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Abstract

We consider data from a dictator game experiment in which each dictator is repeatedly exposed to two different treatments: a *Giving treatment* in which the amount *given* to the recipient is constrained to be non-negative; and a *Taking treatment* in which the amount *taken* from the recipient is constrained to be non-negative. Another key design feature is that the price of transferring is varied between tasks. The data is used to estimate the parameters of a Stone-Geary utility function over own-payoff and other's-payoff. Between-subject heterogeneity is assumed in one of the selfishness parameters. The econometric model incorporates zero observations (e.g. zero-giving or zero-taking) by applying a version of the Kuhn-Tucker theorem and treating zeros as corner solutions in the Dictator's constrained optimisation problem. The method of maximum simulated likelihood (MSL) is used for estimation. We find that the average dictator exhibits a strong degree of selfishness in the sense of having a high *subsistence level* for own payoff. However, once this basic need is met, dictators appear willing to share the remaining endowment equally. Above all, we find that selfishness is lower in taking tasks than in giving tasks, and we attribute this difference to the "cold prickle of taking".

Keywords: Dictator games; Taking games; Kuhn-Tucker conditions; Experimetrics.

JEL classification: C57;C91;D64;D91.

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1 Introduction

Dictator games (Forsythe et al., 1994) were originally designed with the objective of investigating the determinants of giving. Although in essence the game is very simple, a huge literature has revealed that dictator behaviour is highly sensitive to certain design features. Engel (2011) provided a thorough meta analysis of dictator games, pooling the results of more than 100 studies. Factors he found to have a positive effect on giving include "endowment earned by recipient" and "deserving recipient". Factors having a negative effect include "endowment earned by dictator" and "repeated game".

A particularly interesting development was the introduction of a "taking treatment".[1] Bardsley (2008), List (2007) and Cappelen et al. (2013) all find evidence that the extension of the choice set to allow the dictator to take from the recipient has a negative effect on giving. Bardsley (2008) interprets this finding as the result of an experimenter demand effect (Zizzo, 2010). List's (2007) interpretation is that the social norm of the game is choice-set dependent.

A different way of investigating the impact of a taking treatment is to test for a framing effect. Here, typically the choice set is identical between the two treatments, but in one, the choice is framed as a giving decision, and in the other, it is framed as a taking decision. This sort of test has been carried out by Jakiela (2013) and Korenok et al. (2014, 2018). Common findings from these studies are that dictators tend to prefer the giving frame to the taking frame, dictators are prepared to sacrifice a proportion of their endowment to avoid the taking frame, and recipients tend to receive higher payoffs in the taking frame. In terms coined by Andreoni (1995), the "cold prickle" of taking is stronger than the "warm glow" of giving.

In this paper, we consider data from an experiment in which each dictator faces a sequence of tasks, in half of which only giving is possible, and in the remaining half only taking is possible. Between tasks, endowments and the price of transferring are varied. With this data, in a manner similar to Andreoni and Miller (2002), we estimate a parametric utility function over own-payoff and other's payoff, and the central question is whether and how the parameters of this utility function change between giving and taking tasks.

We make a number of contributions. Firstly, we assume a utility function that has not, to our knowledge, been used previously in social preference modelling: the Stone-Geary utility function. This function is best interpreted in

[1] A predecessor of the taking game was the "gangster game" introduced by Eichenberger and Oberholzer-Gee (1998), in which social norms were found to play an important role.

terms of the individual having a subsistence level (i.e. a minimum consumption level) for each "good". When subsistence requirements have been met, the endowment is then divided between goods according to a different set of parameters. As we shall see, the estimation of the parameters of this utility function leads to interesting new insights for social preference modelling.

Secondly - and this we consider to be the key innovation - we develop a way of dealing consistently with observations appearing on the the boundary of the feasible region (e.g. zero giving; zero taking; maximal taking). In previous studies, such observations have been treated on an equal basis to observations on the interior (Jakiela, 2013) or have been dealt with in an ad-hoc way, for example, by using doubly censored regression (Andreoni and Miller, 2002). The importance of allowing for a positive probability of zero observations and observations at other extremes (such as maximal taking), is firstly that the Nash Equilibrium prediction is typically at one of these extremes, and secondly that these observations typically make up a sizeable proportion of the experimental sample. Here, we are doing more than simply allowing for a positive probability of boundary observations, because we are finding a way of embedding boundary observations into the theoretical model whose parameters we estimate.

The approach adopted is to apply a version of the Kuhn-Tucker theorem (Arrow and Enthoven, 1961) to the dictator's constrained optimisation problem, and to treat zero observations (and also observations at other extremes) as corner solutions. The resulting econometric model is similar to that of Wales and Woodland (1983), who estimated the parameters of a utility function over three highly disaggregated consumption goods using household-level data containing a high incidence of zero expenditures. The possibility of applying the Wales and Woodland's Kuhn-Tucker approach in the context of dictator game experiments was first suggested by Moffatt (2015).

Thirdly, we compare giving and taking treatments using what might be described as a "structural treatment test". This is a test for a change in the structural parameters between treatments. Note that this sort of test is essential in the present situation, because the effect cannot be seen by simply comparing payoffs between treatments. The test is similar to that of Jakiela (2013) who tested for a change in the CES parameters. Note that this test fulfills the key objective of the paper, which is to determine whether dictators display more or less selfishness in a taking situation than in a giving situation.

Finally, we obtain posterior estimates of subject-specific selfishness, and use this to identify "types" in the population. A prominent type is the "Nash type", who maximise their own payoff in every task.

The remainder of the paper is organised as follows. Section 2 describes the experimental design. Section 3 presents the theoretical model and describes the estimation procedure. Section 4 provides descriptive data analysis. Section 5 presents estimation results, with discussion thereof. Section 6 concludes.

