

# Why Do People Give?

## Testing Pure and Impure Altruism\*

Mark Ottoni-Wilhelm, IUPUI  
Lise Vesterlund, University of Pittsburgh and NBER  
Huan Xie, Concordia University

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**Abstract:** Researchers measure crowd-out around *one* level of charity output to identify whether giving is motivated by altruism and/or warm-glow. However crowd-out depends on output, implying first that the power to reject pure altruism varies, and second that a single measurement of incomplete crowd-out can be rationalized by many different preferences. By instead measuring crowd-out at different output levels we allow both for identification and for a novel and direct test of impure altruism. Using a new experimental design we present the first empirical evidence that consistent with impure altruism, crowd-out decreases with output.

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## 1. Introduction

Optimal designs of both public policy and fundraising mechanisms rely on the extent to which charitable donations are motivated by altruism and warm-glow. Motives for giving influence donor responses to changes in public funding for projects, and influence the effectiveness of a wide range of solicitation strategies, such as the characteristics of the ask; whether past donations should be announced to future donors; and whether a charitable lottery is likely to increase the funds raised.

To identify preferences for charitable giving researchers center on measuring how much individual donations respond to, or are crowded out by, donations by others. We explore this central crowd-out test and demonstrate that it is not well-suited for identifying preferences.

The theory of pure altruism assumes that the sole motive for charitable giving is the utility derived from the charity's output — e.g., from children in need getting aid (Becker 1974).<sup>1</sup> Such altruistic motives imply that gifts are valued because they increase the charity's output, and that donations by self and others are seen as perfect substitutes. While altruism is a compelling motive, *pure* altruism implies great responsiveness to donations by others, and in turn produces extreme predictions. For example, a one-dollar lump-sum tax used to increase the charity's output is predicted to decrease the donor's contribution dollar-for-dollar, leaving the charity's total output unchanged (Warr 1982). Complete crowd-out is a testable prediction of the pure altruism model.<sup>2</sup>

Andreoni (1989) suggested that in addition to getting utility from the charity's output, donors also get 'warm-glow' from the act of giving. Warm-glow is a private benefit that is experienced only by the individual contributing. Motivated by both altruism and warm-glow, the impure altruist does not see donations by self and others as perfect substitutes. A one-dollar increase in the charity's output financed by a lump-sum tax does not produce the warm-glow of a voluntary gift, thus in response the impure altruist decreases her own gift by less than a dollar, in turn increasing the charity's total output. Less-than-complete crowd-out is a testable prediction of the impure altruism model.

The different predictions have led to crowd-out becoming the central test when identifying motives: the null hypothesis of pure altruism/complete crowd-out is tested against the alternative of impure altruism/incomplete crowd-out.<sup>3</sup> This test has always been carried out around *one* level of the charity's

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<sup>1</sup> The literature on motives for giving can be seen as examining the supply side of charitable giving. Significant research has also been done on the demand side to understand the mechanisms fundraisers use to solicit funds (for reviews see e.g., Andreoni and Payne, 2013; List, 2011; Vesterlund, forthcoming).

<sup>2</sup> Andreoni (1988), Bergstrom, Blume, and Varian (1986), and Warr (1983) provide additional examples of the discrepancies between the theoretical predictions of the pure altruism model and field evidence. For reviews of the literature on crowd-out, see Steinberg (1991), Khanna, Posnett, and Sandler (1995), Kingma (1989), Okten and Weisbrod (2000), Payne (1998), Ribar and Wilhelm (2002), and Vesterlund (2006).

<sup>3</sup> Recognizing the difficulty associated with drawing inference on motives from secondary data, recent work relies on experimental methods. Lab experiments eliminate fundraising responses to others' giving (Andreoni and Payne, 2011), and provides the needed control of the information each donor has about the level of others' giving. Laboratory studies have produced a wide range of crowd-out estimates from zero to complete, though the majority of studies find less than complete crowd-out and reject pure altruism (Andreoni 1993; Bolton and Katok 1998; Chan, Godby, Mestelman, and Muller 2002; Sutter and Weck-Hannemann 2004; Eckel, Grossman, and Johnston 2005; Gronberg, Luccasen, Turocy, and Van Huyck 2012).

output resulting in a *single* crowd-out measurement. Although a single incomplete crowd-out measurement appears indicative of the degree of departure from pure altruism, and of the weight placed on warm-glow, such inference is not correct. Building on the insights of Ribar and Wilhelm (2002) and Yildirim (2014) we show that under impure altruism the degree of crowd-out is sensitive to the charity's output level. Intuitively, as the charity's output increases, the marginal utility from further increasing output decreases, and so an impure altruist's *marginal* motive for giving shifts away from being influenced by altruism (the benefit of increasing output) toward being influenced by warm-glow (the private benefit of making the gift). This shift in marginal motive toward warm-glow decreases how substitutable donations by self and others are, and in turn decreases crowd-out. Thus, for a given set of impurely altruistic preferences the degree of crowd-out varies with the output level at which it is measured.

The sensitivity to the charity's output implies that a single crowd-out measurement is insufficient for identifying preferences. First, the power to reject pure altruism/complete crowd-out from a single crowd-out measurement depends on the output level where it is measured. Second, because crowd-out varies, a single measurement cannot identify altruism and warm-glow preferences. Indeed, a single measurement of incomplete crowd-out is consistent with an infinite set of preferences, ranging from impure altruism in which altruism plays a predominant role to preferences where giving is motivated only by warm-glow. However, *multiple* crowd-out measurements around different levels of the charity's output both secure identification and permit a new test of the impure altruism model: namely whether the comparative static of the impure altruism model — that crowd-out is decreasing in the charity's output — is supported by the data.

We introduce a new experimental design to measure crowd-out at multiple levels of output. By creating an individualized charity for each participant, our design controls the charity's exogenously given initial level of output. Each participant is paired with a child whose house has suffered extensive fire damage, and the participant may donate money to purchase books for the child. The participant's donation is added to an exogenous donation by a foundation, the charity's initial output level, and the sum of the two is used to purchase books for the child. Book donations are distributed to the child by the American Red Cross as they aid the family immediately after the fire. The foundation's exogenous donation is the only other contribution toward books for the child, and thus the participant has control over the total and final amount given. By controlling the charity's initial output level, our design closely captures the theoretical framework used to model charitable giving.

We use the design to measure crowd-out at an initially low and at an initially high output level and provide the first evidence that crowd-out depends on where it is measured. At the low level of output we find essentially complete crowd out, while crowd-out is incomplete at the high level of output. Had we followed the literature by taking only one crowd-out measurement, and had that one measurement been at the low output level, we would have concluded that donations were motivated by pure altruism. If instead we had measured crowd-out at the higher output, we would have concluded that donations were motivated by impure altruism. Thus, the power to reject pure altruism depends on the level of output.

