The Impact of Endowment Effects on Public Good Contributions

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Abstract

Prior research has yet to adequately explore the role of endowment effects in decision-making. To this end, this research paper investigates the importance of how endowments are distributed to subjects over time in the context of a public goods game setting. Using the voluntary contribution (VCM) game, several treatments are considered, each with a unique endowment distribution scheme. The treatments that provide the greatest opportunity for over-contribution to the public good are predicted to generate the highest levels of contribution while the treatments that provide the lowest opportunity for over-contribution are predicted to generate the lowest levels of overall contribution. The opportunity for over-contribution is a function of whether allocation decisions are binding or not and the size of effective endowment, with binding decisions and/or greater effective endowment increasing the opportunity for over-contribution. The actual frequency distributions of total contributions for each treatment as well as the Wilcoxon rank-sum tests conducted on these frequency distributions provides evidence of the basic behavioral hypothesis; the higher the opportunity for over-contribution, the greater the overall level of contribution. Analyses of per-period contributions as well as individual decision-making add further support to these basic conclusions.

1. INTRODUCTION

The voluntary contribution mechanism (VCM) game is frequently used to investigate collective action in a public goods environment. Rational choice theory predicts that subjects won't contribute to the public good account, instead choosing to free-ride on the contributions of others (Olsen, 1965). However, historical evidence from experimental VCM games finds the converse: subjects typically allocate a nonzero amount to the public good account, although these contributions tend to decay over time.[1] Furthermore, prior research has identified several, key determinants of contribution levels in the VCM setting, including the marginal per capita return (MPCR) from the group account[2] and the size of endowment,[3] with an increase in either factor generating higher contribution levels. Additional areas of the literature have found that the implementation of punishment/sanctioning mechanisms[4] or

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[1] For surveys of the literature, see Davis & Holt (1993), Ledyard (1995), Offerman (1997), Ostrom (2000), and Holt (2007).

[2] For instance, see Marwell and Ames (1979), Isaac et al. (1984), Isaac and Walker (1988a), Isaac et al. (1994), Fisher et al (1995), Dickinson (1998), Laury et al. (1999), Goeree et al. (2002), and Cadigan et al. (2011).

[3] For instance, see Rapoport (1988), Van Dijk & Grodska (1992), Chan et al. (1999), Clark (2002), Cherry et al. (2005), Buckley & Croson (2006), Hofmeyr et al. (2007), De Cremer & Van Dijk (2009), Muehlbacher & Kirchler (2009), and Spraggon & Oxoby (2009).

[4] For instance, see Ostrom et al. (1992), Dickinson and Isaac (1998), Fehr and Gächter (2000), Dickinson (2001), Masclet et al. (2003), Walker & Halloran (2004), Egas and Riedl (2005), Cinyabuguma et al. (2005), Page et al. (2005),

the presence of pre-play communication[5] can also successfully raise contribution levels.

Despite these efforts, previous research has yet to fully explore the impact of endowment effects on subject behavior in a public goods setting such as the VCM game. While prior research on endowment effects has investigated the influence of endowment heterogeneity between subjects[6] and endowment origin[7] on subject behavior, it hasn't considered the importance of how endowments are distributed to subjects over time. As such, the primary purpose of this paper is to examine the impact of different endowment distribution schemes on the contribution decisions of subjects in a public goods game setting, with the primary contribution of this research to the literature being both the analysis herein and its implications for the successful provision of public goods. The remainder of the paper is organized as follows: section two details the experimental design, section three presents the behavioral hypotheses, section four discusses the experimental results, and section five concludes.

2. EXPERIMENTAL DESIGN AND PROCEDURE

In the basic VCM game, subjects in groups of size *n* are each individually endowed with a number of tokens that may either be allocated to a group account or a private account. The marginal per capita return (MPCR) from the group account is non-excludable, meaning that all subjects receive the return regardless of their allocation decision, and non-rival, meaning that all subjects receive the same return. The MPCR from the group account is generally lower than the MPCR from the private account. Under these parameters, the Nash equilibrium prediction is for all subjects to allocate

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Anderson & Putterman (2006), Bochet et al. (2006), Gurerk et al. (2006), Carpenter (2007), Sefton et al. (2007), Ones and Putterman (2007), Nikiforakis(2008), Nikiforakis & Normann (2008), and Ertan et al. (2009).

[5]For instance, see Dawes et al. (1977), Isaac and Walker (1988b), Palfrey & Rosenthal (1991), Ostrom et al. (1992), Sally (1995), Wilson & Sell (1997), Brosig et al. (2003), Rege & Telle (2004), Bochet et al. (2006), and Chaudhuri (2006).

[6]For instance, see Rapoport (1988), Van Dijk & Grodska (1992), Chan et al. (1999), Cherry et al. (2005), Buckley & Croson (2006), Hofmeyr et al. (2007), De Cremer & Van Dijk (2009).

[7]For instance, see Clark (2002), Cherry et al. (2005), Muehlbacher & Kirchler (2009), Spraggon & Oxoby (2009).

zero tokens to the group account, producing the common free-riding dilemma. In sharp contrast, the socially efficient equilibrium is for all subjects to allocate all tokens to the group account. The presence of multiple periods doesn't change either equilibrium.