2 Experimental Design and Procedure

The experimental data used in this study was originally collected and analysed by Zevallos-Porles (2018). The experiment was conducted in June 2014 at the Laboratory for Economic and Decision Research (LEDR) at the University of East Anglia. Subjects were undergraduate students, recruited through the on-line recruitment system ORSEE (Greiner, 2015). A total of 138 subjects (69 dictators and 69 recipients) participated over seven experimental sessions. Each subject participated in only one session. None of the subjects had participated in a similar experiment before. The experiment was programmed and conducted with the software z-Tree (Fischbacher, 2007).

Upon arrival, all subjects were invited into the same room and seated at one of the computer cubicles at random. In each session, subjects were given a set of printed instructions. The experimenter read the instructions aloud and answered questions. Subjects also followed the instructions on their own computer screen. All forms of communication between subjects were strictly forbidden for the whole duration of the session. After receiving the instructions, all subjects were asked to answer a set of control questions. Control questions were administered to make sure that subjects understood the experiment and these questions were computerized. Once all subjects had satisfactory answered correctly the control questions, the experiment began. The instructions can be found in Appendix A.

The experimental design is similar to that of Andreoni and Miller (2002). In each session, dictators made allocation decisions in a series of different tasks. The tasks differ in the amount of the endowment, the price of self-allocation, the price of other-allocation, and the experimental treatment. The order of the tasks was randomized at individual level.

At the start of the experiment, half of the subjects were randomly assigned to the role of dictators and the other half to the role of recipients. Dictators and recipients kept their role throughout the experiment. Table 1 below shows the dictator's endowment, the recipient's endowment and the price of transferring in each task. There are two different treatments: "giving" (rows 1-9 of Table 1), in which dictators can give any part of their endowment in £0.50 increments;

and “taking” (rows 10-18 of Table 1), in which dictators can take any part of the recipient’s endowment in £0.50 increments. In both treatments, dictators engaged in nine allocation tasks. As seen in Table 1, the dictator’s endowment was either £1.5, £3, £5, £6 or £10, the recipient’s endowment was either £3 or £6 and the price of self-allocation and the price of other-allocation were either 1 or 0.5.

For each task, dictators were also given a menu of possible payoff combinations associated to their decisions. Dictators made their decisions by selecting one of the payoff combinations. Once the dictator had made her decision in one of the tasks, the following task was displayed on her computer screen and she was not able to go back to the previous task. Recipients had no decisions to make. Recipients were occupied and entertained by being invited to solve puzzles (unrelated to the experiment) during the time the dictators were making decisions.

Consider for example Task 4, which is a giving game. As seen in the fourth row of Table 1, the dictator’s and recipient’s endowments are £6 and £3 respectively, while the prices of self-allocation and other-allocation are 1 and 0.5. If the dictator transfers zero, both players receive a payoff of £6. Note that although the recipient’s endowment is only £3, her payoff is £6 because the price of other-allocation is 0.5. If the dictator decides to transfer, say, £2 to the recipient, then the dictator’s payoff reduces by £2 (to £4), but the recipient’s payoff increases by £4 (to £10). The screenshot of Task 4 as presented to the dictator is shown in Figure B.1 in the Appendix.

As a second example, consider Task 15, which is a taking game. As seen in the fifteenth row of Table 1, the dictator’s and recipient’s endowments are £3 and £6 respectively, while the prices of self-allocation and other-allocation are 0.5 and 1. Similarly to the first example, if the dictator takes zero, both players receive a payoff of £6. If the dictator decides to take, say, £3 from the recipient, then the dictator’s payoff increases by £6 (to £12), and the recipient’s payoff decreases by £3 (to £3). The screenshot of Task 15 as presented to the dictator is shown in Figure B.2 in the Appendix.

After all dictators had made their decisions, they were randomly matched with one subject from the recipient group. Then, for each dictator-recipient pairing, one task was randomly chosen to determine payments. Before the payment, all subjects answered a short computerised questionnaire, which gathered data on age, gender, field of study, and country of origin.

Each experimental session lasted for about one hour and the average payment per subject (including a participation fee of £2) was £8.59. Payments were administered individually and privately.

Table 1: Allocation Tasks

Task	Treatment	Dictator's endowment (m_1)	Recipient's endowment (m_2)	Price of self-allocation (p_1)	Price of other-allocation (p_2)
1	Giving	3	3	1	0.5
2	Giving	3	6	1	1
3	Giving	3	6	0.5	1
4	Giving	6	3	1	0.5
5	Giving	6	6	1	1
6	Giving	6	6	0.5	1
7	Giving	10	3	1	0.5
8	Giving	10	6	1	1
9	Giving	10	6	0.5	1
10	Taking	3	6	1	0.5
11	Taking	3	6	1	1
12	Taking	1.5	6	0.5	1
13	Taking	6	6	1	0.5
14	Taking	6	6	1	1
15	Taking	3	6	0.5	1
16	Taking	10	6	1	0.5
17	Taking	10	6	1	1
18	Taking	5	6	0.5	1

3 A model of Dictator game behaviour with binding non-negativity constraints

3.1 Notation

We define the following variables:

m_1 = own endowment
m_2 = other's endowment

x_1 = amount received by self
x_2 = amount received by other

p_1 = "price" per unit of x_1 (i.e. for each unit of the endowment allocated to self, self receives $1/p_1$ units).

p_2 = "price" per unit of x_2 (i.e. for each unit of the endowment allocated to other, other receives $1/p_2$ units).

Taking products of price and "quantity", we obtain something analogous to expenditure in a consumer demand model:

p_1x_1 = amount directed to self
p_2x_2 = amount directed to other

Note that the decision variable in the experiment is essentially p_1x_1. If $p_1x_1 < m_1$, this implies positive giving. If $p_1x_1 > m_1$, this implies positive taking. If $p_1x_1 = m_1$, this implies zero giving or taking.