Measuring crowd-out at different output levels, we also conduct the first direct test of impure altruism. Finding that the decrease in crowd-out is statistically significant, we confirm the novel comparative static that crowd-out decreases as the charity's output increases, and conclude that donations in our study on average are motivated by impure altruism.

Finally, our design allows inference on the underlying preferences. Measuring crowd-out and income effects at different output levels, we demonstrate how a structural model of impure altruism can be estimated to determine altruism and warm-glow parameters. We estimate both representative-agent and individual-specific preferences, with the latter capturing the natural heterogeneity in motives across individuals. While our direct test of impure altruism makes it possible to conclude that giving is motivated both by altruism and warm-glow, the structural analysis is needed to assess the relative weight placed on the two motives.

## 2. Theory and Background

To demonstrate that the degree of crowd-out depends on the charity's output level, we follow Becker (1974), Bergstrom, Blume, and Varian (1986), and Andreoni (1989, 1990) in reviewing the pure and impure altruism models.

In the pure altruism model, individual  $i$  derives utility  $U(x_i, G)$  from private consumption  $x_i$  and from the charity's output  $G$ , a public good. Normalizing prices,  $i$ 's budget constraint is  $x_i + g_i \leq w_i$ , where  $g_i$  is her gift to the charity and  $w_i$  is her income.  $G = \sum_{i=1}^n g_i$  denotes the sum of the individual gifts, and  $G_{-i} = \sum_{j \neq i} g_j$  the amount given by others. Assuming that  $U(\cdot, \cdot)$  is continuous and strictly quasi-concave,  $i$ 's preferred level of the charity's output is given by the continuous demand function  $G^* = q(w_i + G_{-i})$ . A pure altruist's preferred charity output,  $G^*$ , only depends on her social income,  $Z_i \equiv w_i + G_{-i}$ . Capturing that donations by self and others are perfect substitutes the 'income' effects with respect to own income and giving-by-others are equal:  $dG^*/dw_i = dG^*/dG_{-i} \triangleq q_1$ .<sup>4</sup> An increase in giving-by-others, that is funded through a lump-sum tax on  $i$  ( $dG_{-i} = -dw_i$ ) will change the composition but not the level of social income, and leave unchanged  $i$ 's preferred charity output.  $i$ 's response to the tax funded increase in giving-by-others is a one-for-one decrease in her contribution and crowd-out is predicted to be complete  $\frac{dg_i^*}{dG_{-i}} \Big|_{dw_i = -dG_{-i}} = -1$ .

Responding to substantial empirical evidence of less than complete crowd-out, Andreoni (1989) proposed instead that individuals benefit both from the increase in output and from the act of giving.<sup>5</sup> Such impurely altruistic individuals have preferences of the form  $U(x_i, G, g_i)$ , where  $i$ 's gift,  $g_i$ , affects utility both from increasing output  $G$ , and from generating a private warm-glow benefit,  $g_i$ . In adding warm-glow, the demand for the charity's output is now a function of two arguments, social income and

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<sup>4</sup> This statement holds provided  $i$ 's gift is strictly positive. Bergstrom, Blume, and Varian (1986) examine altruistic giving when some individuals are at corner solutions  $g_i^* = 0$ .

<sup>5</sup> See also Cornes and Sandler (1984) and Steinberg (1987).

giving-by-others:  $G^* = q(w_i + G_{-i}, G_{-i})$ .<sup>6</sup> Donations by self and others are no longer perfect substitutes, and the ‘income’ effects with respect to own income  $dG^*/dw_i \triangleq q_1$  and giving-by-others  $dG^*/dG_{-i} \triangleq q_1 + q_2$  are no longer equal. Assuming that warm-glow is a normal good,  $q_2 > 0$ , the individual’s desired charity output increases more in response to an increase in giving-by-others ( $dG_{-i}$ ) than in response to an increase in income ( $dw_i$ );  $q_2$  is the difference between the two income effects =  $dG^*/dG_{-i} - dG^*/dw_i$ .

The impure altruism model reduces to pure altruism if  $q_1 > 0$  and  $q_2 = 0$ . Pure warm-glow implies that giving-by-others does not affect the individual’s contribution, causing  $i$ ’s preferred level of output to increase dollar-for-dollar with an increase in giving-by-others:  $dG^*/dG_{-i}|_{dw_i=0} = q_1 + q_2 = 1$ . Finally if  $q_1 > 0$ ,  $q_2 > 0$  and  $q_1 + q_2 < 1$ , then both altruism and warm-glow influence giving.

Importantly, incomplete crowd-out is predicted by the impure altruism model. A one dollar lump-sum tax accompanied by a one dollar increase in the giving-by-others ( $dG_{-i} = -dw_i = 1$ ) increases  $i$ ’s preferred output level by  $q_2 > 0$ , securing less than complete crowd-out:  $dg_i^*/dG_{-i}|_{dw_i=-dG_{-i}} = -1 + q_2$ .

In testing motives for giving, researchers hold the complete crowd-out prediction of pure altruism as the null hypothesis ( $H_0: |dg_i^*/dG_{-i}|_{dw_i=-dG_{-i}}| = 1$ ). For example, Bolton and Katok (1998) look at transfers in two dictator game treatments to measure crowd-out. In one treatment, the decision maker has an endowment of \$18 and the recipient has \$2; in another treatment, the decision maker has \$15 and the recipient has \$5. Seeing the recipient’s earnings as the charitable output, crowd-out is measured at  $G_{-i} = \$2$ , with  $dG_{-i} = -dw_i = \$3$ . Bolton and Katok find that — in contrast to the prediction by pure altruism — transfers in the second treatment are not \$3 lower than in the first. Instead, crowd-out is found to be incomplete ( $|dg_i^*/dG_{-i}|_{dw_i=-dG_{-i}}| = .737$ ), and they conclude that individuals are impurely altruistic. Other experiments also measure crowd-out at a single level of giving-by-others and produce a wide range of crowd-out estimates. Most reject pure altruism.<sup>7</sup>

However, a single measure of crowd-out is insufficient for determining the extent to which preferences deviate from pure altruism. To demonstrate, consider the Cobb-Douglas impure altruism utility function:

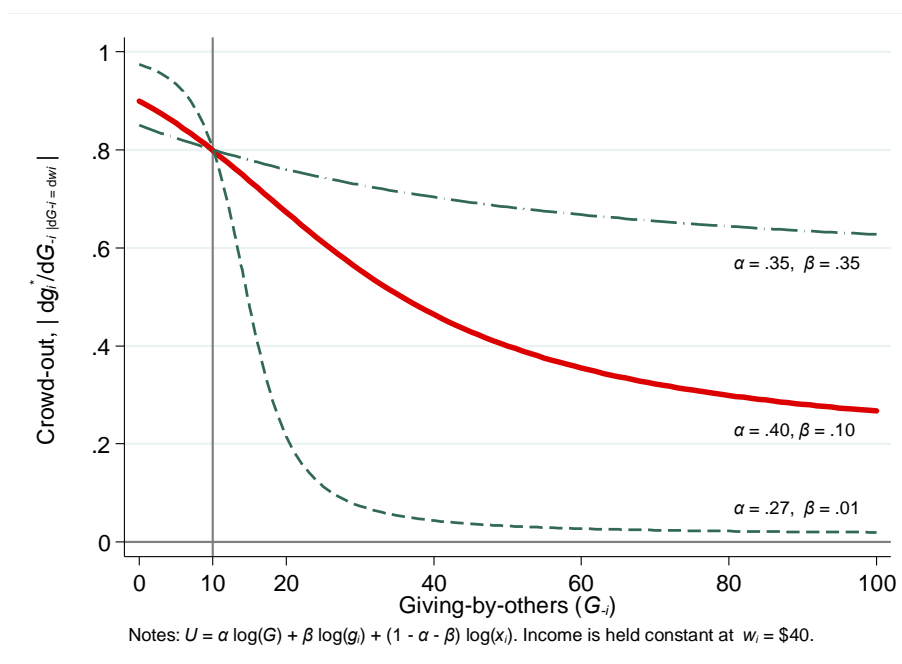
$$U(x_i, G, g_i) = (1 - \alpha - \beta) \ln x_i + \alpha \ln G + \beta \ln g_i. \quad (1)$$

<sup>6</sup> While the first order condition of a pure altruist is  $-U_x(x_i, G) + U_G(x_i, G) = 0$ , that of an impure altruist adds a second marginal-benefit-of-giving term, i.e.,  $-U_x(x_i, G, G - G_{-i}) + U_G(x_i, G, G - G_{-i}) + U_{g_i}(x_i, G, G - G_{-i}) = 0$ , when using  $g_i = G - G_{-i}$ .

<sup>7</sup> Andreoni (1993) finds 0.715 crowd-out, and rejects pure altruism. Gronberg, Luccasen, Turocy, and Van Huyck (2012) obtain a larger crowd-out (0.90), but still reject pure altruism. Eckel, Grossman, and Johnston (2005) obtain zero crowd-out or complete crowd-out depending on how the lump-sum taxation is framed, and interpret their results as supporting pure warm-glow. Sutter and Weck-Hannemann (2004) replicate Andreoni (1993), but obtain complete crowd-out and therefore cannot reject pure altruism. Chan, Godby, Mestelman, and Muller (2002) also replicate Andreoni (1993) but take two crowd-out measurements around a single (low) level of giving-by-others; one measure moves to the left and the other moves to the right (akin to a left and right derivative) yielding crowd-out measurements that are not significantly different (one is complete, the other is similar to Andreoni’s). Experiments using the linear voluntary contribution mechanism have produced a similar range of results (Anderson, Goeree and Holt 1998; Goeree, Holt and Laury 2002; Palfrey and Prisbrey 1996, 1997).

The difficulty in inferring preferences from one crowd-out measurement is seen in Figure 1. For three different sets of parameters, we show how crowd-out varies with output, or more precisely with the amount given by others ( $G_i$ ). Looking first at the bold line where  $\alpha = .40$  and  $\beta = .10$ , we see that crowd-out depends on where it is measured. Crowd-out decreases when it is measured at higher levels of output. When measured at a low level of output the marginal utility to further increasing output is high, and the degree of crowd-out is close to complete, suggesting that altruism strongly affects the marginal motive for giving. However, as output increases, the marginal utility from output decreases, the marginal motive shifts toward warm-glow, and crowd-out decreases. As output increases the *marginal* motive for giving (governed by  $q_1$  and  $q_2$ ) shifts away from being influenced by altruism ( $\alpha$ ) toward being influenced by warm-glow ( $\beta$ ). This sensitivity to output, or giving-by-others, implies that under impure altruism the power to reject pure altruism depends on where crowd-out is measured.

Figure 1. Crowd-out as a function of giving-by-others.



Second, to see that measuring crowd-out around a *single* output level cannot identify the relative strengths of altruism and warm-glow preferences, consider a study that finds a single crowd-out measurement of 80 percent when the amount given by others equals \$10 ( $= G_i$ ). Figure 1 shows that this measurement of crowd-out is consistent with  $\alpha = .40$ ,  $\beta = .10$ , where preferences place less weight on warm-glow than altruism.<sup>8</sup> However an 80 percent crowd-out at  $G_i = \$10$  is also consistent with preferences where the relative weight on warm-glow is much smaller or substantially larger (e.g.,  $(\alpha = .27, \beta = .01)$  or  $(\alpha = .35, \beta = .35)$ , respectively). In fact, there are infinitely many  $\alpha, \beta$  parameterizations that generate this one crowd-out measurement. Thus, the relative weight placed on warm-glow and altruism cannot be identified from a single crowd-out measurement. In addition, we cannot use a single measurement of incomplete crowd to infer that individuals are impurely altruistic because a model of pure warm-glow ( $\alpha = 0, \beta = .80$ ) also generates an 80 percent crowd-out. While this single crowd-out

<sup>8</sup> The weight on warm-glow,  $\beta$ , relative to overall generosity,  $\alpha + \beta$ , is  $0.2 (= \beta / (\alpha + \beta))$ .

measurement makes it possible to reject the pure altruism null, such rejection does not imply acceptance of any specific alternative.

Finally, measuring crowd-out at *multiple* output levels allows a new test of impure altruism: decreasing crowd-out. Figure 1 shows that decreasing crowd-out holds for Cobb-Douglas preferences, and Ribar and Wilhelm (2002) show that this comparative static holds asymptotically for preferences in general. Separability and mild restrictions on preferences secure that the decrease in crowd-out is monotonic, thus producing a direct and novel test of the impure altruism model (proofs are shown in Appendix A).<sup>9</sup> The test is direct because impure altruism is positioned as the null hypothesis and novel because it tests a prediction for which there did not exist supporting evidence at the time the theory was proposed.<sup>10</sup>

In the next section, we introduce a new experimental design that controls the charity's output and measures crowd-out at two output levels. That is, we vary the level of giving-by-others and measure crowd-out at two levels of  $G_i$ : a low and a high level. We use these crowd-out measurements to both demonstrate that rejection of pure altruism depends on where the hypothesis is tested, and to test impure altruism's decreasing crowd-out prediction. Eliciting contributions across six different budgets, we identify crowd-out and the associated own-income effects, which in turn allow us to structurally estimate the relative weights placed on altruism and warm-glow.

