# Social Pressure Bias & Stated Preferences*

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**Abstract**

Does social pressure inflate stated preferences for public goods? Herein we show the answer depends on the elicitation mechanism. We develop a model that predicts social pressure will create a greater bias in a referendum than in a dichotomous-choice mechanism. Our experimental evidence supports our theory - social pressure did not have a significant impact in the dichotomous-choice mechanism, whereas it did in the referendum. This result suggests that if one elicits preferences in an environment where subjects experience social pressure, the dichotomous-choice device may be the more reliable elicitation mechanism.

*Keywords:* Voting Referendum; Dichotomous choice; Social isolation; Preference revelation.

*JEL Classification:* C9; H4; Q5

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# 1 Introduction

Evidence suggests that decreasing social pressure by providing subjects with social isolation leads to smaller contributions to public goods in the lab (see e.g., Bohnet and Frey, 1999; Andreoni and Petrie, 2004; Rege and Telle, 2004). Examining the robustness of this phenomenon within the stated-preference literature, List *et al.*, (2004) find an analogous result - social isolation significantly decreases the probability that people will vote "yes" in a referendum for a costly public good. In a similar experimental design, Berrens *et al.*, (1997) test the effect of social isolation on stated preferences in a dichotomous-choice format. They find that the magnitude of social-pressure bias depends on the bid structure. For example, they find evidence of social-pressure bias when the bid level is \$2.00 or \$20.00, but not when the bid level is \$7.00 or \$9.00. The results of their study are suggestive but not conclusive.[1]

The open question is why List *et al.* (2004) find that social isolation significantly deflates stated preferences, whereas Berrens *et al.* (1997) did not. Is a referendum more susceptible to social-pressure bias or are the results due to the different characteristics of the two experimental settings?[2] Herein we address this question. Our model predicts that a voting referendum is particularly susceptible to social-pressure bias because within a referendum a voter faces only a probability of being a decisive voter. This creates an incentive for a person to vote "yes". A person can gain social approval while having little influence on the outcome of the referendum. Experimental data are consistent with this prediction. Our results suggest social-pressure bias may be specific to a referendum. Our results suggests that when the degree of social isolation is low, dichotomous choice may yield more unbiased estimates of $WTP$ than a voting referendum.

[1] The impact of social isolation has been tested on other formats. For instance, Alpizar *et al.*, (2008) use a natural field experiment to investigate whether social context affects actual contributions in an open-ended format. In their paper, an open-ended question is used as an elicitation device to obtain contingent valuations regarding the continued, successful operation of a national park in Costa Rica. They find that contributions made in public are 25% higher than contributions made in private. Soetevent (2005) also observes that the value of individual donations in churches is negatively associated with the degree of social isolation.

[2] Berrens *et al.* (1997) solicited subjects at Oregon State University and the public good was the expansion of the student cultural centers program. List *et al.* (2004) solicited subjects at the University of Central Florida (UCF) and the public good was a proposed Center for Environmental Policy Analysis based at UCF.

## 2 The model

### 2.1 Referendum Voting

Assume a representative person receives utility from (1) the consumption of a composite good $c_i$, (2) total contributions to a public good $A$, and (3) by being perceived as valuing the public good by an audience.[3] We refer to the utility a person receives from being perceived by an audience as valuing the public good as the audience effect. The audience forms an expectation of person $i$'s true preference for the public good, $\nu_i$, based on person $i$'s voting behavior. For simplicity assume each person is identical except in their preference for the public good.

Assume a person makes a decision from within a group. The audience is the voting bloc. Each person votes either "yes" or "no" for every member of the bloc to donate $t$ dollars towards a public good. If the majority (more than 50%) vote "yes", everyone in the bloc must donate. If the majority votes "no", no one in the bloc donates. Assume that with probability $q$ the vote of person $i$ is revealed to the audience and that with probability $p$ person $i$ is a tie-breaker. We refer to the tie-breaking voter as the "decisive voter". The revelation of person $i$'s vote updates the audience's perception of person $i$'s true preference for the public good.