3.2 The Utility Function

With the notation set out in Section 3.1, we specify the Stone-Geary utility function:

$$U(x_1, x_2) = a_1 ln(x_1 - b_1) + a_2 ln(x_2 - b_2) \tag{1}$$

For identification of the parameters, it will be necessary to impose the normalisations:

$$\begin{aligned} a_1 + a_2 &= 1 \\ b_1 + b_2 &= 0 \end{aligned} \tag{2}$$

b_1 and b_2 are conventionally interpreted as "subsistence levels" of x_1 and x_2. However, one of them is allowed to take a negative value, implying that indifference curves cross axes. This is necessary in order to explain zero observations in x_1 or x_2. Specifically, we expect the subsistence level for other's payoff to be negative, since this will allow zero observations in other's payoff, which is a standard feature of Dictator game data.

The assumption that the subsistence level for own payoff is positive is also a natural one. It captures the plausible idea that a dictator has in mind a minimum acceptable payoff for themselves, and only when that minimum is exceeded will they consider giving to others. The proportion of "supernumerary endowment"[2] they allocate to the other is in fact given by the parameter a_2.

[2]In demand analysis, "supernumerary income" is the term used for the portion of an indi-

Note that we are positing that a dictator can display two different types of selfishness. The first (b_1) represents their (privately considered) minimum acceptable payoff. The second (a_1) represents the proportion of their supernumerary endowment they wish to keep for themselves.

Various Stone-Geary indifference maps are illustrated in Figures 1 and 2. In each case, the feasible region is represented by the shaded triangle.[3] As illustrated in the Figures, whether the solution is an interior or a corner solution depends on the positions of the indifference curves relative to the feasible region.

(a) Giving Task. Positive Giving (b) Giving Task. Zero Giving

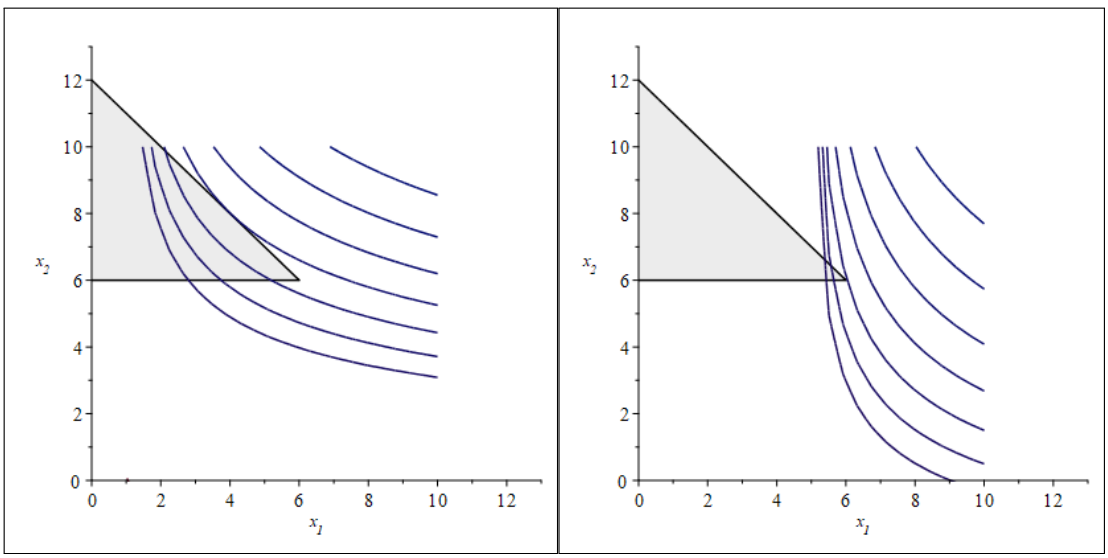

Figure 1: Stone-Geary Indifference Maps under Giving Task. x_1 is own payoff; x_2 is other's payoff. Feasible region represented by shaded triangle. In both (a) and (b), $m_1 = m_2 = 6$; $p_1 = p_2 = 1$. (a) parameter values: $b_1 = 1$; $a_1 = 1/4$; interior solution (positive giving); (b) parameter values: $b_1 = 5$; $a_1 = 1/4$; corner solution (zero giving)

vidual's income that remains after all the individual's basic needs have been met. See Deaton and Muellbauer (1980)

[3]Strictly speaking the feasible region is a single line - the hypotenuse of the shaded triangle. This is because the rules of the game stipulate that the total endowment must be divided between dictator and recipient. However, given the assumption of an increasing utility function, the implications of the model are the same if we present the feasible region as a triangle. This is convenient since it brings the analysis into alignment with standard textbook treatment of the 2-good model in consumer theory.

