} < 0, -.1, and -.2; i \in$ subjects who do not accept buyout.

Independent Variables: **Count Round** $= 1$ if environment task is counting task this round, else 0; **Buyout Session** $= 1$ if buyout is offered this session, else 0; **Expected Buyout Profitability** $= 1$ if subject expected to profit from buyout based on round 4 performance, else 0; **Expected Aggregate Permit Change** $=$ expected change in the aggregate permits retired this round based on round 1 performance and buyout pattern; **Buyout Rate** $=$ proportion of group that accepted the buyout this round; **Buyout-Profitability Interaction** $=$ interaction of **Buyout Rate** and **Expected Buyout Profitability**; **Round 1 Performance** $=$ subject's round 1 performance relative to the max performance across all sessions.

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

B Session Instructions

Introduction

- You are about to participate in a session in which you will complete tasks at a computer. This is part of a study intended to provide insight into certain features of decision processes. I encourage you to follow the instructions carefully. You will be paid in cash at the end of the session.
- *During the session, I ask that you please do not talk to or otherwise communicate with (e.g., text messaging) each other.* If you have a question, please raise your hand and a session moderator will assist you.
- In consideration for others in the session, we do ask that you take a moment to make sure that the ringer on your cell phone is off.
- Your computer screen should have two open windows: an internet browser and a "Welcome to z-Leaf" window. If these two windows are not open on your screen, please raise your hand.
- During the session, you are free to use the internet browser on your computer. The session monitor will inform you when you are required to respond to the z-Leaf window.
- You should have a pen and two blank sheets of paper at your workspace. Please check to make sure the pen works. If you do not have these items, or if your pen does not work, please raise your hand.
- During this session, you are going to be assigned to a group. In some parts of this experiment, you and your group members will have the opportunity to complete computer-based tasks for the environment, where more tasks completed will lead to larger reductions in greenhouse-gas emissions, believed by most scientists to be a leading contributor to global warming. Before continuing with the more detailed session instructions, we would like to give you an idea of how this will work.
- **According to the Intergovernmental Panel on Climate Change:** Global atmospheric concentrations of greenhouse gas emissions have increased markedly as a result of human activities. Scientists have very high confidence that this process has caused increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising sea levels. The likely range for warming by the end of the 21st century is between 5 and 14 degrees F. The effects will last for centuries due to the long-lived nature of emissions. The longer-term magnitude of these effects and the impacts on different regions of the planet are less certain but will likely include widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones. While some changes might be beneficial (like

longer growing seasons for agriculture), on balance scientists believe these changes will be damaging to humans. There is also some small risk that there could be catastrophic impacts, such as major reductions in polar ice that could result in approximately 15-20 feet of sea level rise.

- The tasks you and your group complete in the **Environment Rounds** directly reduce greenhouse gas emissions. The European Union Emission Trading System, which came into effect in 2005, caps the number of tons of greenhouse gas emissions EU member countries may produce in any year. In order to emit greenhouse gases, a polluter needs a permit, with the total number of permits equal to the total number of tons allowed. Based on the number of tasks you and your group complete in Environment rounds, session sponsors will purchase the appropriate number permits. We will retire these permits. That is, we will not sell these permits to emit greenhouse gases, and thus the number of tons of greenhouse gases emitted will decrease by this amount. Therefore, your effort in Environment rounds directly reduces greenhouse gas emissions.
- Driving a mid-size car from Palm Beach, FL to Williamstown, MA produces the equivalent of approximately .7 tons of carbon dioxide, a greenhouse gas.