The representative person's optimization problem is

$$\max_{j\in\{0,1\}} U_{i,VR} = (1-j)[p(c_i+t) + qhE_{\mathrm{VR}}(\nu_i|j=0)] \\ +j[p(c_i+\nu_i g(A))+qhE_{\mathrm{VR}}(\nu_i|j=1)] + (1-p)\bar{x}, \qquad (1)$$

subject to

$$A = \begin{cases} tN, \text{ if the decisive voter votes "yes"} \\ 0, \text{ if the decisive voter votes "no"} \end{cases}$$

by voting either "yes" ($j=1$) or "no" ($j=0$). $N$ is the total number of people in the voting bloc and $\bar{x}$ is the exogenously determined level of utility when person $i$ is not the decisive voter (net of any audience effect),[4] Person $i$'s preference for the audiences expectation of their preference for the public good is given by $h$ and $\nu_i$ is person $i$'s true preference for the public good. Assume preferences for the public good are positive, so $\nu_i > 0$. is The audience's expectation of $\nu_i$ given that person $i$ votes "yes" in a voting referendum is given by

[3] We model utility as a function of audience perception following existing literature (see for example Della Vigna, List and Malmendier, 2012; Benabou and Tirole, 2006; Andreoni and Bernheim, 2007).

[4] Person $i$ treats $\bar{x}$ as an exogenously determined parameter. The size of the audience effect is not contingent on person $i$ being the decisive voter. The exogenous level of utility earned when person $i$ is not the decisive voter is given by $\bar{x}$ which can take on one of two values. The group will decide to give or not to give.

$E_{\text{VR}}(\nu_i|j = 0)$ and the audiences expectation of $\nu_i$ given that person $i$ votes "no" in a voting referendum is given by $E_{\text{VR}}(\nu_i|j = 1)$. Let $g$ be a function that maps the level of the public good into a person's utility function. Assume $g' > 0$.

Seminal work by Asch (1951, 1952, 1956) suggests that the social impact on individual behavior is constant for group sizes greater than three. However, some more recent social-psychology literature has argued that social impact is an increasing and concave function of group size (Gerard *et al.*, 1968; Latane, 1981). The marginal social impact created by an additional audience member is largest when few audience members are present. Latane (1981) argues the social impact on individual behavior is increasing and concave, based on studies that vary group size from 1 to around 10 audience members. Because our experimental sessions vary group size from approximately 35 to 60 subjects, we treat $h$ as exogenous so that increasing group size does not change the size of the audience effect.

Person $i$ is the *decisive voter* in the event that their vote is a tie-breaker. Following Beck (1975), we define the probability of being a decisive voter as the probability the voting behavior of $N - 1$ other voters results in a tie, where $N$ is an odd number. Assuming voter $i$ believes voter $k$ will vote "yes" with probability $\bar{p}$ (before any votes are cast) and that $N$ is large, the probability that voter $i$ is the decisive voter (the probability that the voting behavior of $N - 1$ people results in a tie) is

$$p(\bar{p}, N) = (4\bar{p}(1 - \bar{p}))^{\frac{(N-1)}{2}} \left( \frac{2}{\pi(N - 1)} \right)^{\frac{1}{2}}. \tag{2}$$

Later, it will be helpful to know how the probability of being the decisive voter changes as $N$ changes. Taking the derivative of (2) with respect to $N$ indicates that the probability of being the decisive voter is decreasing in the size of the voting bloc:

$$\frac{dp}{dN} = p \left( ln\,(4\bar{p}(1 - \bar{p})) - \frac{1}{2(N - 1)} \right) < 0 \tag{3}$$

for $0 \leq \bar{p} \leq 1$.

Person $i$ votes "yes" if the benefit of giving $tN$ dollars towards the public good and the net audience effect outweigh the cost of forgone consumption

$$p(\bar{p}, N)t \leq \nu_i p(\bar{p}, N)g(tN) + \underbrace{qh\left(E(\nu_i\,|_{y,VR}) - E(\nu_i\,|_{n,VR})\right)}_{\text{net audience effect}}$$

or

$$\Omega_{VR} \equiv \frac{p(\bar{p}, N)t + qh\left(E(\nu_i\,|_{n,VR}) - E(\nu_i\,|_{y,VR})\right)}{p(\bar{p}, N)g(tN)} \leq \nu_i, \tag{4}$$

where $\Omega_{VR}$ is the upper bound on the audiences expectation of $\nu_i$ if person $i$ votes "no" and it is the lower bound on the audiences expectation of $\nu_i$ if person $i$ votes "yes" in a voting referendum.