(a) TAKING TASK. ZERO TAKING

(b) TAKING TASK. POSITIVE TAKING

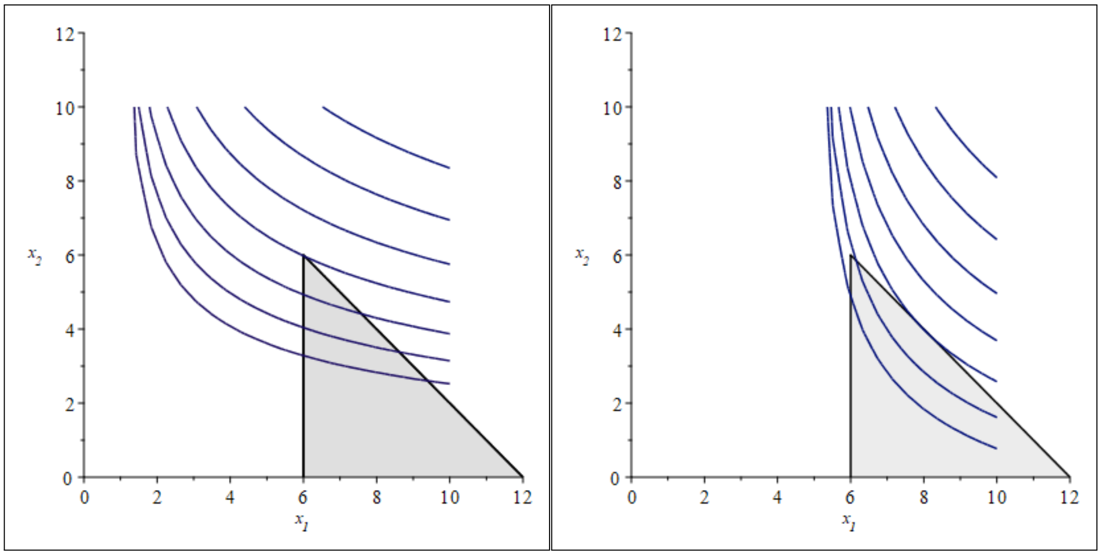

Figure 2: Stone-Geary Indifference Maps under Taking Task. x_1 is own payoff; x_2 is other's payoff. Feasible region represented by shaded triangle. In both (a) and (b), $m_1 = m_2 = 6$; $p_1 = p_2 = 1$. (a) parameter values: $b_1 = 1$; $a_1 = 1/4$; corner solution (zero taking); (b) parameter values: $b_1 = 5$; $a_1 = 1/4$; interior solution (positive taking)

3.3 Giving Task - Theory

The budget constraint (in both giving and taking tasks) is:

$$p_1 x_1 + p_2 x_2 \leqslant m_1 + m_2 \tag{3}$$

In the giving task, the non-negativity constraints are embodied in $0 \leqslant p_1 x_1 \leqslant m_1$. The two constraints taken together give rise to a feasible region such as those represented by the shaded triangles in Figures 1a and 1b above.

The constrained optimisation problem for the giving task may be stated as:

$$\max_{x_1, x_2} U(x_1, x_2) \quad \text{s.t.} \quad p_1 x_1 + p_2 x_2 \leqslant m_1 + m_2; \quad 0 \leqslant p_1 x_1 \leqslant m_1 \tag{4}$$

Where $U(x_1, x_2)$ is specified in (1). The Lagrangean function is:

$$\begin{aligned} L = a_1 ln(x_1 - b_1) + a_2 ln(x_2 - b_2) + \lambda(m_1 + m_2 - p_1 x_1 - p_2 x_2) \\ + \mu_1 p_1 x_1 + \mu_2 (m_1 - p_1 x_1) \end{aligned} \tag{5}$$

Applying a version of the Kuhn-Tucker Theorem (Arrow and Enthoven, 1961) to (5), we obtain the following complementary slackness conditions:

$$\begin{aligned}
\frac{a_1}{p_1(x_1-b_1)} &< \frac{a_2}{p_2(x_2-b_2)} \quad \Leftrightarrow \quad p_1x_1 = 0 \\
\frac{a_1}{p_1(x_1-b_1)} &= \frac{a_2}{p_2(x_2-b_2)} \quad \Leftrightarrow \quad 0 < p_1x_1 < m_1 \\
\frac{a_1}{p_1(x_1-b_1)} &> \frac{a_2}{p_2(x_2-b_2)} \quad \Leftrightarrow \quad p_1x_1 = m_1
\end{aligned} \tag{6}$$

Let us focus on the self-allocation (x_1). Combining the complementary slackness conditions (6) with the (binding) budget constraint ($p_1x_1 + p_2x_2 = m_1 + m_2$), we obtain the well-known linear expenditure system (with non-negativity constraints):

$$\begin{aligned}
p_1x_1 =& p_1b_1 + a_1(m_1 + m_2 - p_1b_1 - p_2b_2) \quad \Leftrightarrow \quad 0 < RHS < m_1 \\
p_1x_1 =& 0 \quad \Leftrightarrow \quad RHS \leqslant 0 \\
p_1x_1 =& m_1 \quad \Leftrightarrow \quad RHS \geqslant m_1
\end{aligned} \tag{7}$$

In (7), "RHS" denotes the right-hand side of the first equation. The first equation of (7) has the following interpretation. Given an interior solution, expenditure on good 1 (p_1x_1) is subsistence expenditure for self (p_1b_1) plus a proportion a_1 of supernumerary endowment.

Applying the normalisations (2), and after some rearranging, the three conditions (7) may be written:

$$\begin{aligned}
b_1 &< \frac{-a_1(m_1+m_2)}{(1-a_1)p_1 + a_1p_2} \quad \Leftrightarrow \quad p_1x_1 = 0 \\
b_1 &= \frac{p_1x_1 - a_1(m_1+m_2)}{(1-a_1)p_1 + a_1p_2} \quad \Leftrightarrow \quad 0 < p_1x_1 < m_1 \\
b_1 &> \frac{(1-a_1)(m_1+m_2)}{(1-a_1)p_1 + a_1p_2} \quad \Leftrightarrow \quad p_1x_1 = m_1
\end{aligned} \tag{8}$$

3.4 Taking Task - Theory

In the taking task, the non-negativity constraints are represented by $m_1 \leqslant p_1x_1 \leqslant m_1 + m_2$. The lower bound of this double inequality represents zero taking, while the upper bound represents maximal taking. This constraint, together with the budget constraint (3), gives rise to a feasible region such as those represented by the shaded triangles in Figures 2a and 2b above.