This basic VCM game framework was adopted to examine the impact of different endowment distributions on subject decision-making. Specifically, in every treatment, subjects were randomly placed into groups of four subjects, with the identities of group members kept unknown. The groups remained the same throughout the entire 10 period duration of the experiment. At the end of each period, subjects were notified of their contribution to the group account as well as total contribution to the group account. The MPCR from the private account and the group account were also kept constant across all treatments: subjects received 1 experimental dollar (ED) for each token they allocated to the private account and 1/2 ED for each token allocated to the group account, whether or not they contributed to the group account. At the end of the experimental session, the EDs were exchanged for real dollar compensation at a rate of $0.10 per 1 ED. The total endowment (100 tokens) remained fixed across all treatments, although the distribution scheme varied.

Despite varying distribution schemes, the Nash equilibrium prediction and socially efficient equilibrium outcome remain the same across all of the experimental treatments. Therefore, given that the total endowment remains constant at 100 tokens in all treatments, each subject earns 100 ED at the Nash equilibrium and 200 ED at the socially optimal equilibrium over the entire 10 periods. In this way, societal outcomes closer to the social optimum are defined as more economically efficient, as evidenced by the improved wellbeing of subjects (in terms of ED).

2.1. Baseline

In the baseline treatment, subjects were endowed with 10 experimental tokens (W_i) at the beginning of every period. The effective per-period endowment to a subject in period t ($w_{i,t}$) of the baseline can be expressed as:

$$w_{i,t} = W_i$$

In each period, subjects decided independently and simultaneously how to allocate these tokens between the group account (C_i) and the private account($W_i - C_i$). At the end of each round, subjects were informed of their contribution to the group account as well as the total contribution to the group account ($\sum_{i=1}^{4} C_i$). Per-token-returns from the private account of 1 ED and from the group account of 1/2 ED results in the following per-period-earnings formula for each subject(expressed in ED):

$$\pi_i = (W_i - C_i) + 0.5\sum_{i=1}^{4} C_i$$

2.2. Carryover

In the carryover treatment, subjects received 10 experimental tokens each period, similar to the baseline treatment. Each subject then decided how to allocate these tokens between the group account and the private account. Importantly, any tokens allocated to the private account were available for reallocation to the group account in all subsequent periods. As a result, the effective endowment for a subject in all periods beyond period 1 consisted of 10 tokens as well as all tokens currently allocated to the private account. In this way, the precise per-period endowment to subjects varied according to past allocation decisions, with effective endowment in period t expressed as:

$$w_{i,t} = W_{i,t} + \sum_{k=1}^{t-1}(W_{i,k} - C_{i,k})$$

where $\sum_{k=1}^{t-1}(W_{i,k} - C_{i,k})$ represents the sum of contributions to the private account in all previous periods. Note, this formula only applies to effective endowment for $t > 1$; the first period endowment of 10 tokens is unaffected by the carryover treatment.

Unfortunately, there is no effective way to develop a per-period-earnings formula for subjects in this treatment since tokens allocated to the private account could always be reallocated to the group account in a future period. Only the returns from the group account could be calculated on a per-period basis. Instead, the per-period earnings equation can be reinterpreted, in the context of the carryover treatment, as a total earnings equation expressed as follows:

$$\hat{\pi}_i = (\widehat{W}_i - \hat{C}_i) + 0.5\sum_{i=1}^{4} \hat{C}_i$$

where the hat indicates that the variable represents a total (e.g. total profits, total endowment, total subject contribution to the group account, and total group contribution to the group account).

2.3. Full Endowment

In the full endowment treatment, subjects were endowed with the full 100 tokens at the beginning of the first period and received no further endowments in the remaining periods. In each period, subjects decided how many tokens to allocate between the group account and the private account. Any tokens allocated to the private account would be available for reallocation to the group account in every subsequent period. As a result, the effective per-period endowment in period t depended on the past allocation decisions in periods 1 to t-1. Accordingly, one can express the effective endowment in period t as:

$$w_{i,t} = \widehat{W}_i - \sum_{k=1}^{t-1} (C_{i,k})$$

where $\widehat{W}_i$ is equal to the lump-sum endowment in period 1 and $\sum_{i=1}^{t-1}(C_{i,t})$ represents the sum of contributions to the group account by subject i in all preceding periods.

Again, because of the design of this treatment, it is not possible to construct a per-period earnings equation. Instead, refer to the total earnings equation derived in the carryover treatment.

2.4. Pledge

In the pledge treatment, subjects were endowed with all 100 tokens in the first period, receiving no other endowments for the rest of the periods, similar to the full endowment treatment. At the beginning of each period, subjects allocated tokens between the group account and the private account. Any tokens allocated to the private account could be reallocated to the group in the following periods. Additionally, subjects were given the option at the end of each period to reallocate tokens from the group account to the private account, the only treatment in which this action was possible. Thus, the initial contribution to the group account by subject i represents a pledge, which can later be reneged. Since subjects could freely reallocate tokens between the group account and the private account in all rounds, the effective endowment of each subject in period t can be expressed simply as:

$$w_{i,t} = \widehat{W}_i$$

As such, only the allocation after the last round mattered in the determination of subject earnings, which can be similarly defined according to the total profits equation derived earlier.

2.5. Procedures

All participants were recruited from a list of currently enrolled students at Gettysburg College using the Gettysburg College email system. Overall, one hundred and thirty-six students participated in nine sessions across four treatments. The participants possessed different cultural and academic backgrounds, potentially including economics. The same individual conducted all of nine sessions using the z-Tree software (Fischbacher, 2007).