Procedures

- At the start of the session, the computer randomly assigns one-half of participants to the Blue group and one-half to the Purple group. You remain in the same group for the entire session.
- This session will proceed in a series of 5-minute rounds.
- In **Environment Rounds**, you are presented with counting tasks in your z-Leaf window. At the end of the round, the computer adds up the number of tasks completed by members of your group. For each 200 counting tasks, the session sponsors will purchase and retire a permit to emit one ton of carbon dioxide, directly reducing global greenhouse-gas emissions by that amount. (If the total is not divisible by 200, the appropriate fraction of a permit will be purchased.)
- In **Earning Rounds**, you are presented with encryption tasks in your z-Leaf window. At the end of the session, you receive a cash payment of $0.10 (10 cents) for each encryption task you complete.
- **The Encryption Task:** In your z-Leaf window, there will be a table translating each letter of the alphabet into a unique 2-digit number. This table remains the same for the round. For each task, your monitor presents you with 2 letters. You complete a task by translating the 2 letters into their numeric equivalent, entering the correct 4 numbers (without spaces) into a box on your monitor, and clicking the **OK** button. Once you have entered the correct 4 numbers, your monitor presents you with the next 2 letters.

- **The Counting Task:** For each task, your z-Leaf window presents you with a table with 4 rows and 4 columns with either a 0 or 1 in each position. You complete a task by counting the number of zeros, entering the correct number into a box on your monitor, and clicking the **OK** button. Once you have entered the correct number of zeros, your z-Leaf window presents you with the next table.
- At the start of each round, your z-Leaf window will inform you whether the round is an Environment Round or an Earning Round.
- At the end of each Earning Round, your z-Leaf window will display the number of encryption tasks you completed and the amount of money you earned.
- At the end of each Environment Round, your z-Leaf window will display the number of counting tasks completed by you and your group as a whole. It will also display the number of tons greenhouse gas emissions your group has prevented.
- The experiment will start with two one-minute practice rounds (one encryption and one counting). The purpose of the practice rounds is to give you an opportunity to familiarize yourself with the computer interface. You will not earn money in the practice rounds, nor will greenhouse gas permits be purchased.
- At the end of the experiment, I will pay you, in cash, your participation fee plus your earnings from all Earning Rounds. I will also provide you with a web address where you may verify the purchase of greenhouse gas permits that your group earned. At the end of the calendar year, you may verify that all of the permits have been retired (that is, none have been resold).
- Are there any questions?

B.1 Buyout Instructions

You and everyone in your Group will be offered a Buyout Option this round.
Please read carefully.

- If you accept the **Buyout Option**, you pay a **Buyout Fee**: a flat fee which session sponsors will use to purchase and retire as many greenhouse gas permits as possible.
- If you accept the Buyout Option, your computer will present you with earning (encryption) tasks. The amount you would receive per completed encryption task may be different than in regular Earning Rounds. If you accept the Buyout Option, your earnings, which may be negative, would be the number of encryption tasks you complete times the amount per completed encryption task, minus the Buyout Fee.
- All members of your group are offered the same Buyout Fee, which you would pay only if you accept the Buyout Option. Also,all members of your group will be offered the same number of cents per completed encryption task.

- The Buyout Fee has been calculated to replace the average number of permits produced in the first Environment Round. Thus, if your 8 group members retired a total of 8 pollution permits in the first Environment Round, the calculated Buyout Fee will be exactly equal to the price of 1 pollution permit.
- If you do not accept the Buyout option, your Environment Round proceeds as usual. Your computer presents you with counting tasks, with the session sponsor purchasing and retiring 1 ton of greenhouse gas emissions for each 200 tasks.
- At the end of the round, the computer adds up:
    1. all Environments tasks completed by group members not accepting the Buyout option, with the session sponsor purchasing and retiring a permit for 1 ton of greenhouse gas emissions for each 200successfully completed Environment tasks; and
    2. the Buyout Fees collected from group members accepting the Buyout Option, with the session sponsor using these fees to retire as many greenhouse gas permits as possible.
- On the next screen, your monitor will display information which may be helpful in deciding whether to accept the Buyout Option:
    - the Buyout Fee;
    - the amount you will receive per encryption task if you accept the Buyout option;
    - your earnings if you complete as many encryption tasks as last round;
    - the number of greenhouse gas permits retired if you pay the Buyout Fee; and
    - the number of greenhouse gas permits retired as a result of the number of counting tasks you personally completed in the first Environment Round.
- Are there any questions?