We now discuss how the audience updates its expectation of person $i$'s true preference for the public good. From the audience's perspective, voting "yes" signals that

$$\Omega_{VR} \leq \nu_i \tag{5}$$

and voting "no" signals that

$$\Omega_{VR} > \nu_i. \tag{6}$$

For simplicity, assume an audience considers $\nu_i$ to be uniformly distributed and bounded from below by zero and from above by $\bar{\nu}$ (greatest possible preference for the public good). Before any votes are revealed, the audience expects $\nu_i$ to be the mean of this distribution

$$E(\nu_i) = \frac{1}{2}[\bar{\nu}]. \tag{7}$$

If person $i$'s vote is revealed, the audience updates its expectation of $\nu_i$ accordingly. From equation (5), a "yes" vote signals to the audience that $\nu_i$ is bounded from below by $\Omega_{VR}$. The audience remains uncertain about the person's actual $\nu_i$ but knows it must be greater than or equal to $\Omega_{VR}$. The audience re-calculates the mean of the updated distribution, replacing the original lower bound, zero, with the updated lower bound, $\Omega_{VR}$, such that

$$E(\nu_i\mid_{y,VR}) = \frac{1}{2}\left[\Omega_{VR} + \bar{\nu}\right] > 0. \tag{8}$$

Similarly, voting "no" signals that the distribution of $\nu_i$ is bounded from above by $\Omega_{VR}$. An audience remains uncertain about a person's actual $\nu_i$ but knows it must be less than or equal to $\Omega_{VR}$. The mean $\nu_i$ is updated by replacing the original upper bound, $\bar{\nu}$, with the updated upper bound $\Omega_{VR}$

$$E(\nu_i\mid_{n,VR}) = \frac{1}{2}[\Omega_{VR}] > 0. \tag{9}$$

Note from (8) and (9) that

$$E(\nu_i\mid_{y,VR}) - E(\nu_i\mid_{n,VR}) = \frac{1}{2}[\bar{\nu}]. \tag{10}$$

Because a person must vote either "yes" or "no", she votes "yes" if the net utility of doing so is positive and "no" otherwise. Substituting equations (2) and (10) into equation (1), yields that the net utility of voting "yes" in a referendum is

$$U_{i,y,VR} - U_{i,n,VR} = p(\bar{p}, N)(\nu_i g(tN) - t) + \frac{1}{2} q h \bar{\nu}, \tag{11}$$

where the last term in equation (11) is the net audience effect from voting "yes" in a referendum. Note that if voters are in social isolation, $q = 0$. In this special case, a person votes "yes" if $\nu_i g(tN) - t > 0$. A person's voting decision is unaffected by the probability, $p$, of being the decisive voter. In the absence of social isolation, $q > 0$ and a person votes "yes" if expression (11) is positive. Now, the probability of being the decisive voter plays a key role. In social isolation, if person $i$ votes "yes", she continues to vote "yes" in the absence of social isolation because the net audience effect is positive. But it is possible for a person to vote "no" in social isolation and "yes" without social isolation. This is more likely to occur when the probability of being the decisive voter is low. Specifically, this occurs when $\nu_i g(tN) < t$ and $p(\bar{p}, N)(\nu_i g(tN) - t) + \frac{1}{2} q h \bar{\nu} > 0$. This is a main result of the model. Social pressure inflates "yes" responses in a voting referendum because a person can gain social approval by voting "yes" while experiencing little risk of altering the outcome of the referendum.

We now examine how group size effects the size of social-pressure bias within a referendum. Group size, $N$, enters equation (11) in two places. First, the probability of being the decisive voter is decreasing in $N$. Second, the potential contribution to the public good, $g(tN)$, is increasing in $N$. Taking the derivative of expression (11) with respect to $N$ yields

$$p'(\nu_i g(tN) - t) + p \nu_i g'(tN) t, \tag{12}$$

where $p'$ is the derivative of $p$ with respect to $N$. The first term in (12) describes how an increase in $N$, through its effect on $p$, affects the net utility of voting "yes". It is positive for $\nu_i g(tN) < t$ and negative for $\nu_i g(tN) > t$ (recall that $p' < 0$). If $\nu_i g(tN) > t$, a person votes "yes" even in social isolation because the utility she gets from the group contributing to the public good outweighs the utility she would get from consuming $t$ privately (see (11)). An increase in $N$, through its effect on $p$ can change the sign of (11) only when (11) is negative. Therefore, an increase in $N$, through its effect on $p$, can only work to increase the number of "yes" responses.