Participants were instructed via email to arrive at a designated laboratory location whereupon they were seated in partitioned desks containing instructions and a computer. The instructions (see Appendix A) outlined the procedures of the experimental treatment while the computers were used to connect to a host computer running the z-Tree software. The subjects were monitored via an observation room throughout the duration of the experiment. Upon conclusion of the experimental session, subjects were individually called to receive compensation. Experimental sessions typically lasted 45 minutes, including time spent reading instructions. Participant compensation ranged from $5.85-$21.75, with an average compensation of $14.98. The number of subjects per treatment and the average compensation per treatment can be found in Table I.

Table 1

Subjects per treatment		
Treatment	**Number of subjects**	**Average compensation**
Baseline	28	$14.83
Carryover	40	$15.89
Full Endowment	36	$15.26
Pledge	32	$13.64

3. BEHAVIORAL HYPOTHESES

As a function of the basic structure of the VCM game, subjects are only able to contribute nonnegative amounts to the group account. As a result, subjects are unable to recoup losses associated with positive, albeit suboptimal, contributions to the group account in previous periods (relative to Nash equilibrium). Given that the typical decay in contributions in a VCM game is often interpreted as evidence of subjects learning to free-ride, unfamiliarity with the VCM game in early periods may generate greater contributions than would otherwise be present (Andreoni, 1988). Therefore, the endowment distribution schemes which provide subjects with the greatest opportunity for over-contribution, relative to Nash equilibrium, before they learn how to free-ride should lead to the highest contribution levels and, therefore, the greatest economic efficiency.

The opportunity for over-contribution consists of two aspects: whether subject allocation decisions are binding or non-binding, and whether the effective endowment to subjects is relatively large or small. Non-binding allocations decisions are those decisions that don't affect earnings outcomes for subjects. These decisions lower the potential for over-contribution because subjects are provided the chance to learn about the game without having to forgo any profits by mistakenly contributing to the group account. Binding allocation decisions are the opposite, meaning there are costs to subjects associated with learning about the game, in the form of contributions to the group account. Effective endowment, whether large or small, affects the opportunity for over-contribution by influencing the number of tokens available to subjects for allocation. If subjects are provided with a relatively large effective endowment, the opportunity for over-contribution would rise because subjects have more tokens to potentially misallocate, especially in the early periods when subjects are most unfamiliar with the game.

Following this behavioral intuition, the baseline, carryover, and full endowment treatments should produce higher levels of contributions to the group account than the pledge treatment. While the allocation decisions in the baseline, carryover, and full endowment treatments are binding in every period, only the allocation decision in the tenth and final round is binding for the pledge treatment. Since the allocation decisions made in the first nine periods of the pledge treatment are non-binding, subjects are free to learn about the intricacies of the treatment without any associated costs. At the tenth period, when the allocation decision becomes binding, subjects have experienced the maximum amount of learning possible in a ten-period VCM framework. This suggests that subjects will contribute relatively little to the group account, as evidenced by the typical decay in contributions (in accord with Nash equilibrium). Even though subjects in the pledge treatment consistently have the greatest effective endowment, the effects of learning about the game would presumably offset the potential opportunity for over-contribution associated with a high effective endowment in period ten. Ultimately, given that overall contributions to the group account depend solely on the allocation decisions in the final round when subjects are likely to contribute little to the group account, the pledge treatment should lead to the lowest level of efficiency.

Of the fully-binding treatments, the full endowment treatment should produce the greatest overall level of contribution and economic efficiency.

Unlike the baseline and carryover treatments, subjects are endowed with the full 100 tokens at the beginning of the very first period, when they are the most inexperienced with the game. Therefore, the full endowment distribution scheme provides substantial opportunity for subjects to over-contribute to the group account, especially in the early periods when subjects haven't learned to free-ride. In contrast, the opportunity for subjects in the baseline and carryover treatments to over-contribute to the group account is consistently limited by their per-period endowment of 10 tokens. In effective endowment terms, the effective endowment in the full endowment treatment is greater than the effective endowments in either the baseline or the carryover treatments, particularly in earlier periods. Accordingly, the full endowment treatment should produce the highest contribution level and efficiency.