The constrained optimisation problem may be stated as:

$$\max_{x_1,x_2} U(x_1,x_2) \quad \text{s.t.} \quad p_1x_1 + p_2x_2 \leqslant m_1 + m_2; \quad m_1 \leqslant p_1x_1 \leqslant m_1 + m_2 \tag{9}$$

As with the giving task considered in Section 3.3, we apply a version of the Kuhn-Tucker theorem, and arrive at a set of three conditions analogous to (8) above:

$$\begin{aligned}
b_1 &< \frac{(1-a_1)(m_1+m_2)}{(1-a_1)p_1+a_1p_2} \quad \Leftrightarrow \quad p_1x_1 = m_1 \\
b_1 &= \frac{p_1x_1 - a_1(m_1+m_2)}{(1-a_1)p_1+a_1p_2} \quad \Leftrightarrow \quad m_1 < p_1x_1 < m_1+m_2 \\
b_1 &> \frac{(1-a_1)(m_1+m_2)+m_2}{(1-a_1)p_1+a_1p_2} \quad \Leftrightarrow \quad p_1x_1 = m_1+m_2
\end{aligned} \tag{10}$$

3.5 Likelihood Function

Whichever of the two types of task (giving or taking) is being considered, the dictator's decision falls into one of three "regimes" of behaviour: lower bound (Regime I); interior solution (Regime II); upper bound (Regime III). Since the three regimes are defined differently in giving and taking tasks, we provide explicit definitions in Table 2.

Table 2: Definitions of the three behavioural regimes for each type of task

Regime	Giving Tasks	Taking Tasks
I	$p_1x_1 = 0$	$p_1x_1 = m_1$
II	$0 < p_1x_1 < m_1$	$m_1 < p_1x_1 < m_1 + m_2$
III	$p_1x_1 = m_1$	$p_1x_1 = m_1 + m_2$

Let $i = 1, ..., n$ index dictators, and let $t = 1, .., T$ index tasks. In order to allow within-subject preference variability, and also to allow a treatment effect, we shall assume that the self-allocation "subsistence level", b_1, varies between tasks. Denote the value of this parameter for dictator i in task t as $b_{1,it}$. We will assume:

$$b_{1,it} \sim N(\gamma_i + \beta_{take} d_{take,t} + \beta_\tau \tau_{it}\ ,\ \sigma^2) \tag{11}$$

where γ_i is the baseline mean subsistence parameter for dictator i, $d_{take,t}$ is a treatment dummy indicating whether (1) or not (0) task t is a taking task, and τ_{it} is the position of task t in the ordering of tasks faced by dictator i. The key parameter of the model is β_{take}, since this represents the treatment effect of central interest. The parameter β_τ represents the change in selfishness with experience of the task.

Conditional on the (baseline) subject mean γ_i, the likelihood contributions associated with a single observation in each of the three regimes are:

$$\begin{aligned}
I: L_{it}^{I}|\gamma_i &= \Phi\left[\frac{\frac{p_{1,t}x_{1,it} - a_1(m_{1,t}+m_{2,t})}{(1-a_1)p_{1,t}+a_1 p_{2,t}} - (\gamma_i + \beta_{take} d_{take,t} + \beta_\tau \tau_{it})}{\sigma}\right] \\
II: L_{it}^{II}|\gamma_i &= \frac{1}{\sigma}\phi\left[\frac{\frac{p_{1,t}x_{1,it} - a_1(m_{1,t}+m_{2,t})}{(1-a_1)p_{1,t}+a_1 p_{2,t}} - (\gamma_i + \beta_{take} d_{take,t} + \beta_\tau \tau_{it})}{\sigma}\right] \\
III: L_{it}^{III}|\gamma_i &= 1 - \Phi\left[\frac{\frac{p_{1,t}x_{1,it} - a_1(m_{1,t}+m_{2,t})}{(1-a_1)p_{1,t}+a_1 p_{2,t}} - (\gamma_i + \beta_{take} d_{take,t} + \beta_\tau \tau_{it})}{\sigma}\right]
\end{aligned} \tag{12}$$

where $\phi(.)$ and $\Phi(.)$ are the standard normal p.d.f. and c.d.f. respectively. Note that the likelihood contributions defined in (12) apply to both giving and taking tasks.

If we then define three indicators D_{it}^{I}, D_{it}^{II}, D_{it}^{III} taking the value 1 if subject i in task t is in regime I, II, and III respectively, and zero otherwise, we can express the conditional likelihood contribution for this single observation as:

$$L_{it}|\gamma_i = \left(L_{it}^{I}|\gamma_i\right)^{D_{it}^{I}} \left(L_{it}^{II}|\gamma_i\right)^{D_{it}^{II}} \left(L_{it}^{III}|\gamma_i\right)^{D_{it}^{III}} \tag{13}$$

The likelihood contribution (still conditional on γ_i) for subject i is then:

$$L_i|\gamma_i = \prod_{t=1}^{T}(L_{it}|\gamma_i) \tag{14}$$

Between-subject heterogeneity may be introduced by allowing the (baseline) mean parameter γ_i to vary between subjects. Accordingly, we assume:

$$\gamma_i \sim N(\mu, \eta^2) \tag{15}$$

The marginal likelihood contribution for subject i is obtained by integrating (14) over γ, as follows:

$$L_i(a_1, \mu, \beta_{take}, \beta_\tau, \eta, \sigma) = \int_{-\infty}^{\infty} \left[\prod_{t=1}^{T} (L_{it}|\gamma) \right] \frac{1}{\eta} \phi \left(\frac{\gamma - \mu}{\eta} \right) d\gamma \tag{16}$$

Finally, the sample log-likelihood function may be written as:

$$LogL(a_1, \mu, \beta_{take}, \beta_\tau, \eta, \sigma) = \sum_{i=1}^{n} ln(L_i(a_1, \mu, \beta_{take}, \beta_\tau, \eta, \sigma)) \tag{17}$$

The sample log-likelihood (17) is maximised with respect to the model's six free parameters, a_1, μ, β_{take}, β_τ, η, σ, to obtain estimates thereof.[4]

3.6 Posterior Estimates of Selfishness Parameter

Having estimated the model, it is useful to obtain posterior estimates of the mean self-subsistence level for each subject. Such posterior estimates are obtained using Bayes' Rule:

$$\hat{\gamma}_i = \frac{\int_{-\infty}^{\infty} \gamma \left[\prod_{t=1}^{T} (L_{it}|\gamma) \right] \frac{1}{\eta} \phi \left(\frac{\gamma - \mu}{\eta} \right) d\gamma}{\int_{-\infty}^{\infty} \left[\prod_{t=1}^{T} (L_{it}|\gamma) \right] \frac{1}{\eta} \phi \left(\frac{\gamma - \mu}{\eta} \right) d\gamma} \tag{18}$$

4 Data

Data from the experiment described in Section 2 have been used to estimate the model developed in Section 3.