The second term in equation (12) is positive. It describes how an increase in $N$, through its effect on the potential contribution to the public good, $g(tN)$, affects the net utility of voting "yes". Because $\nu_i > 0$, the second term in equation (12) is positive even when voter $i$ is in social isolation. This is because as $N$ increases, the size of the potential contribution to the public good increases as well ($N$ people contribute if the decisive voter votes "yes").

Our examination of the voting referendum indicates that a person is more likely to vote "yes" for a costly public good in the presence of a large audience for two reasons. First, if a voter cares about social approval, she may vote “yes” in order to appear to the audience as if they value the public good. Second, when the audience is the voting bloc, increasing audience size decreases the probability the person’s vote will matter. This exacerbates social-pressure bias, because a person can gain social approval by voting “yes” while having minimal impact on the outcome of the referendum.

## 2.2 Dichotomous Choice

We now modify the model to examine social-pressure bias in a dichotomous-choice format. In dichotomous choice, the original utility function (1)is transformed to

$$\max_{j\in\{0,1\}} U_{i,DC} = (1-j)[(c_i+t)+qhE_{\mathrm{DC}}(\nu_i|j=0)] + j[c_i+\nu_i\tilde{g}(t)+qhE_{\mathrm{DC}}(\nu_i|j=1)]. \quad (13)$$

Equation (13) differs from equation (1) in three respects. First, $p = 1$ because person $i$’s is perfectly decisive because if she answers “yes” she will donate with certainty. Second, the constraint on equation (1) has been dropped reflecting person $i$’s inability to affect the behavior of other members of the group. Third, $g(A)$ from (1) has been transformed to $\tilde{g}(t)$, reflecting that person $i$ decides only whether she will contribute, not whether each member of the group will contribute.[5]

Similar to equation (5), person $i$ answers “yes” in a dichotomous choice format if

$$\Omega_{DC} \equiv \frac{t+qh\left(E_{\mathrm{DC}}(\nu_i|j=0)-E_{\mathrm{DC}}(\nu_i|j=1)\right)}{\tilde{g}(t)} \leq \nu_i \quad (14)$$

and “no” otherwise. Similar to the referendum, answering “yes” signals to an audience that

$$\Omega_{DC} \leq \nu_i \quad (15)$$

and answering “no” signals that

$$\Omega_{DC} > \nu_i. \quad (16)$$

The net utility of answering “yes” in dichotomous choice is

$$U_{i,y,DC} - U_{i,n,DC} = \nu_i\tilde{g}(t) - t + \frac{1}{2}qh\bar{\nu}, \quad (17)$$

where $U_{i,y,DC}$ ($U_{i,n,DC}$) is the utility earned from voting “yes” (“no”). The last term in equation (17) is the net audience effect from answering “yes” in a dichotomous choice mechanism. Note

[5]Let $n$ be the number of other people that person $i$ expects will give to the public good. Then $\tilde{g}(t) \equiv g(tn+t) - g(tn)$. If $g'' = 0$ then $\tilde{g}(t) = g(t)$, which is more likely to be true when subjects are giving to an expensive public good because each donation has a relatively small and similar effect.

it is identical to the net audience effect earned when a person votes "yes" in a referendum. Comparing equations (11) and (17) suggests that social pressure biases the two elicitation mechanisms in different ways. The net audience effect is identical for both elicitation mechanisms, but in a voting referendum the probability that a person is the decisive voter is less than unity. This exacerbates the size of the social pressure bias within a voting referendum because a person can gain social approval by voting "yes" while having a minimal impact on the outcome of the referendum.[6]

# 3 Experimental Design

The model suggests that a referendum may be more susceptible to social-pressure bias relative to a dichotomous choice mechanism. We test this using a $2 \times 2$ experimental design in which social isolation and the elicitation mechanism are the treatments. We replicate List *et al.*'s public and private referendum format as close as possible, and we extend the design to consider the dichotomous choice format. List *et al.* (2004) hypothesize that social isolation affects other preference elicitation mechanisms similarly, e.g., the classic dichotomous choice method (see p. 749) but do not test for the relative affect. Each format, dichotomous choice and voting referendum, has a private and public treatment. To test the prediction of the model that increasing group size will increase social pressure bias in a referendum by allowing group size to vary from approximately 30 to 60 subjects.