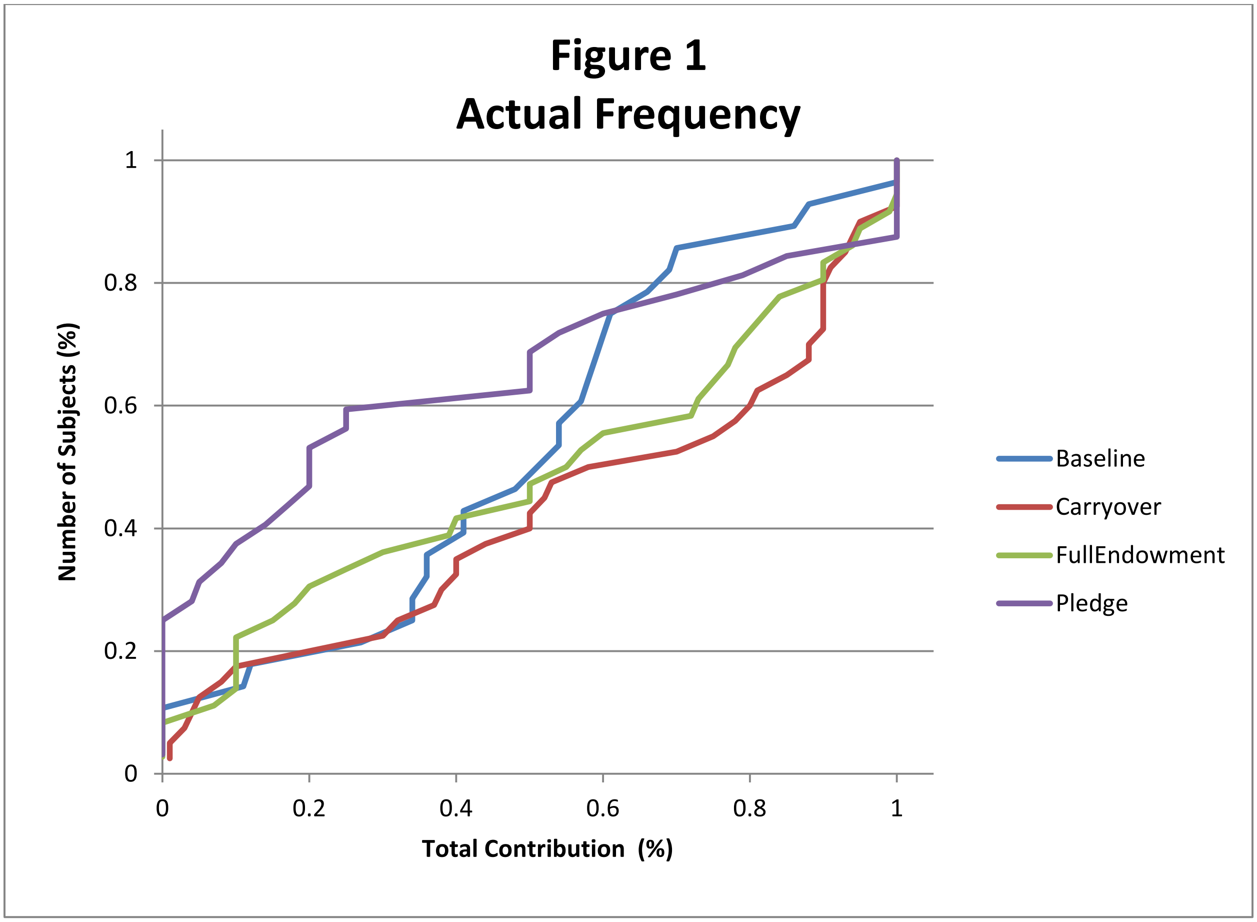
Between the baseline and carryover treatments, the carryover treatment provides the greater opportunity for subjects to over-contribute, leading to higher relative contributions and efficiency. With only a 10 token endowment per period in the baseline treatment, the potential for subjects to misallocate tokens to the group account is directly limited by the endowment scheme. On the other hand, while subjects also only receive 10 tokens per period in the carryover treatment, allocations to the private account in previous periods carry over into subject endowment in future periods, thereby increasing the effective endowment to subjects in every period following the first period. This causes effective endowments to be greater in each period relative to the baseline, even though the sum of the endowments remains fixed at 100 tokens. As a result, subjects in the carryover treatment have a greater chance of over-allocating tokens to the group account because they have effectively more tokens to potentially misallocate.

In sum, considering whether allocations decisions are binding as well as the size of effective endowments, one would expect the following: the full endowment treatment generates the greatest contributions to the group account, the pledge treatment produces the lowest level, and the carryover treatment leads to a greater level of overall contributions than the baseline.

4. EXPERIMENTAL RESULTS

4.1. Total Contributions

To begin a discussion of the experimental results, consider the actual frequency chart in Figure 1. The actual frequency chart displays the distribution of total contributions to the group account across subjects for each treatment. In percentage terms, total contribution is calculated at the end of the tenth period and is defined as the fraction of total endowment (100 tokens) allocated to the group account over the course of the experiment.



The actual frequency distribution for the pledge treatment appears to be the most distinct, which is unsurprising given that the pledge treatment was hypothesized to generate the lowest contributions and economic efficiency. Relative to the other treatments, the pledge treatment possesses the largest percentage of subjects to contribute zero tokens to the group account (exactly 25%). Furthermore, with approximately 60% of subjects contributing less than 25% of endowment, the pledge treatment produced the results most consistent with Nash equilibrium predictions.

The actual frequencies for the carryover and full endowment treatments are difficult to discern given the similar distributions of total contributions. Still, both frequency distributions do indicate greater total contributions than the other treatments, with roughly 80% of subjects contributing 90% or less of total endowment for both. Relative to the pledge and baseline treatments with 75% and 65% of total endowment, respectively, these results suggest that the carryover and full endowment treatments did increase total contributions. Of the two, however, the carryover treatment appears to have increased total contributions more substantially, as evidenced by its consistent position on the right side of the chart (the further to the right an actual frequency is, the greater the total contributions for each subject %). Interestingly, the effect of the carryover and full endowment treatments on the actual frequencies appears most prevalent on the upper 50% of the total contribution distribution, at which point both actual frequencies diverge substantially from the baseline treatment. In contrast, for the first half of the distribution the treatments, pledge aside, are roughly consistent as 50% of subjects contribute approximately 50% or less of endowment. Presumably, these results suggest that the contributions of about 50% of subjects are contingent upon the treatment.