### 3. Experimental Design

The experimental design mirrors the theory by strictly controlling the level of giving-by-others so that each participant's gift determines the final and total output for an "individualized" charity. We collaborated with a chapter of the American Red Cross to give participants the opportunity to help a child in need in a way no one outside the experiment was doing. Specifically, in the event of a fire, the chapter helps affected families find temporary shelter and provides them with clothing, essential

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<sup>9</sup> Ribar and Wilhelm (2002) show under weak conditions on preferences (concave utility and strictly operative warm-glow at all levels of  $G$ ) that an impure altruism model converges to a model where, at the margin, giving is motivated only by warm-glow:  $G_i \rightarrow \infty \Rightarrow q_1 + q_2 \rightarrow 1$ . Appendix A examines the conditions sufficient to secure that the associated decrease in crowd-out is monotonic. First, crowd-out decreases monotonically if utility is additively separable with positive third derivatives. Cobb-Douglas preferences meet these conditions, thus generating the decreasing crowd-outs shown in Figure 1. Second, with Cobb-Douglas preferences and holding income constant, an individual's contribution becomes less sensitive to an increase in giving-by-others ("unfunded" crowd-out) the higher the initial level of giving-by-others. The marginal motive for giving monotonically moves from impure altruism to pure warm-glow ( $q_1 + q_2 \rightarrow 1$ ). Third, we present necessary and sufficient conditions for separable impure altruism utility functions to have monotonically decreasing unfunded crowd-out. Appendix A demonstrates that a test of impure altruism's decreasing crowd-out prediction must be conducted jointly with some restrictions on preferences. We offer three perspectives. First, absent restrictions, the impure altruism model is void of testable predictions, other than the assumption that  $q_2 > 0$ . Second, previous empirical and experimental analyses of the impure altruism model assume separability (see e.g., Andreoni 1990, 1993; Chan, Godby, Mestelman, and Muller 2002; Gronberg, Luccasen, Turocy, and Van Huyck 2012; Sutter and Weck-Hannemann 2004). Third, beyond some level of  $G_i$ , monotonically decreasing crowd-out becomes applicable to non-separable impurely altruistic utility functions. As  $G_i \rightarrow \infty$  these utility functions become asymptotically separable, i.e.,  $U_{GG} \rightarrow 0$  and  $U_{xG} \rightarrow 0$  (Ribar and Wilhelm, 2002).

<sup>10</sup> According to some, though not all, theories of confirmation, confirmation of a novel prediction provides stronger support for a theory (e.g., Musgrave, 1974).

toiletries, and a meal. We joined with the chapter to collect funds to buy books for the affected children. Prior to our study no items were given to the children affected by the fire.<sup>11</sup>

Each participant in the study was paired with a child (1-12 years old) whose family home had suffered extensive fire damage. Each participant was given an endowment and asked to allocate it between herself and the child. They were told that in addition to their donation, a research foundation would donate a fixed amount of money towards the child; this is the individualized charity's initial output level. The foundation's donation was independent of the participant's allocation, and the total amount to be spent on books for the child would be the sum of the individual's donation and the foundation's donation. The books would be given to the child by the Red Cross immediately after the child had been affected by a fire. Participants knew that: "Each participant in this study is paired with a different child . . . Only you have the opportunity to allocate additional funds [additional to the foundation's fixed donation] to the child. Neither the American Red Cross nor any other donors provide books to the child."

Building on Andreoni and Miller (2002) and Fisman et al. (2007) we use a within-subject design to identify individual preferences.<sup>12</sup> Each participant faced six budgets received in one of six random orders. The six budgets are summarized in Table 1. Each budget indicated the participant's endowment,  $w_i$ , and the foundation's fixed donation,  $G_{-i}$ . For each budget, the participant was free to give any portion of the endowment to the child,  $g_i$ . For example for Budget 1 the participant was informed that the foundation would donate \$4 toward books for the child, and that the participant had an endowment of \$40 that she could allocate between herself and the child. Any amount allocated to the child would be added to the \$4 foundation donation and the sum of funds used to buy books ( $G^* = G_{-i} + g_i$ ) for the child.<sup>13</sup> One randomly selected decision was carried out for payment.

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<sup>11</sup> Donations were made immediately after the fire along with the Southwestern Pennsylvania chapter of the American Red Cross' transfer of other provisions. In explaining why the Red Cross was seeking the participant's contribution for books, participants were informed that the chapter's Emergency Preparedness Coordinator Sandi Wraith had made the following statement: "Children's needs are often overlooked in the immediate aftermath of a disaster because everyone is concerned primarily with putting the fire out, reaching safety, and finding shelter, food and clothing...just the basics of life. So many times, I've seen children just sitting on the curb with no one to talk to about what's happening...for this reason I've found trauma recovery experts in the community to work with us to train our volunteer responders in how to address children's needs at the scene of a disaster...being able to give the children fun, distracting books will provide a great bridge for our volunteers to connect with kids and get them talking about what they've experienced."

<sup>12</sup> The objective of these studies is to determine whether giving is consistent with GARP and whether choices can be rationalized by altruistic preferences. Using the within-subject variation, both studies point to individual heterogeneity and estimate pure altruism preferences (CES). Identification of individual preferences requires a within-subject design. Empirically there is limited evidence that such elicitation influences average choices. Theoretically in paying for only one decision identification is not compromised by risk aversion provided participants are assumed to maximize expected utility. See Azrieli, Chambers and Healy (2015) for the much weaker condition under which such random problem selection (RPS) mechanisms are incentive compatible.

<sup>13</sup> While there effectively are only two contributors (participant and foundation) to the charitable output (books for one child) the increase in giving-by-others/foundation mimics the effect of increasing the set of donors.



Table 1: Experimental budgets.

Budget	Foundation's fixed donation ( $G_{-i}$ )	Participant's endowment ( $w_i$ )	Participant's social income ( $G_{-i} + w_i$ )
1	4	40	44
2	10	40	50
3	28	40	68
4	34	40	74
5	4	46	50
6	28	46	74

The six budgets in Table 1 allow us to examine the participant's demand for giving books to the child and the motives for such giving. Budgets 5 and 2 measure crowd-out at a low level of output ( $G_{-i} = 4$ ). Holding social income ( $G_{-i} + w_i$ ) constant at \$50, the two budgets capture the effect of a \$6 increase in output funded through a \$6 lump-sum tax. Similarly, measured at the high output level ( $G_{-i} = 28$ ) Budgets 6 and 4 hold social income constant at \$74, capturing the effect of the same \$6 balanced-budget increase in output. Hence, we measure crowd-out ( $dg_i^*/dG_{-i}|_{dw_i=-dG_{-i}} = -1+q_2$ ) at a low and at a high level of output. Furthermore, comparing Budgets 1 and 5 and Budgets 3 and 6 allow for measurement of own income effects ( $dg_i^*/dw_i = q_1$ ) at low and high levels of output, respectively. Finally, to assess the extent to which the marginal motive for giving shifts toward warm-glow, we can use Budgets 1 and 2, and then 3 and 4, to hold own income constant and determine whether, between the low and high output levels, there is a change in how participants respond to an increase in output that is not funded by a corresponding lump-sum tax—so-called “unfunded” crowd-out:  $dg_i^*/dG_{-i}|_{dw_i=0} = -1+q_1 + q_2$ . Recall that under pure warm-glow, giving-by-others has no effect on the individual's contribution, hence unfunded crowd-out equals zero:  $dg_i^*/dG_{-i}|_{dw_i=0} = 0$ , with  $q_1 + q_2 = 1$ . Measuring unfunded crowd-out at low and high output levels we can determine whether warm-glow becomes a relatively more important motive at the margin — whether  $q_1 + q_2$  gets closer to 1 — when output increases.<sup>14</sup>