For each treatment, monitors gave subjects \$15.00 of which they decided to keep or donate to the University of Wyoming Wind Energy Research Center (WERC). In the voting referendum treatment, subjects answered "yes" or "no" which corresponded to votes for whether the group should donate or keep its money. The group decision was made by a majority rule. If the referendum passed, the payment was applied to everyone in the group. Similarly, subjects in the dichotomous choice treatment were asked to answer "yes" or "no" which represented their personal preference to donate their \$15.00 to WERC.

In the public treatments, 25% of subjects were required to announce to the group their answer. To choose 25% of subjects randomly, each answer sheet provided a box for subjects to write a random number from 1 to 100. The 25% of subjects with random numbers closest to the number 1 were chosen to announce their answer. The method used in the public treatments assured that if subjects were not randomly chosen to present their preference, their answer

[6]Note that group size, $n$, may enter equation (17) through $\tilde{g}(t)$ if $g'' < 0$ because $\tilde{g}(t) \equiv g(tn + t) - g(tn)$, see footnote 5. If $g'' = 0$, group size does not enter equation (17). Nonetheless, the size of *social-pressure bias* is not affected by group size in the dichotomous-choice format.

would remain private from the rest of the group.[7]

In the private treatments, anonymity from the group and from the monitors of the experiment was created by using the unrelated question randomized response model of Greenberg *et al.* (1969). This approach has the benefit of creating pure anonymity, however, this increases the standard errors of the estimates. Each participant in the private treatment was given a six-sided die. They were instructed to roll the die one time and fill in the answer sheet appropriately. A roll of a 1 or 2 resulted in a participant answering question A, a roll of 3,4,5 or 6 prompted them to answer question B. Question A asked them, "Did you roll a 1?" Question B was the real - valuation question which asked them if they wanted to donate $15.00 to WERC. To answer either question A or B subjects simply circled either "yes" or "no" at the bottom of the answer sheet. This randomization device creates complete anonymity and therefore relieves social pressure by preventing the monitors (and any nosy audience members) from knowing the true preferences of individual subjects.[8]

Before making the donation decision, monitors gave each subject a description of the Wind Energy Research Center:[9]

> Energy in the United States is largely derived from non-renewable resources such as oil, coal and natural gas. Environmental scientists argue that in addition to providing a cleaner source of energy, harvesting wind energy is important because of its renewable characteristics; the advancement of wind technology offers a buffer to dwindling stocks of non renewable energy sources. Wind energy has yet to be harvested on mass scales in the United States; the U.S. currently receives less than 1% of its energy from wind. However, the American Wind Energy Association (AWEA) believes by the year 2030, 20% of America's energy could come from wind. According to Mark Northam, director of UW's School of Energy Resources,

[7] After subjects were paid, they were requested to return to their seat to complete a survey which is included in the Appendix.

[8] Given the randomization device, one-third of private treatment subjects answered the random question. One-sixth of all private treatment "yes" and one-sixth of all private treatment "no" answers are random responses.

[9] The validity of our design rests on subjects viewing wind energy as a public good. The relaxation of this assumption reduces the potential level of social pressure associated with donating to WERC and can lead to corrupt results. If wind energy technology advancements were viewed as a public bad, it is possible that social pressure actually worked in the opposite direction. Survey results suggest undergraduate students at the University of Wyoming view wind energy as a public good. One hundred and twenty-one students from introductory economics courses who did not participate in the experiment were surveyed and asked the following question: "Do you consider the advancement of wind energy technology to be a good thing?" Most students (113 (93%)) answered "Yes."

> "important breakthroughs in technology must occur to increase wind energy consumption in the United States". To that regard, the University of Wyoming will soon establish a wind energy research center. The center will provide natural scientists and engineers with the ability to advance wind energy technology. According to the School of Energy Resources (SER) director, the Wind Energy Research Center will be “a program that’s probably as impressive as anybody’s in the country.” The success of the Wind Energy Research Center has and will continue to be dependent on private and public charitable donations. Referencing why the center was not developed years ago, Jonathan Naughton, a University of Wyoming professor of Mechanical Engineering, says that “The problem has always been funding.”