In order to test whether the actual frequency distributions are statistically different from each other, a Wilcoxon rank-sum test is conducted for each possible frequency distribution pairing. The results are shown in Table 2.

Table 2

RANK SUM RESULTS	
Treatment Combination	**Prob > |z|**
Baseline/Carryover	0.1626
Baseline/Full	0.5649
Baseline/Pledge	0.1049
Carryover/Full	0.4379
Carryover/Pledge	0.0119
Full/Pledge	0.0709

The only statistically significant difference at the 0.05 significance level occurs between the distributions for the carryover and pledge treatments, although the distribution for the pledge treatment is close to being statistically different from the baseline and full endowment frequency distributions as well. These results confirm the intuition that the actual frequency distribution for the pledge treatment was the most distinct of the four treatments, as suggested earlier. Additionally, the probabilities associated with four out of the six pairings are less than 0.20. While not all of these differences are statistically significant at standard significance levels, they are fairly close to being so, providing evidence for the behavioral hypotheses outlined previously. Overall, both the ordering of the actual frequency distributions and the statistical results are consistent with the behavioral predictions: contributions increased in the baseline treatment relative to the pledge treatment as well as in the full endowment and carryover treatments relative to the baseline treatment, although the magnitude of the increase was not always sufficient to generate statistically significant differences.

In addition to predicting that the different treatments would affect total contributions differently, the behavioral hypotheses developed earlier also predicted that each treatment would uniquely affect economic efficiency. Define a total efficiency index for treatment *s* with *n* subjects indexed by *i* as:

$$Efficiency = \left(\frac{\sum_{i=1}^{n} Total\ Contribution\ (\%)_i}{n}\right)$$

The efficiency calculations for each treatment are provided in Table 3.

Table 3

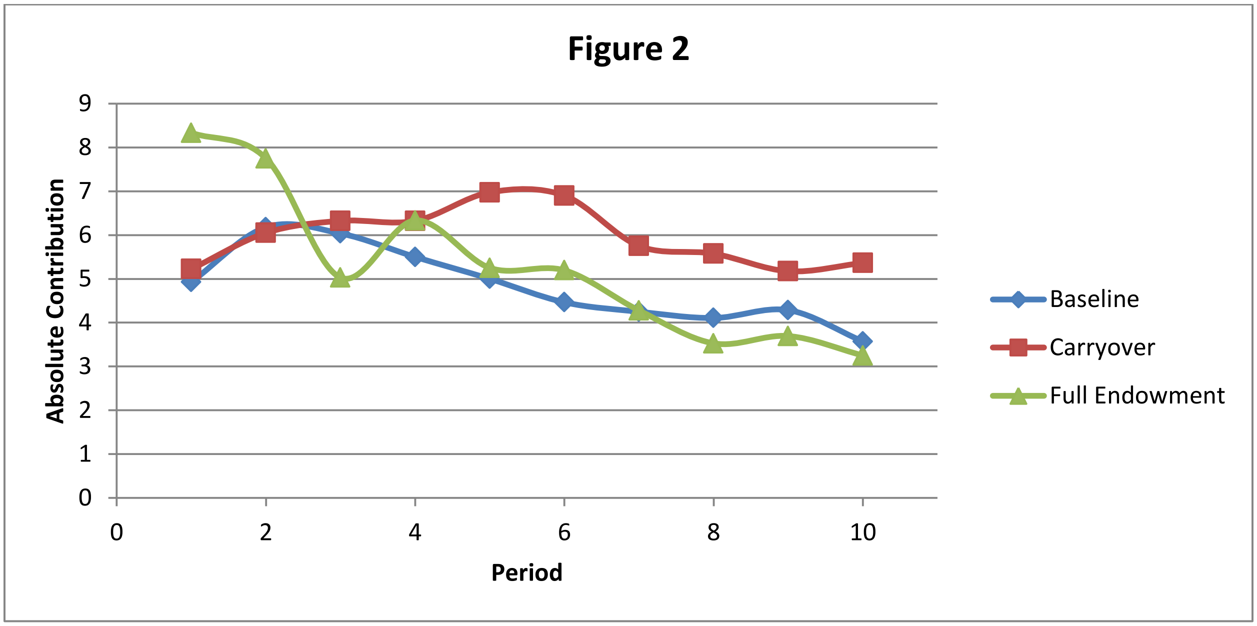
EFFICIENCY RESULTS*	
Treatment	**Efficiency**
Baseline	48.32%
Carryover	58.85%
Full Endowment	52.64%
Pledge	36.44%

*No significant differences

This efficiency index characterizes the average level of total contribution for each treatment. In this way, the Nash equilibrium of zero contributions to the group account corresponds to an efficiency of 0% while the socially efficient equilibrium of contribute all corresponds to an efficiency of 100%. Ultimately, there were no statistically significant differences between these proportions at the 0.05 significance level. Again, these results do not provide evidence that the different endowment schemes in each treatment affected economic efficiency differently. However, similar to the actual frequency distributions, the results are fairly consistent with the behavioral predictions. The pledge treatment obtained the lowest overall economic efficiency while the carryover and full endowment treatments obtained the greatest total economic efficiency, with the baseline in the middle.

4.2. Per-Period Contributions

To complement the analysis of aggregate contributions, per-period contributions are now examined. Figure 2 depicts the average, absolute, per-period contribution to the group account across treatment and period. Absolute contribution for subject i in period t of treatment s is simply $C_{i,t,s}$.