The procedures of the experiment were as follows. A total of 85 undergraduates at the University of Pittsburgh participated in one of six sessions. Participants were seated in a large classroom and given a folder with a set of instructions, a quiz, an envelope, a calculator, and a pen. Participants were asked to take out the instructions and to follow along as these were read out loud. They were then given a brief quiz to make sure that they could calculate the payoffs of a sample decision. The quiz was collected and participants given answers to the quiz. These answers were carefully reviewed before participants proceeded to the decision task. Using pen and paper, participants made contribution decisions for each of the six budgets. When all decision forms were collected, a number between 1 and 6 was drawn to determine which decision would be implemented. Payments were prepared while participants completed a questionnaire.

<sup>14</sup> A pure altruist gives to influence the output, in this case the gift received, say moving from cheap scholastic paper backs to hardbound colorful picture books. A pure warm-glow giver is not influenced by altering the gift received; for example it may be someone who feels guilty unless a certain percentage of income is donated. With the motive being to assuage guilt, the donation is independent of the gift received by the child.

The study was double-blind. Each decision form was identified only by a claim check number, and this number was used for the participant's anonymous payment. However, participants had the option of relinquishing their anonymity if they wanted to receive an acknowledgement directly from the Red Cross. Once the decision task was completed, the participant placed the decision form in the envelope. From that point onward, decisions were identified only by a claim check number. While one set of experimenters placed the participants' payments in sealed envelopes, another experimenter, who did not oversee the payment, distributed the envelopes by claim check number.

To assure participants that the experimental procedures were followed, we used a verification procedure similar to Eckel et al. (2005). During the instruction phase we randomly selected one participant to be a monitor. The monitor oversaw all procedures of the experiment, and reported to the participants at the end of the experiment whether the experimenters had followed the procedures described in the instructions. Participants were also, from a distance, shown the acknowledgements and checks that were to be sent to the Red Cross. Once the participants had received their payment and left the study, the monitor walked with the experimenter to mail the envelopes with the checks to the Red Cross, the monitor signed a statement to certify that all procedures had been followed, and the statement along with a receipt for donations were posted in the Economics Department. At the request of the Red Cross, the experimenters handled the purchase of books. For each participant in the experiment, we ordered three books of values corresponding to the total amount donated on the selected decision and packaged the purchased books in an individual gift bag.

## 4. Results

Participants found the charitable cause worthy of donations. Average giving across the six budgets (6 x 85 = 510 decisions) was \$20.82 with a standard deviation of \$12.11, indicating substantial individual variation. One participant never contributed while five participants contributed the entire endowment for each of the six budgets.

### 4.1. Reduced-form measures of crowd-out: Altruism vs. Impure Altruism

Table 2 presents the crowd-out estimates. Using a linear regression with individual fixed-effects, columns 1 and 2 report crowd-out estimates at low and high levels of output, respectively. Starting at the low level of giving-by-others (\$4) we see a 94 percent crowd-out (column 1). That is, every dollar increase in giving-by-others from \$4 to \$10 — while at the same time decreasing own income from \$46 to \$40, ensuring budget balance — caused a \$0.94 reduction in the participants' contribution. Consistent with pure altruism, we cannot reject the hypothesis that this degree of crowd-out is complete ( $H_0: |dg_i^*/dG_{-i}|_{dw_i=-dG_{-i}} \geq 1$  has  $p = .255$ ). Had we followed the procedures of previous experiments and examined only one crowd-out measurement, this result would have led us to conclude that donations were motivated by pure altruism.

Table 2. Change in crowd-out between a low and a high level of giving-by-others.

	Crowd-out $(\frac{dg_i^*}{dG_{-i}}  _{dw_i=-dG_{-i}})$					Unfunded crowd-out $(\frac{dg_i^*}{dG_{-i}}  _{dw_i=0})$
	Linear model		Accounting for corner decisions			
	Giving-by-others		Giving-by-others			
	Low (1)	High (2)	Low (3)	High (4)	Low/High (5)	Low/High (6)
Giving-by-others ( $G_{-i}$ )	-0.94 <sup>a</sup> (0.09)	-0.77 <sup>b</sup> (0.08)	-0.97 <sup>c</sup> (0.09)	-0.82 <sup>d</sup> (0.09)	-0.99 <sup>e</sup> (0.09)	-0.64 (0.08)
Giving-by-others × High interaction	-	-	-	-	0.18 <sup>f</sup> (0.12)	0.22 <sup>g</sup> (0.09)
Budgets: $G_{-i}, w_i$	\$4, \$46 \$10, \$40	\$28, \$46 \$34, \$40	\$4, \$46 \$10, \$40	\$28, \$46 \$34, \$40	\$4, \$46 \$10, \$40 \$28, \$46 \$34, \$40	\$4, \$40 \$10, \$40 \$28, \$40 \$34, \$40

Notes: The dependent variable is the number of dollars a participant contributes. The estimates in columns 1 and 2 are from linear regressions with individual fixed effects. The estimates in columns 3–6 are marginal effects from the two-side estimator by Alan, Honoré, Hu, and Leth-Petersen (2014) that accounts for the corner solutions at \$0 and \$40 or \$46 with individual fixed effects. Standard errors are in parentheses and are bootstrapped in columns 3–6.  $N = 85$  participants. Tests of complete crowd-out have  $p$ -values: <sup>a</sup>  $p = 0.255$ , <sup>b</sup>  $p = 0.002$ , <sup>c</sup>  $p = 0.390$ , <sup>d</sup>  $p = 0.034$ , and <sup>e</sup>  $p = 0.477$ . <sup>f</sup> Test of no decrease in crowd-out has  $p = 0.07$ . <sup>g</sup> Test of no decrease in unfunded crowd-out has  $p = 0.013$ .