There are 69 subjects carrying out 18 tasks, of which 9 are giving tasks and 9 are taking tasks. As seen in Table 1 above, the tasks differ in the amount of the

[4]The method of maximum simulated likelihood (MSL; Train (2009)) is used, with the integral in (16) being evaluated using Halton draws. The program is written in STATA 16 and is available on request. See Moffatt (2015) for detailed accounts of the use of MSL in settings similar to this.

endowment, the price of self-allocation, and the price of other-allocation. To give a feel for the data, Table 3 shows the distribution of the data between the three behavioural regimes defined in Table 2 above. We see that in giving tasks there is a strong bias towards selfishness with almost 90% of giving decisions being zero. In taking tasks, while there is again a bias towards the most selfish regime, the distribution of taking decisions between the three regimes is much more even. The high numbers in the final row of Table 3 (implying maximal selfishness) underline the importance of allowing for corner solutions in the theoretical model.

Table 3: Distribution of decisions between the three behavioural regimes, separately for giving tasks and taking tasks

Regime	Definition	Giving tasks	Proportion of Giving tasks	Taking tasks	Proportion of Taking tasks
I	Lower bound	1	0.2%	75	12.1%
II	Interior solution	74	11.9%	199	32.1%
III	Upper bound	546	87.9%	347	55.9%

Note: Total number of giving taks: 621. Total number of taking tasks: 621.

Further descriptive analysis of the data is provided in Figure 3, where we provide jittered scatter plots of amount received by other, against amount received by self, separately for the giving tasks and the taking tasks. Firstly, note that in both plots, as expected, observations are grouped on downward-sloping straight lines, corresponding to the budget lines implied by the endowment-price combinations in the design (see Table 1).

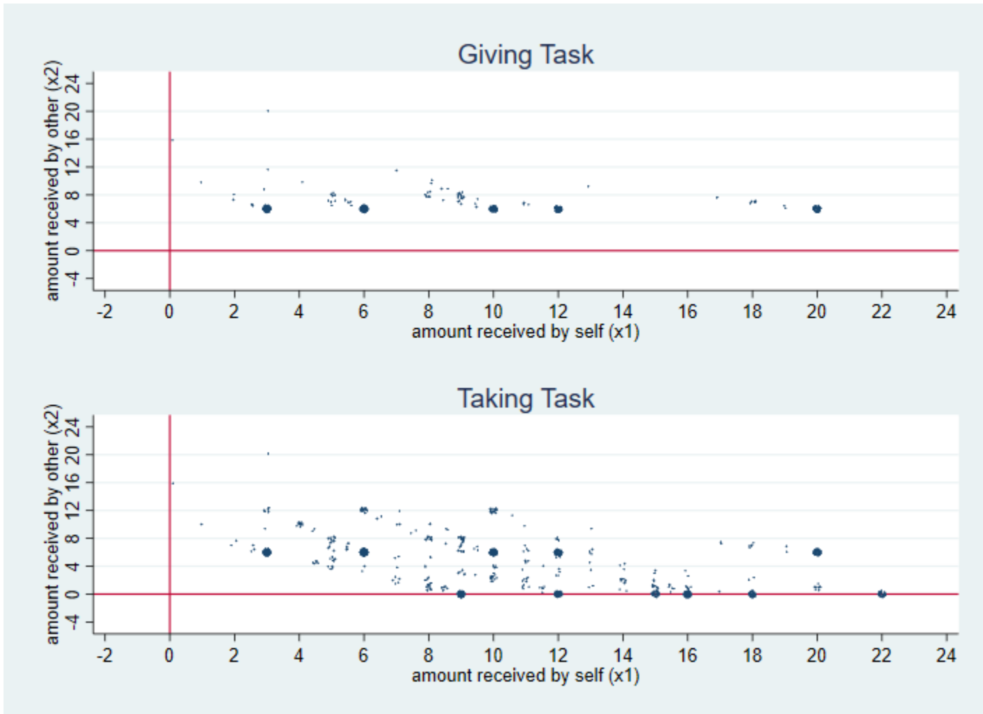

Figure 3: Jittered scatterplots of amount received by other (x_2), against amount received by self (x_1), separately for giving tasks and taking tasks.

Secondly note that, in both graphs, a high proportion of observations lie on a lower bound of x_2, implying either zero giving or maximal taking. This accords with the high numbers appearing in the final row of Table 3, interpreted above.

Finally, note that a comparison of the two plots indicates that dictator behaviour *appears to* be more selfish in taking tasks than in giving tasks. To confirm this, the mean of dictator's payoff is higher in the taking treatment (£12.34) than in the giving treatment (£8.25), while the mean of recipient's payoff is *lower* in the taking treatment (£2.28) than in the giving treatment (£6.24). However, these comparisons are misleading, since taking tasks are - regardless of dictator preferences - prone to higher payoffs to the dictator and lower payoffs to the recipient (than in giving tasks). To identify the true underlying effect of the taking treatment on selfishness, it is necessary to conduct a structural treatment test of the type performed in the next section.

5 Results

The results are presented in Table 4.

Table 4: Maximum Likelihood Estimates

Parameter	All subjects	Nash subjects excluded
a_1	0.550	0.550
	(0.036)	(0.035)
μ	10.158	6.176
	(1.083)	(0.843)
β_{take}	-1.648	-1.586
	(0.411)	(0.404)
β_{τ}	-0.048	-0.052
	(0.031)	(0.031)
η	6.484	3.558
	(0.677)	(0.373)
σ	3.506	3.481
	(0.167)	(0.165)
LogL	-1049.36	-999.734
n	69	47
T	18	18

Note: Estimated model is defined in (1), (11), (15). Estimation is by maximum simulated likelihood. Asymptotic standard errors in parentheses.

