Appendix 2: Methodology for Prediction

To Accompany
"Giving According to GARP:
An Experimental Test of the Consistency
of Preferences for Altruism"
by James Andreoni and John Miller

This appendix describes the methods for using an estimated CES utility function $U = U(\pi_s, \pi_o)$ to predict choices along $p_s\pi_s + p_o\pi_o = m$, although similar methods apply to all utility functions estimated. The CES utility function generates a homothetic demand function, hence the demand curve can be written as $\pi_s = f(p_s, p_o, m) = f(p_o/p_s)m/p_s$. We then estimate the demand expression

$$\frac{\pi_s}{m/p_s} = f(p_o/p_s) + \varepsilon \qquad \text{(A1)}$$

where ε is assumed to be distributed normally with mean zero and variance σ^2. For ease of notation, let the normalized choice be $C = \pi_s/(m/p_s)$.

Note that in the estimating equation $(A1)$ the demands are written in as a proportion of the normalized budget m/p_s. This is because the error term was found to vary with the fraction of the budget allocated rather than the level allocated, hence this formulation allows us to use an error term that is homoskedastic.

Notice that our data is subject to censoring. The experiment is structured such that own payoffs must be in the range $0 \leq C \leq 1$. To account for this, equation $(A1)$ is estimated using a two-limit tobit maximum likelihood procedure. Upon estimating the parameters of the demand curve, we can obtain an estimate of the individual's own payoff, conditional on price, income, and a set of censoring rules.

Consider a set of censoring rules that restricts choices to the range $L \leq C \leq H$. Let D be the predicted choice if censoring were ignored, that is, the value obtained simply by substituting the budget parameters into the estimated demand function. Next let $z_1 = (H - D)/\sigma$ and let $z_2 = (L - D)/\sigma$, where σ is the standard error determined in the maximum likelihood estimation. Finally, let $\phi(\cdot)$ be the standard normal distribution function and $\Phi(\cdot)$ be the standard normal density function. Then one can show (see Maddala (1983), pp. 365–67) that the expected value of C given the censoring rule is

$$\hat{C} = [1 - \Phi(z_1)]H + \Phi(z_2)L + (\Phi(z_1) - \Phi(z_2))\left[D + \sigma\frac{\phi(z_2) - \phi(z_1)}{\Phi(z_1) - \Phi(z_2)}\right]. \qquad \text{(A2)}$$

Consider the application of this to dictator games. In this case use $L = 0$ and $H = 1$ in the above to determine $\hat{C}$. Then the predicted number of people keeping the entire pie is simply $1 - \Phi(z_1)$.

Turn next to the public goods game. Let x be the *fraction* of the endowment that the individual keeps, and g be the *fraction* of the endowment given to the public good. Hence, $x + g = 1$ is the budget constraint. We would like to predict g. Since $\pi_s = x + \alpha g$, where α is the return on the contribution to the public good, we can solve for g to find

$$g = \frac{1 - \pi_s}{1 - \alpha}. \tag{A3}$$

Also, we know $\pi_o = \alpha g$. Substituting from π_s and π_o into the budget constraint, we see that the (normalized) payoffs are $\pi_s + p\pi_o = 1$, where $p = (1 - \alpha)/\alpha$. Note that in the public goods game an individual cannot allocate less to herself than to the other, hence $\pi_s \geq \pi_o$. This means that the smallest π_s can be is $1/(1 + p)$ while the largest it can be is 1. Hence, in expression $(A2)$ we set $L = 1/(1 + p)$ and $H = 1$ to estimate $\hat{\pi}_s$, and convert this to g using expression $(A3)$. Finally, the measure of the percent free riders is the probability $\Pr(\pi_s = 1) = 1 - \Phi(z_1)$.

From the above we obtain the aggregate percent contributed and the aggregate percent of free riders. It is a simple extension of this method to obtain the disaggregate percent contributed and the disaggregate percent free riders. Separate the sample into six types: Strong Leontief, Strong Selfish, Strong Perfect Substitutes, Weak Leontief, Weak Selfish and Weak Perfect Substitutes. For the strong types the predictions are exact. Since there is no clear prediction for the strong Perfect Substitutes at a relative price of 1, we follow our sample proportions in which the 50 percent of the players split evenly, 30 percent keep everything, and 20 percent give everything. For each of the three weak types we calculate the percent contributed and percent free riding as in the aggregate case. To obtain the disaggregate percent contributed and the disaggregate percent free riders take a weighted sum of the percent contributed and percent free riders of each of the six types, where the weights are the proportion of each type within the sample as given in Table 3.