Subjects then indicated their donation preference by circling either “yes” or “no” on an answer sheet. In the voting referendum format, each answer sheet was turned in face down, all votes were counted and subjects were paid. Because each subject in the voting referendum format is paid an identical amount, individuals were not singled out for payment. To assure anonymity, individuals participating in the dichotomous choice format were paid outside of the classroom. It was announced prior to the experiment that such measures would be taken to assure anonymity.

Before each experimental treatment, subjects were assured that donations would be given to WERC. An envelope and a check made out to WERC were presented to the group and it was announced that, “After the experiment has ended, this check will be made out for the appropriate donation amount and anyone can accompany us to mail the check to WERC when the experiment has ended.” Following Berrens *et al.* (1997), subjects were solicited to participate in the experiment during class time and thus were not paid for participating. One benefit of this approach is that it minimizes potential selection bias. All treatments were run in freshman composition introductory economics classes. This resulted in subjects being fairly homogeneous in age but diverse with regards gender and parental income.[10]

# 4 Experimental Results

Our experimental results support the predictions of the model. Pooling the voting referendum sessions, people answering the real, valuation question were about 16 percent more likely to donate in public than in private. Conversely, people in the dichotomous choice format were 8

[10]The survey asked subjects to state the approximate yearly income of their parents, not their own income. Given the average participant was a 20 year old college student parental income was decided to be a more revealing statistic.

percent *less* likely to donate in public than in private (not significant). Table 1 summarizes the raw data.

The percent of "yes" responses in parenthesis in Table 1 reflects actual responses to the valuation question. Following Fox and Tracy (1981), the probability of a "yes" response is

$$\bar{z} = a\hat{\mu}_x + (1-a)\hat{\mu}_y \tag{18}$$

where $a$ is the probability of answering the valuation question, $\hat{\mu}_x$ is the probability a person answers "yes" to the valuation question and $\hat{\mu}_y$ is the probability of answering "yes" if a person answers the random - anonymity generating question. Rearranging yields the probability a person answers "yes" to the valuation question

$$\hat{\mu}_x = \frac{\bar{z} - (1-a)\hat{\mu}_y}{a}. \tag{19}$$

Because a person answered the valuation question with a 2/3 probability (the probability of rolling a 3,4,5 or 6 on a six-sided dice) and a person faced a 1/2 probability of answering "yes" if they answered the random - anonymity generating question (the probability that a person rolled a 1, given they rolled a 1 or 2), the probability a person answers "yes" to the real, valuation question is

$$\hat{\mu}_x = \frac{3}{2}\bar{z} - \frac{1}{4}. \tag{20}$$

The initial observations are borne out with formal hypothesis testing. Our first null hypothesis is that people in a voting referendum are equally or less likely to vote "yes" in public as they are in private,

$$H_{0,1} : Yes(VRPU) - Yes(VRPR) \leq 0$$
$$H_{A,1} : Yes(VRPU) - Yes(VRPR) > 0$$

where "VRPU" denotes voting-referendum, public elicitation format and "VRPR" denotes voting-referendum, private elicitation format. For the referendum, we reject the null hypothesis that subjects in the public treatment were equally or less likely to vote "yes" as those in the private treatment. This result is significant at the 5% confidence level. Splitting the sample into large and small-group sessions highlights the effect of group size on social-pressure bias. Subjects in the large-group, referenda sessions ($N \approx 60$) were 28% more likely to vote "yes" in public than in private (significant at the 1% confidence level). Subjects in the small-group, referenda sessions ($N \approx 30$) were 8% *more* likely to vote "yes" private than in public (not significant). See Table 2 for the corresponding $z$ - statistics and $p$ - values.