The first set of estimates is from estimation with the complete sample. The key result is the strong negative significance of the estimate of the treatment effect β_{take}, indicating that there is strong evidence that selfishness is lower in taking tasks than in giving tasks, ceteris paribus. The precise interpretation of the estimate of β_{take} is that dictators are prepared to settle for a payoff of £1.65 less when the task is a taking task, presumably in an attempt to allay the "cold prickle" of guilt associated with the task.

Posterior means ($\hat{\gamma}_i$) of the self-subsistence-level for each subject (applying to giving tasks) are obtained using (18) above, and their distribution is shown in the first panel of Figure 4.[5] The striking feature of this histogram is the prominent cluster of subjects at the right-hand end of the distribution. It turns out that this cluster consists of the 22 (out of 69) subjects who exhibit maximal selfishness in every task; that is, they give zero in every giving task, and they take the recipient's entire endowment in every taking task. We can refer to such subjects as "Nash subjects". The presence of this cluster calls into question the assumption (15) of Normality of γ_i.

As a robustness check, we re-estimate the model excluding the 22 Nash subjects. The results are shown in the second column of Table 4. The key result remains the same: the estimate of β_{take} is significantly negative, confirming that selfishness is significantly lower in taking tasks than in giving tasks. The posterior means from estimation with the restricted sample are shown in the second panel of Figure 4. As expected, the right-hand cluster has disappeared, and the remainder of the distribution has become more compact, in agreement with the much lower estimate of η. Moreover, the distribution appears closer to normality.

[5] The distribution for taking tasks is the same but shifted to the left by the estimate of β_{take}.

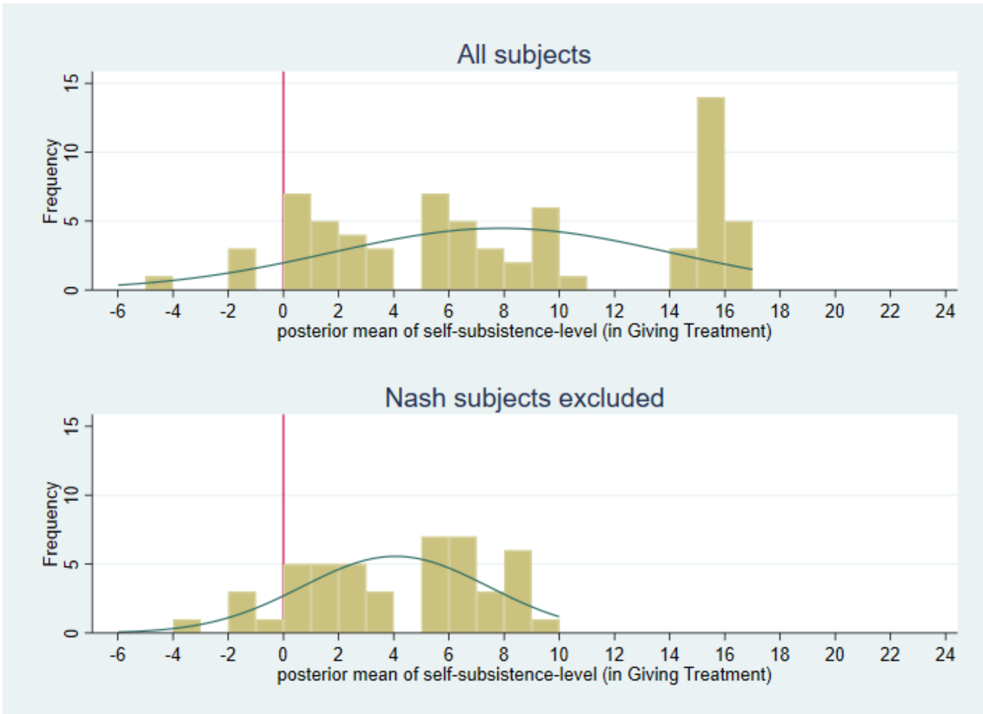

Figure 4: The distribution of posterior mean of self-subsistence-level for the two estimations. Normal densities superimposed.

The other selfishness parameter is a_1, representing the proportion of supernumerary endowment allocated to self. In both estimations, this parameter is not significantly different from 0.5. This leads to the interesting conclusion that once dictators have satisfied their self-determined basic requirement, they are happy to divide the remainder of the endowment equally between themselves and the recipient.

Finally, we see that in both estimations the estimate of β_τ is negative but not significant. This is consistent with the stability of preferences over the course of the experiment.

6 Conclusion

We have contributed to the literature on taking dictator games initiated by Bardsley (2008) and List (2007). In the experimental setting that we have considered, the theoretical (Nash) prediction is either zero giving or maximal taking, and there is a high incidence of such observations in the data. For these reasons, it is clearly very important for any theoretical model to assign positive probability to these observations. We have accomplished this by treating zero giving and maximal taking as corner solutions in the dictator's constrained optimisation problem.

The Stone-Geary utility function has been assumed. This is mainly because this utility function has indifference curves crossing axes, which makes way for the required corner solutions. The Stone-Geary assumption also leads to a novel characterisation of selfishness, in which the dictator may be thought of as first deciding (privately) how much of an endowment is rightfully theirs (referred to as the "self-subsistence level"), end then deciding the proportion of the remaining endowment they are prepared to share with the recipient. As expected, post-estimation analysis reveals wide between-subject variation in the self-subsistence level. In particular, there is a clearly identified cluster of dictators with a very high subsistence level and these are, of course, the dictators who exhibit fully selfish behaviour in every task. This sort of heterogeneity usually calls for the use of a finite mixture model (see Moffatt, 2015). In the present case, there is no need to estimate a finite mixture model because the "Nash" type is so clearly identifiable. The model estimated excluding the Nash subjects is essentially a 2-type finite mixture with mixing proportion for Nash types estimated as $22/69 = 0.32$.