The inference on motives would, however, be different if instead we measured crowd-out at a high level of giving-by-others (i.e., \$28). Column 2 shows that in this case crowd-out is 77 percent, and we easily reject complete crowd-out ( $p = 0.002$ ). Had we only measured crowd-out at this high output level we would conclude that donations were motivated by impure altruism. This is the first empirical evidence that crowd-out depends on the output level where it is measured, and that the power to reject pure altruism depends on where the hypothesis is tested.

The results in columns 1 and 2 however do not take into account that 12.5 percent of decisions involved a contribution of none or all of the individual's endowment. In failing to account for these corners the results are biased against pure altruism. We therefore re-estimate the models taking into account corner decisions. Using the two-sided individual fixed effects censored estimator of Alan, Honoré, Hu, and Leth-Petersen (2014) the crowd-out estimates reported in columns 3 and 4 reveal that indeed failure to account for corners biases the results against pure altruism: both crowd-out estimates increase. The qualitative conclusions however remain. At the low level of giving-by-others, crowd-out is 97 percent and we cannot reject that it is complete. At the high level, crowd-out is 82 percent and we can reject that it is complete ( $p = 0.034$ ).

The estimates in columns 3 and 4 suggest that, consistent with the new test of impure altruism, crowd-out is decreasing in the level of output. Column 5 conducts this test by combining the two sets of data. An interaction term is included to indicate when the data are from the budgets where giving-by-others is high. Consistent with impure altruism, we find that crowd-out decreases by 18 percentage points going from the low to high level of giving-by-others. To assess the strength of the evidence, we test the opposite hypothesis — that the magnitude of crowd-out did not decrease with output — and reject the hypothesis at  $p = 0.07$ . This decrease in crowd-out offers qualitatively new, and statistically significant, support for the impure altruism model.<sup>15</sup>

Column 6 presents estimates of unfunded crowd-out. Recall that impure altruism predicts that as output increases, the marginal motive for giving will shift away from altruism toward warm-glow and unfunded crowd-out will decrease. The interaction term indicates that unfunded crowd-out is 22 percentage points smaller at the high level of giving-by-others, and the hypothesis that it did not decrease is rejected ( $p = 0.013$ ). Thus, the change in unfunded crowd-out is also consistent with a model of impure altruism.

<sup>16,17</sup>

In summary, the reduced-form results — that crowd-out is not complete and that both crowd-out and unfunded crowd-out decrease with output — demonstrate that on average participants are motivated by impure altruism.

#### 4.2. A structural model: The relative concern for altruism and warm-glow

To investigate the relative strength of warm-glow and altruism, this section demonstrates how one can structurally estimate the parameters of the Cobb-Douglas impure altruism utility function from equation (1). The optimal gift  $g_{ib}^*$  derived from this utility function is:

$$g_{ib}^* = \frac{1}{2} \left[ (1 - \beta) G_{-i,b} + (\alpha + \beta) Z_{ib} + \left\{ [(1 - \beta) G_{-i,b} + (\alpha + \beta) Z_{ib}]^2 - 4 \alpha G_{-i,b} Z_{ib} \right\}^{1/2} \right] - G_{-i,b} + e_i + u_{ib} \quad (2)$$

<sup>15</sup> Comparing the estimates of crowd-out from column 5 with the estimates from columns 3 and 4 indicates slight differences that are due to the nonlinear estimation method: the nonlinear method applied to two separate samples (columns 3 and 4) generates slightly different estimates than the nonlinear method applied to the two samples combined into a single model with an interaction term (column 5). Estimates from the linear model are, of course, identical whether generated using separate samples or one combined sample with an interaction term. Random effects Tobit estimation, an alternative approach to account for the corners under the additional assumption that the errors are normally distributed (which they approximately are), produces results similar to the two-sided individual fixed effects censored estimates presented in Table 2.

<sup>16</sup> A subtle point is that in a pure altruism model, unfunded crowd-out varies with output if the own income effect varies with output. However, estimates from the linear fixed-effects model show that the own income effects are .40 and .41 at the low and high levels of giving-by-others. The two-sided fixed effects censored estimates are slightly smaller (.32 and .36); the hypothesis that the two income effects are the same cannot be rejected ( $p = .583$ ). Hence, in our setting the own income effect is essentially constant, and with the own income effect constant, pure altruism predicts that unfunded crowd-out will not change as output increases.

<sup>17</sup> The zero unfunded crowd-out prediction of pure warm-glow is rejected at both the low and the high level of giving-by-others ( $ps < .001$ ).

where  $i = 1, \dots, 85$  indexes the participants,  $b = 1, \dots, 6$  indexes the six decisions each participant faces with corresponding budgets of giving-by-others and own income,  $Z_{ib} \equiv w_{ib} + G_{-i,b}$ ,  $e_i$  is an individual-specific random effect, and  $u_{ib}$  is the randomness in each participant's giving that is not correlated across decisions. Using the data from all 85 participants to estimate the two parameters  $\alpha$  (altruism) and  $\beta$  (warm-glow) we first use a representative-agent approach.

Estimation of (2) presents three econometric problems: non-linearity in the parameters  $\alpha$  and  $\beta$ , the within-participant correlation in random departures of giving from the Cobb-Douglas specification (the random effect  $e_i$ ), and the corner decisions that can occur at \$0 and at two different upper amounts, \$40 and \$46. To handle these challenges simultaneously, we construct a non-linear random effects Tobit estimator permitting both lower and upper corner solutions, and use it to estimate (2).<sup>18</sup>

Table 3 reports the estimates. Consistent with our crowd-out results, the significant coefficients on both  $\alpha$  and  $\beta$  reveal that individuals are motivated both by altruism and warm-glow. The 0.021 estimate on the warm-glow component is significantly greater than zero, implying rejection of the pure altruism model. However, the warm-glow component is relatively small. With the estimate on altruism being 0.594, the weight placed on warm-glow relative to overall generosity,  $\alpha + \beta$ , is 0.034 ( $\beta / \alpha + \beta$ ).<sup>19</sup> The 0.902 estimate of the correlation coefficient  $\rho$  indicates that there is substantial heterogeneity in participants' random deviations from the Cobb-Douglas model. Next we look at individual choices to explore the heterogeneity across participants in their  $\alpha$  and  $\beta$  parameter values.

Table 3. Estimated Representative-Agent Cobb-Douglas preferences

	Coefficient	Standard error	$p$ -value
$\alpha$	0.594	0.025	0.000
$\beta$	0.021	0.009	0.022
$\rho$	0.902	0.016	0.000

Notes: Non-linear random effects Tobit estimates of (2).  $\rho$  is the correlation coefficient of the error term across decisions within-individuals. The log-likelihood is -1466.9.  $N = 85$  participants, six decisions per participant.

<sup>18</sup> Estimates of  $\alpha$  and  $\beta$  are calculated using maximum likelihood, assuming that  $u_{ib}$  and  $e_i$  are normally distributed. To calculate the multivariate normal probabilities when  $g_{ib} = 0$  and when  $g_{ib} = w_{ib}$  we use STATA's maximum simulated likelihood routines (Cappellari and Jenkins 2006), adapting Barslund's (2007) multivariate Tobit program.