For the dichotomous choice treatment, we cannot reject the null hypothesis that subjects in a public treatment are equally or less likely to contribute as those in a private treatment,

$$H_{0,2} : Yes(DCPU) - Yes(DCPR) \leq 0$$
$$H_{A,2} : Yes(DCPU) - Yes(DCPR) > 0$$

where "DCPU" and "DCPR" denote dichotomous-choice, public and dichotomous-choice, private elicitation formats, respectively. Surprisingly, subjects in the private treatment were 8% *more* likely to contribute than those in the public treatment. However, this result is not significant, see Table 2 for the corresponding $z$ - statistic and $p$ - values. We do not carry out an ex - post power test because it has been shown to be flawed (see Hoenig and Heisey, 2001). Rather, for dichotomous choice we implement the following equivalence test[11]

$$H_{0,3} : Yes(DCPU) - Yes(DCPR) \geq \theta$$
$$H_{A,3} : Yes(DCPU) - Yes(DCPR) < \theta$$

We consider social pressure to have a negligible effect if the null hypothesis is rejected for $\theta = .05$. For robustness, we also allow for $\theta$ to take on the values of .01 and .10. Results are listed in Table 3. We cannot reject the null hypothesis for $\theta$ equal to .01 or .05. However, we reject the null hypothesis for $\theta$ equal to .10 with a 10% confidence level. This indicates social pressure did not inflate stated preferences in dichotomous choice treatments by more than 10%.

We additionally assess the robustness of the results by conditioning the treatment effect on the observed heterogeneity of the subject pool. We account for the randomized response question in private treatments by augmenting the likelihood function according to Berrens *et al.* (1997). Maximum likelihood estimation was then completed using GAUSS 6.0.

Column 2 of Table 4 reports the results of a probit regression of the decision to answer "yes" in a dichotomous choice format on a treatment effect and socio-economic variables including age, parental income and gender. The reference observation is a female who's parental income is greater than $90,000 U.S. that participated in a public treatment. The treatment effect enters the probit regression as a dummy variable that takes on the value of 1 if the treatment was private. The conditional results suggest that subjects in the dichotomous choice treatments were more likely to answer "yes" in private than in public, though this result is insignificant. Age enters insignificantly, along with parental income and gender, a result consistent with List *et al.* (2004).

[11] Hoenig and Heisey (2001) argue that power is an increasing function of the observed $z$ - statistic. However, increasing a $z$ - statistic supports rejecting a null hypothesis of no effect. It is therefore problematic to claim that high power implies the probability of experiencing a type II error is low.

We now turn our attention to the voting-referendum treatments. Similar to dichotomous choice, the reference observation is a female who's parental income exceeds $90,000 U.S. that participated in a public treatment. We again control for the treatment effect by including a dummy variable that takes on the value of 1 if the treatment is private. Pooling the voting referendum treatments, we find that the coefficient on the treatment effect is -.440 (significant at the 10% confidence level). All covariates enter insignificantly. Column 3 in Table 4 reports the results for the pooled, voting-referendum treatments.

To test whether the effect of social isolation is group-size dependent, we split the pooled referenda data and run individual probit regressions for small and large-group sessions. The probit results from the small sample session show no significant evidence of social-pressure bias. The coefficient on the treatment effect is 0.22 but is not statistically different from zero. All other covariates enter insignificantly. Column 4 of Table 4 reports the results of the small-group, voting-referendum probit regression.

The large sample treatment appears to be the catalyst for the observed social-pressure bias in the pooled data. Using results from the large-group session, we find a clear and robust social-pressure bias. The coefficient on the treatment effect is -.990 (significant at the 1% confidence level). This result suggests that a voting referendum is more susceptible to social-pressure bias, and the bias is increasing the size of the audience. Column 5 of Table 4 reports the results of the large-group, voting-referendum probit regression.[12]

# 5 Conclusion

Evidence suggests social-pressure bias significantly inflates stated preferences within a voting referendum elicitation mechanism but not in a dichotomous choice format. This paper helps explain this result by exploring the *relative* effect of social isolation across these two formats. The main prediction of our model is that a referendum is relatively susceptible to social-pressure bias. The relative bias is created by the fact that within a referendum, a voter faces a less-than-unity probability of being a decisive voter. This creates an incentive for a voter to vote "yes" to gain social approval, facing little risk of affecting the outcome of the referendum. Our model also predicts that the size of social-pressure bias within a referendum is increasing in group size. This result is driven by the fact that as group size increases the probability of being the decisive voter decreases.