The most important conclusion from the analysis is that selfishness is significantly lower in taking tasks than in giving tasks, ceteris paribus. Note that the structural treatment test was essential in arriving at this finding. As discussed at the end of Section 4, the result cannot be obtained by simply comparing payoffs between treatments, and this provides a strong justification for the fully structural approach adopted in this paper. The result provides fresh evidence that the "cold prickle of taking" is an important influence on agents' behaviour in social preference settings.

Perhaps surprisingly, the second selfishness parameter (a_1) is estimated as being very close to 0.5, indicating that dictators behave like egalitarians once their "subsistence needs" have been met.

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Appendices

Appendix A Experimental Instructions

Thank you for participating in this experiment. In this experiment, you can earn money. What you earn will depend upon your decision, and on the decision of another participant in the room. No data that you provide can be associated with your person; all data will be treated confidentially.

Please follow the instructions carefully. These instructions explain how the experiment works. If any of the instructions are unclear, or if you have any questions, please raise your hand and I will come to you and assist you. Please do not communicate with any other participant during the experiment.

In this experiment, half of the participants in this room will be randomly assigned to the role of Player 1 and the other half of the participants will be assigned to the role of Player 2. You will hold this role throughout the experiment.

Note that Player 1 will not learn the identity of Player 2, neither during nor after the session. Likewise, Player 2 will not learn the identity of Player 1. The experiment is expected to last no more than an hour.

Instructions for Player 1:

You will be Player 1 and another participant will be Player 2. You will be asked to make a series of decisions in 18 scenarios shown in random order.

In each scenario, you will have to decide whether to increase Player 2's earnings by decreasing your earnings, or whether to decrease Player 2's earnings by increasing your earnings. If you decide neither to increase nor to decrease Player 2's earnings, your earnings and Player 2's earnings will remain unchanged.

Player 2 will not make any decisions. Your earnings will depend on your decisions alone.

After you make your decision in all scenarios, you will be randomly matched with one of the participants in the role of Player 2. The computer, then, will randomly choose one of your decisions. You will be paid what you chose as your earnings and Player 2 will be paid what you chose as Player 2's earnings in the randomly selected scenario.

Your earnings, plus £2 for showing up, will be paid to you in cash at the end of the experiment. You will not interact with Player 2 again in today's experiment.

Instructions for Player 2:

You will be Player 2 and another participant will be Player 1. You will not make any decisions. Player 1 will be asked to make a series of decisions in 18 scenarios shown in random order.

In each scenario, Player 1 will have to decide whether to increase your earnings by decreasing his/her earnings, or whether to decrease your earnings by increasing his/her earnings. If Player 1 decides neither to increase nor to decrease your earnings, your earnings and Player 1's earnings will remain unchanged.

After all Player 1s make their decisions in all scenarios, you will be randomly matched with one of the participants in the role of Player 1. The computer will randomly choose one of the Player 1's decisions. You will be paid what Player 1 chose as your earnings and Player 1 will be paid what he/she chose as his/her earnings in the randomly selected scenario.

Your earnings, plus £2 for showing up, will be paid to you in cash at the end of the experiment. You will not interact with Player 1 again in today's experiment.

Before the experiment begins:

All players will have to correctly answer some questions. These questions check your understanding of the experimental instructions.

Appendix B Specimen Dictator's Tasks

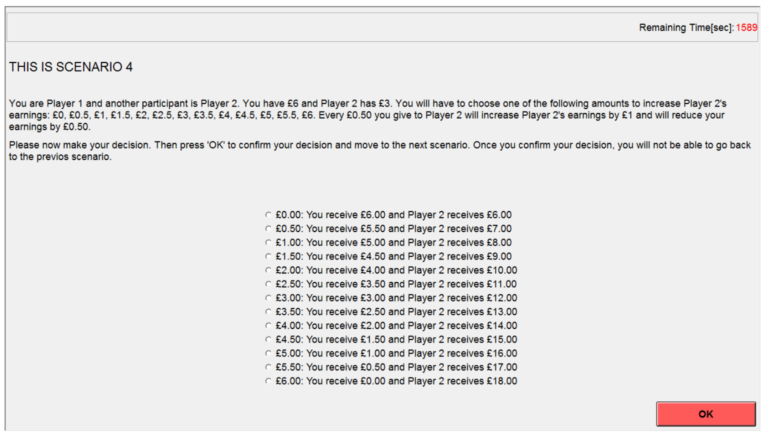

Figure B.1: Task 4

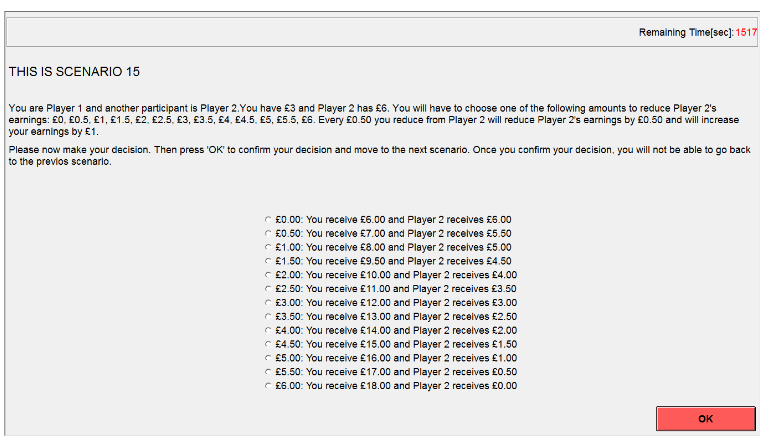

Figure B.2: Task 15