<sup>19</sup> At first it may seem that the large weight placed on altruism results from the economy being 'small' in the sense of Andreoni (1988) and Ribar and Wilhelm (2002). However, this conclusion incorrectly applies intuition gained from thinking about motives at the margin ( $q_1$  and  $q_2$ ) to motives as preference parameters (i.e.,  $\alpha$  and  $\beta$ ). Inference on preference parameters is drawn from the change in crowd-out. Once the preference parameters are known, what defines an economy as 'small' and 'large,' in the sense that the marginal motive shifts from primarily altruism to solely warm-glow, depends on the level of giving-by-others to the charitable cause. In the case of donating books to a fire-victim child, the estimates in Table 3 imply that, with  $w_i = \$40$ , the economy becomes large in the sense that the marginal motive for giving only is warm-glow ( $q_1 + q_2 \approx 1$ ) when the amount given by others surpasses \$61.71.

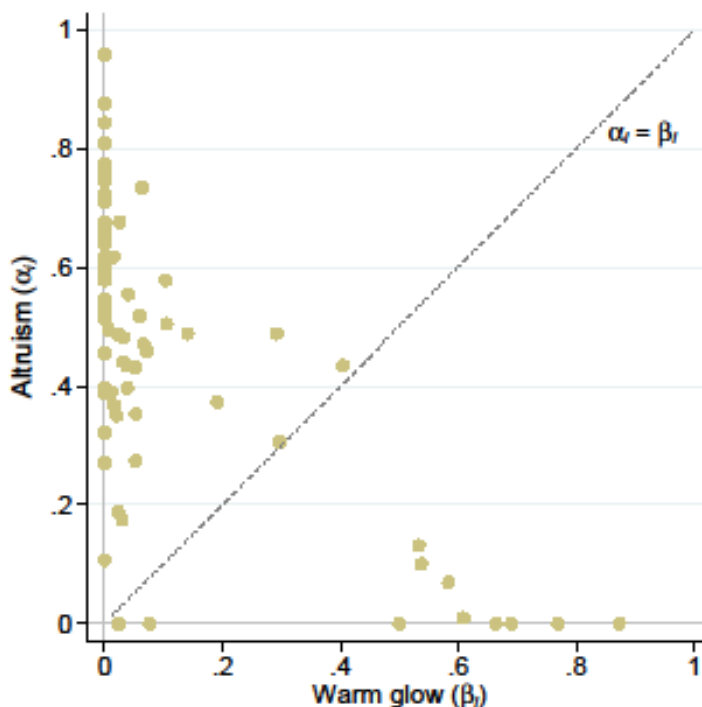
Our within-subject design allows us to estimate for each individual the altruism and warm-glow parameters in equation (2) using maximum likelihood Tobit, with the parameter estimates constrained such that  $\alpha_i, \beta_i \in [0,1]$ . Binding constraints indicate pure altruism ( $0 < \alpha_i < 1, \beta_i = 0$ ) or pure warm-glow ( $\alpha_i = 0, 0 < \beta_i < 1$ ). Figure 2 is a scatter diagram presenting the distribution of the altruism and warm-glow preference parameters. The magnitude of altruism is shown along the vertical axis, and the magnitude of warm-glow along the horizontal axis. Points on the vertical axis represent participants motivated by pure altruism, points in the interior represent individuals whose donations were motivated by impure altruism, and points on the horizontal axis represent participants motivated by pure warm-glow. Donations were for the majority of participants motivated by pure altruism (43.5 percent;  $N = 37$ ) or by impure altruism (38.8 percent;  $N = 33$ ). Nine percent ( $N = 8$ ) were motivated only by warm-glow. Among those motivated by impure altruism, most attach a greater weight to altruism than to warm-glow: there are only two participants with  $\alpha_i \approx \beta_i$ , and only five with  $\alpha_i < \beta_i$ .<sup>20</sup> The relative concern for warm-glow from the individual-specific approach can be evaluated by looking at the median or mean of the individual weights placed on warm-glow ( $\beta_i / (\alpha_i + \beta_i)$ ). The median and mean weight on warm-glow are 0.026 and 0.211, respectively.<sup>21</sup>

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<sup>20</sup> One of these five has  $\alpha_i$  just a little above zero and  $\beta_i = .5$ , and in Figure 2 is indistinguishable from two pure warm-glow participants who have  $\alpha_i = 0$  and  $\beta_i = .5$ . Estimates of  $\alpha_i$  and  $\beta_i$  cannot be obtained for the six participants who chose corner solutions for all six of their decisions, and for a seventh participant who chose the upper corner for four decisions and was close to the upper corner for two other decisions.

<sup>21</sup> Whether one uses the representative-agent or individual-specific approach for estimating preferences depends on the question at hand. The individual-specific approach provides more accurate individual-level predictions, while the representative-agent approach provides a more accurate prediction of contributions at the level of each of the six budgets. The root-mean square error of the crowd-out predictions across the six budgets is \$0.78 from the representative-agent approach and \$0.99 from the individual-specific approach. If the objective is to predict the response to policy changes — such as, “How much will the average response be to a change in government funding (giving-by-others)?” — then the representative-agent approach is more accurate.

Figure 2. Estimated individual-specific Cobb-Douglas preferences ( $N = 78$ ).



While our reduced-form analysis makes clear that individuals are motivated by impure altruism, the representative-agent or individual-specific structural approach is needed to determine the relative role played by altruism and warm-glow. For the type of charity examined here, the weight placed on altruism is much larger than that placed on warm-glow.

## 5. Conclusion

To examine motives for giving the extant approach is to position pure altruism as the null hypothesis, and to test its prediction of complete crowd-out by measuring crowd-out around a single level of charitable output. In rejecting complete crowd-out, impure altruism has been accepted as the alternative.

If impure altruism is the “true” model, we show that one crowd-out measurement is insufficient for inferring preferences for giving. Multiple measurements of crowd-out, at different levels of output, however secure identification. The reason this is the case is that the degree of crowd-out depends on the charity’s output. There are three implications. First, the power to reject pure altruism depends on the level of output where it is tested. Second, a single measurement of crowd-out cannot identify the relative weight placed on altruism and warm-glow preferences. In fact, a single measurement of incomplete crowd-out is consistent not only with impure altruism, but also with pure warm-glow giving. Third, multiple crowd-out measurements permit a direct test of impure altruism. That is, impure altruism can be positioned as the null hypothesis, and its comparative-static prediction, that crowd-out decreases when measured at higher output levels, can be directly tested.