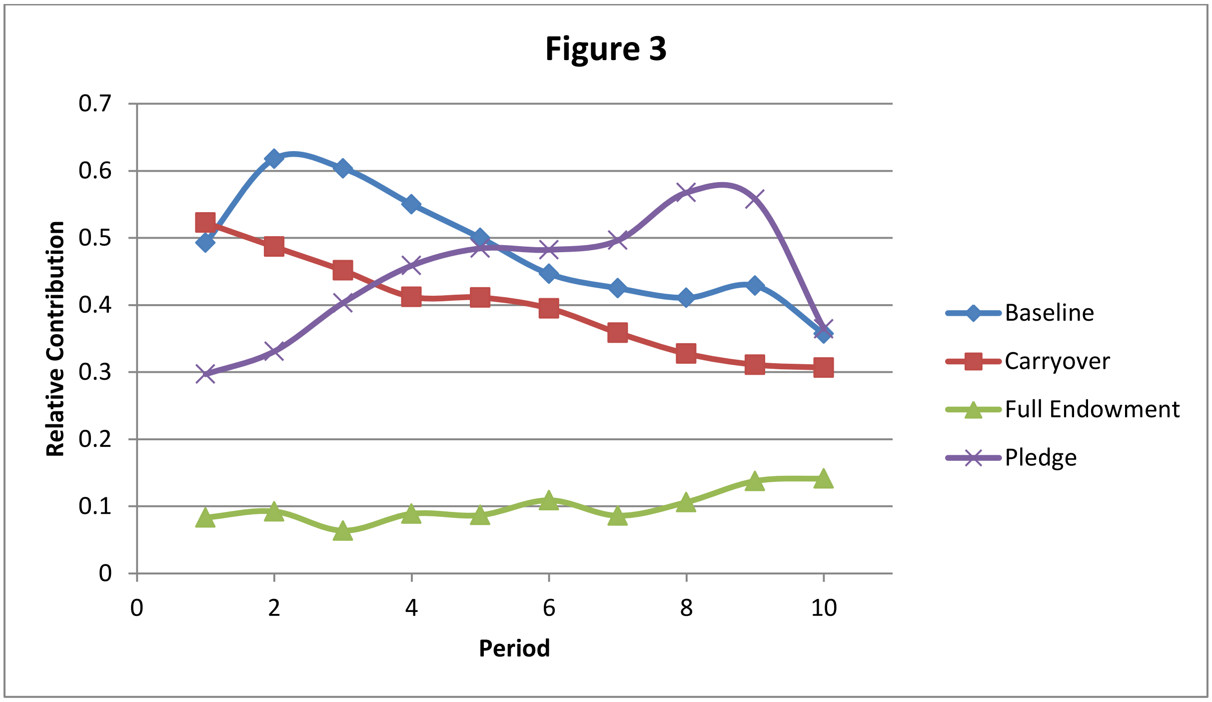
The pledge treatment is excluded from the figure because of substantial volatility in per-period, absolute contributions, a consequence of the non-binding nature of allocation decisions that obfuscates any meaningful comparison between the pledge treatment and the other treatments.

The per-period, absolute contribution trends for the baseline and full endowment treatments are characterized by an obvious decay, as predicted by prior literature. Meanwhile, the carryover treatment trend only exhibits decay in the latter periods; absolute contributions rise steadily in the earlier periods. This result seems to contradict prior literature, but is actually supportive of the previously established behavioral hypotheses. Particularly, of the binding decision treatments, one would expect the opportunity for over-contribution to be greatest in the full endowment and carryover treatments and lowest in the baseline treatment. As the trends demonstrate, per-period, absolute contribution is consistently the largest in the carryover treatment and the lowest in the baseline treatment by a sizeable margin. Since higher absolute contributions are indicative of higher overall contributions, the absolute contribution results are entirely complementary to the overall contribution results discussed earlier.

Given that prior literature predominantly examines per-period contributions as a percentage of endowment, it is worthwhile to develop a similar analysis. Figure 3 displays the average, relative contribution to the group account across treatment and period. Relative contribution ($R_{i,t,s}$) for subject *i* in period *t* of treatment *s* is defined as:

$$R_{i,t,s} = \frac{C_{i,t,s}}{w_{i,t,s}}$$

where $C_{i,t,s}$ represents the contribution to the group account and $w_{i,t,s}$ represents the effective endowment, calculated for each treatment previously.



As predicted, contributions to the group account decayed over time in the baseline, carryover, and pledge treatments. Although the contribution decay didn't occur until the final period in the pledge treatment, this result isn't surprising given that periods 1 through 9 consisted solely of non-binding allocations decisions and learning by subjects. The final period is the only period of binding allocation decisions for the pledge treatment, and this period shows substantial decay. Interestingly, with respect to the full endowment and carryover treatments, relative contributions were consistently lower than the baseline treatment. At first glance, this doesn't make intuitive sense given that these treatments exhibited greater absolute, per-period contributions and higher overall levels of contribution than the baseline treatment. In order to justify this conundrum, it is necessary to explicitly recognize that relative contribution is a function of absolute contribution and effective endowment. Not only did the carryover and full endowment treatments generate greater absolute contributions, they also had greater effective endowments in each period, presumably one of the factors that led to the greater absolute contributions. Therefore, the increase in absolute contributions for these treatments was less than the increase in effective endowment, thereby lowering relative contributions while simultaneously raising absolute and overall contribution levels. In this way, the effect of increasing effective endowment on contributions was less than one-for-one, suggesting that absolute contributions are somewhat inelastic in response to changes in effective endowment.