Experimental data are largely consistent with these predictions. For the voting referen-

[12] We recognize that larger sample sizes in referendum treatments increases the probability of rejecting the null hypothesis of minimal social-pressure bias. However, this will always be the case when comparing the results from large and small sample sessions - regardless of the size of the small sample session.

dum, we reject the null hypothesis that subjects were equally or less likely to vote "yes" in public than in private. For dichotomous choice treatments however, we cannot reject the null hypothesis that subjects in public were equally or less likely to answer "yes" in public as in private. Equivalence testing shows that within a dichotomous choice format, social pressure did not inflate stated preferences by more than 10%. Conditional tests support our prior, unconditional results. After controlling for age, gender and parental income, we find clear evidence of social-pressure bias within a voting referendum. However, this result does not carry over to a dichotomous choice elicitation mechanism. We also find evidence that within a voting referendum, social-pressure bias is increasing in group size. Our results suggest if one cannot protect against social-pressure bias, using a dichotomous choice may be the better choice as an elicitation mechanism. Whether our findings hold across other elicitation formats, e.g., open-ended, is left to future research.

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Table 1: Unconditional Results

| Treatment | N | Yes | Proportion Yes (%) | No | Proportion No (%) |
|---|---|---|---|---|---|
| Voting Referendum, Public | 60 | 37 | 61.6 | 23 | 38.3 |
| voting Referendum, Private | 59 | 23 | 38.9 | 36 | 61 |
| | (39) | (13) | (33.4) | (26) | (66.6) |
| Voting Referendum, Public | 32 | 12 | 37.5 | 20 | 62.5 |
| voting Referendum, Private | 37 | 17 | 45.9 | 20 | 54 |
| | (25) | (11) | (44) | (14) | (56) |
| Dichotomous Choice, Public | 68 | 23 | 34 | 45 | 66.1 |
| Dichotomous Choice, Private | 38 | 17 | 44.7 | 21 | 55 |
| | (25) | (10) | (42.1) | (15) | (60) |

**Note.** Entries in parenthesis represent total responses net random response answers. We expect 1/3 of answers for private treatments to represent answers to the random question. 1/2 of answers pertaining to the random question are expected to be "yes" and the other half "no" answers.

Table 2: Proportions Test

| Test | $Z$-Statistic | $P$-value |
|---|---|---|
| $VRPU - VRPR \leq 0$, Pooled Data | 1.74 | .040 |
| $VRPU - VRPR \leq 0$, Large Session | 2.52 | .005 |
| $VRPU - VRPR \leq 0$, Small Session | -.43 | .333 |
| $DCPU - DCPR \leq 0$ | -.62 | .267 |

**Note.** $Z$-statistics and associated $p$-values pertain to results excluding the expected 1/6 of "yes" and "no" answers from private treatments. We borrow from Tracy and Fox (1981) in our calculation of expected response rates to the real question and corresponding variances.

Table 3: Equivalence Test

| Test | $Z$-Statistic | $P$-value |
|---|---|---|
| $DCPU - DCPR \geq .01$ | -.697 | .245 |
| $DCPU - DCPR \geq .05$ | -.998 | .161 |
| $DCPU - DCPR \geq .10$ | -1.374 | .085 |

Table 4: Probit results

| Dependent Variable: probability of answering "yes" | | | | |
|---|---|---|---|---|
| | DC | VR-Pooled | VR-Small | VR-Large |
| Variable | Coefficient (Std. Err.) | Coefficient (Std. Err.) | Coefficient (Std. Err.) | Coefficient (Std. Err.) |
| Constant | -.811 | -.172 | -.748 | -1.591 |
| | (1.151) | (.599) | (.893) | (1.229) |
| Treatment | .250 | -.440* | .220 | -.990*** |
| | (.353) | (.241) | (.405) | (.354) |
| Age | .042 | .027 | .031 | .125** |
| | (.057) | (.027) | (.035) | (.063) |
| Male | -.415 | -.350 | -.246 | -.481 |
| | (.304) | (.249) | (.396) | (.344) |
| Income | -.240 | -.068 | -.157 | -.183 |
| | (.289) | (.231) | (.380) | (.314) |
| Pseudo $R^2$ | .069 | .0249 | .037 | .082 |

**Note.** ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Numbers in parenthesis represent standard errors. *Treatment* is a dummy variable that takes on the value of 1 if the subject participated in a private treatment. *Male* is a dummy variable that takes on the value of 1 if the subject was male. *Income* is a dummy variable that takes on the value of 1 if the parental income of the subject was less than $90,000 U.S. per year. The results from the private treatments are derived using an augmented likelihood function, explained in detail in Berrens *et al.* (1997).