In order to confirm the aggregate interpretation of relative, per-period contributions, a model of individual per-period, decision-making is now developed. Using random effects regression estimates, the following contribution model is estimated:

$$R_{i,t} = \alpha + \varphi_n + \omega_t + \psi_{t,n} + \mu_{i,t-1} + \rho + \lambda + \varepsilon_i$$

where $R_{i,t}$ is the relative contribution to the group account by subject i in period t, φ_n is a vector of dummies controlling for treatment (baseline is omitted condition), ω_t is a vector for period, $\psi_{t,n}$ is a vector of interaction terms between period and treatment, $\mu_{i,t-1}$ is a vector of lagged controls for past subject behavior, ρ is a dummy variable for the last period (all other periods are omitted condition), λ is an interaction term between the pledge treatment and the final period dummy variable, and $\varepsilon_{i,t}$ is the stochastic, contemporaneous error term. To elaborate, $\mu_{i,t-1}$ is a vector that consists of subject i's relative contribution to the group account in the previous period ($R_{i,t-1}$) and subject i's deviation from the average, relative contribution of her group in the previous period ($R_{i,t-1} - \bar{R}_{G,t-1}$). All control variables follow from prior research.[8] The regression results are depicted in Table 3.

The coefficient estimates on the full endowment treatment variable, the period variable, the interaction term between these two variables, the lagged contribution variable, the interaction term between pledge and the last period, and the lagged contribution deviate variable are all statistically significant at the 0.05 significance level. Furthermore, the coefficient estimates on these variables are in the correct direction. Of the treatment dummies, only the full endowment variable coefficient estimate was statistically significant at the 0.05 significance level, although the carryover estimate was very close to being as well. The negative signs of the coefficient estimates on the carryover and treatment variables support

[8] In particular, see Dickinson (1998), Galbiati & Vertova (2008), Nikiforakis (2008), and Cadigan et al. (2011).

Table 3

Random Effects Regression Results*	
Independent Variable	**Coefficient Estimate (two-tailed p-values)**
Carryover	-0.0717749 (0.077)
FullEndowment	-0.1147246 (0.001)
Pledge	0.015186 (0.743)
Period	-0.0101347 (0.046)
*Period*Carryover*	0.0075213 (0.226)
*Period*FullEndowment*	0.0150233 (0.019)
*Period*Pledge*	0.0086663 (0.248)
LastPeriod	-0.0319348 (0.188)
*LastPeriod*Pledge*	-0.1736916 (0.003)
RelContLagged	0.8852845 (0.000)
RelContLaggedDeviate	-0.1721071 (0.000)
Constant	.106315 (0.003)
R^2 *overall*	0.6995
Wald χ^2	2821.65
Prob > χ^2	0.0000
N	1224

*Robust standard errors

the previous interpretation of the per-period, relative contributions trends. Also, the coefficient estimate on the full endowment dummy is the third most substantial, revealing the importance of the full endowment treatment in the per-period relative contribution decision of individuals. The coefficient estimate on the interaction term between period and full endowment indicates that relative contributions in the full endowment treatment increased each period, relative to the baseline. These results lend credence to the upward sloping trend of relative contributions in the full endowment treatment observed earlier. The entire effect of the full endowment treatment on relative contribution is characterized by the joint effect of its dummy variable and its interaction term, itself a function of period. This interpretation applies to all treatment variables.

The statistical significance and sign of the coefficient estimate on period reveals that subjects' relative contribution to the group account exhibited decay over time, an observation consistently substantiated. These results suggest that subject behavior does converge toward the Nash equilibrium outcome where all subjects contribute 0 tokens to the group account in all periods. Of course, the effect of the decay, relative to other factors, appears relatively small, as indicated by a coefficient estimate of -0.01013. While subject contributions certainly decay in most treatments over the horizon observed, it would take many more periods for this decay to lead to the Nash equilibrium outcome, assuming a constant rate of decay or learning.

Notably, the coefficient estimate on the interaction term between the pledge treatment dummy variable and the dummy variable for the last period is statistically significant in difference from zero at the 0.05 significance level. The sign of this estimate supports the existence of a sharp and distinct decline in subject contributions in the final period of the pledge treatment, as documented earlier, a result of subjects learning to free-ride. This sharp decay is also suggestive of subjects learning how to free-ride most effectively; subjects appear to actively attempt to deceive other players into over-contributing to the group account. Rising relative contributions in non-binding rounds represents subjects signaling their willingness to contribute to the group account to their group members. However, relative contributions decline sharply in the final round, contrary to signaling in prior rounds, as subjects renege on their initial pledges. This behavior is entirely consistent with the strategic framework of Nash equilibrium in which subjects free-ride on the contributions of others, although it does also suggest that subjects actively attempt to encourage other members to over-contribute in addition to simply contributing zero tokens to the group account.

Lagged relative contribution to the group account ($R_{i,t-1}$) influenced subject's contribution decision significantly. Intuitively, one would expect that a subject that had contributed a large amount to the group account in the previous period would also contribute a lot to the group account in the current period. This relationship is borne out with a coefficient estimate of approximately 0.8853, easily the most substantial factor in the contribution decision. Similarly, lagged relative contribution deviation ($R_{i,t-1} - \bar{R}_{G,t-1}$) factored both substantially and significantly into the contribution decision. With a coefficient estimate of roughly -0.1721, the intuition behind this estimate is clear: if a subject contributed more to the group account relative to the rest of the group, she would respond by contributing less in the subsequent period. Similarly, if a subject contributed less to the group account relative to the rest of the group, she would respond by contributing more in the following period. This suggests subjects pursue some notion of social conformity, seeking to contribute at levels consistent with the rest of the group.

5. Concluding Remarks

This experiment investigated the importance of endowment effects in subject decision-making and societal outcomes using different endowment distribution schemes. The experimental design included three treatments in addition to a baseline VCM game, namely carryover, full endowment, and pledge. The treatments that had binding allocation decisions and high effective endowment were predicted to generate the greatest overall levels of contribution. According to this behavioral framework (presented in section three), one would expect the full endowment to produce the greatest level of contribution and the pledge treatment to produce the lowest, while the carryover would generate a greater level than the baseline treatment. Evidence from the lab supported these basic behavioral predictions. Most notably, the pledge treatment possessed the lowest level of overall contribution, followed by the baseline treatment and the full endowment, respectively, with the carryover treatment possessing the highest level of contribution. Only the latter result (i.e. the carryover treatment achieving greater contribution than full endowment treatment) was concerning. Testing differences between the frequency distributions of total contribution for each treatment provided further support of the behavioral hypotheses. Importantly, the difference between the carryover and full endowment treatments was not statistically significant, indicating that the previous discrepancy may merely be a spurious observation.

In addition to analyzing overall outcomes, per-period, absolute and relative contribution trends for each treatment were analyzed. These results were largely complementary to the primary, aggregate analysis. With respect to absolute contributions, the carryover treatment and full endowment had the largest absolute contribution levels while the baseline treatment consistently had the lowest. Concerning relative contributions, the pledge and the baseline treatments possessed the largest relative contributions, while the carryover and full endowment treatments had the lowest. Given that relative contribution was a function of absolute contribution and effective endowment, these results suggested that absolute contributions rose less than one-for-one with increases in effective endowment in the full endowment and carryover treatments.

Finally, to reinforce the nonparametric analysis, an individual model of relative contribution decision-making was developed. The coefficient estimates were consistent with previous literature as well as all analyses herein. For instance, the coefficient estimate on period was statistically significant and negative, indicating decay, while the coefficient estimates on lagged relative contribution and lagged relative deviation were positive and negative, respectively, as well statistically significant. Interestingly, the coefficient estimates on the full endowment and carryover treatment dummies were both negative and either statistically significant or very close to being so, results that agreed with the nonparametric analyses summarized above.

Despite the supportive results, there exists an abundance of possible avenues for future work on endowment distribution schemes and the role they play in affecting the opportunity for over-contribution. For instance, future research could investigate the carryover and full endowment treatments in greater depth. In contrast to the behavioral predictions, the carryover treatment generated greater total contributions and greater economic efficiency than the full endowment treatment, although these differences were not statistically significant. A rationale for this discrepancy may provide insight into the endowment distribution schemes most capable of achieving greater total contributions and economic efficiency. Additionally, the notion that economic efficiency and total contributions may be maximized by imposing mechanisms that take advantage of subject unfamiliarity is worth further consideration.

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APPENDIX

Instructions (Baseline)[9]

This is an experiment about decision-making. The instructions are simple and if you follow them carefully and make good decisions you might earn a fair amount of money that will be paid to you privately and in cash at the end of today's session. The amount of money you earn depends on the decisions that you and the other participants make. You will never be asked to reveal your identity to anyone during the course of the experiment. Your name will never be associated with any of your decisions. In order to keep your decisions private do not reveal your choices to any other participant.

The Experiment

For this experiment you will be placed in a group of **four people** (you plus three other people). We have already randomly assigned you to a group. **You will remain in this group for the duration of the experiment.** However, you *will not* be told each other's identities. Your earnings will depend upon the decisions that you make and the decisions that the other people in your group make.

The experiment will consist of ten rounds.

At the beginning of round one, each person in the group will be **endowed with 10 tokens.** You must choose how many of these tokens to keep in your **private account** and how many tokens to allocate to a **group account.** The amount of money that you earn in each decision round depends on how many tokens you have in your private account, how many tokens you allocate to the group account, and how many tokens the others in your group allocate to the group account.

You will earn 10 cents for each token you have in your private account. Your will earn 5 cents for each token you have allocated to the group account, plus 5 cents from each token allocated to the group account by the other persons in your group.

To summarize, in each round you will earn:
$0.10 times the number of tokens you have in your private account +
$0.05 times the total number of tokens allocated to the group account by your group

After you have made your decision for the round, please wait while the others in your group finish making their decisions. At the end of each round, there will be a summary screen that allows you to see how many tokens were allocated to the group account, as well as your personal earnings. You will not be able to see which individuals allocated tokens to the group account, or how much a specific individual allocated.

The same process will be repeated for all tenrounds. At the conclusion of all ten rounds, each participant's earnings will be totaled and shown privately.

If you have any questions at this time, please raise your hand. Otherwise, please press the "Continue" button at the bottom right of your screen.

[9] Instructions for other treatments available upon request.