An advantage of this direct test of impure altruism is that it relies on a comparative static that was unanticipated at the time the model was proposed. Although continued evidence of incomplete crowd-out is a necessary criterion for the model to pass, evidence of decreasing crowd-out is needed to confirm a novel prediction of impure altruism.

Our experimental study yields three empirical contributions. It presents the first evidence that inference on preferences can be misled by a single crowd-out measurement. Second, it provides the first confirmation of the direct test of impure altruism: statistically significant evidence that crowd-out decreases with output. Third, it demonstrates how structural estimates of altruism and warm-glow preferences can be inferred with multiple measurements of crowd-out.

The central implication of our study is methodological: inference on preferences for giving requires more than one crowd-out measurement. This finding has implications for both experimental and non-experimental studies. In lab and field experiments the change in output is secured by manipulating the amount given-by-others to an existing charity, and when using non-experimental data the change in output is secured by comparing different points in time over which charity funding changes. In measuring crowd-out around more than one output level, existing practice merely has to be extended to more than one change in output.

Our finding that crowd-out decreases is essential for understanding motives for giving and for interpreting existing crowd-out estimates. Although there likely are several reasons why previous studies have generated a range of different crowd-out estimates, the sensitivity to output level provides a theoretically-grounded reason for the differences. Of course, another explanation for the varied set of crowd-out estimates is that these studies examine contributions by different populations to different causes. Much as for demands for private goods, we should not expect that preferences for contributing to one non-profit will be predictive of preferences for contributing to all non-profits. In our setting, we find that warm-glow is weak relative to altruism, however there is no reason to expect altruism to be equally important for all donations. The estimates herein may be a better indicator of the types of preferences expected for donations to other humanitarian charities — similar to the type examined in our experiment, while a poorer indicator of preferences for giving to, say, one's alma mater. Importantly, our analysis demonstrates that although reduced-form results point to warm-glow playing a statistically significant role, structural estimates are needed to assess the relative weight placed on altruism and warm-glow.



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**Online Appendix A:  
Monotonically decreasing balanced-budget and unfunded crowd-out.**

In this appendix we derive three results. First, we derive sufficient conditions for balanced-budget crowd-out ( $\frac{dg_i^*}{dG_{-i}}|_{dw_i=-dG_{-i}}$ ) to be monotonically decreasing in giving-by-others. Second, we show that unfunded crowd-out ( $\frac{dg_i^*}{dG_{-i}}|_{dw_i=0}$ ) is monotonically decreasing with Cobb-Douglas impure altruism. Third, we present necessary and sufficient conditions for separable impure altruism utility functions to have monotonically decreasing unfunded crowd-out.

Following Andreoni (1989) an impure altruist's preferences are given by  $U(x_i, G, g_i)$ , where  $x_i$  denotes private consumption,  $G$  the charity's output, and  $g_i$ 's gift to the charity.  $G = \sum_{i=1}^n g_i$  is the sum of the charitable gifts, and  $G_{-i} = \sum_{j \neq i} g_j$  the amount given-by-others. Normalizing prizes  $i$ 's budget constraint is:  $x_i + g_i \leq w_i$ , where  $w_i$  denotes own income. Adding  $G_{-i}$  to both sides the budget constraint can be re-written as:  $x_i + G \leq w_i + G_{-i}$ . Setting  $g_i = G - G_{-i}$  the resulting first-order condition equals:

$$-U_x(x_i, G, G - G_{-i}) + U_G(x_i, G, G - G_{-i}) + U_{g_i}(x_i, G, G - G_{-i}) = 0. \quad (\text{A.1})$$

The Engel curve for the public good derived from the first-order condition is a function of two arguments, social income ( $Z_i = w_i + G_{-i}$ ) and giving-by-others ( $G_{-i}$ )

$$G^* = q(w_i + G_{-i}, G_{-i}) \quad (\text{A.2})$$

Thus in the impure altruism model the response to a change in own income  $dG^*/dw_i \triangleq q_1$  does not equal that seen for a change in giving-by-others  $dG^*/dG_{-i} \triangleq q_1 + q_2$ .  $q_2$  is the difference between the two effects  $= dG^*/dG_{-i} - dG^*/dw_i$ .

Equation (A.2) implies:

$$g_i^* = -G_{-i} + q(w_i + G_{-i}, G_{-i})$$

and

$$dg_i^* = -dG_{-i} + q_1[dw_i + dG_{-i}] + q_2 dG_{-i}$$

Thus balanced-budget crowd-out equals  $\frac{dg_i^*}{dG_{-i}}|_{dw_i=-dG_{-i}} = -1 + q_2$ . A one dollar decrease in own income accompanied by a one dollar increase in the giving-by-others increases  $i$ 's preferred provision of the public good by the amount  $q_2$ .

If  $q_1 > 0$ ,  $q_2 > 0$  and  $q_1 + q_2 < 1$ , then at the margin both altruism and warm-glow influence giving. The model reduces to the pure altruism model if  $q_1 > 0$  and  $q_2 = 0$ , and it reduces to a model of pure warm-glow model if  $i$ 's preferred level of the public good increases dollar-for-dollar with the unfunded amount provided by others:  $dG^*/dG_{-i} = q_1 + q_2 = 1$ ; hence, if individuals are motivated at the margin by warm-glow only (no altruism), crowd-out in response to an unfunded increase in  $G_{-i}$  is  $\frac{dg_i^*}{dG_{-i}}|_{dw_i=0} = -1 + q_1 + q_2 = 0$ .

Examining the impure altruism model Ribar and Wilhelm (2002) show that although impure altruists are predicted to respond to changes in giving by others, unfunded crowd-out  $\frac{dg_i^*}{dG_{-i}}|_{dw_i=0} = -1 + q_1 + q_2 < 0$ , this prediction does not hold in the limit. Rather, they show that under weak conditions on preferences (concave utility and strictly operative warm-glow at all levels of  $G$ ) as giving-by-others  $G_{-i} \rightarrow \infty \Rightarrow q_1 + q_2 \rightarrow 1$ . Hence,  $\frac{dg_i^*}{dG_{-i}}|_{dw_i=0} \rightarrow 0$  as  $G_{-i} \rightarrow \infty$ . That is, the impure altruism model converges to a model where, at the margin, giving is motivated only by pure warm-glow.<sup>22</sup>

To obtain a comparative static from the impure altruism model that is testable in an experiment, we need to secure that the associated shift in the marginal preferences from impure altruism to warm-glow is monotonic. We begin by showing sufficient conditions on preferences to secure that balanced-budget crowd-out is monotonically decreasing.

PROPOSITION 1. Consider a concave impurely altruistic utility function, with strictly operative warm-glow, and that satisfies the technical conditions described in footnote 22. Further, if utility is additively separable with positive third derivatives, then  $q_2$  is monotonically increasing in  $G_{-i}$ .<sup>23</sup>

Proof: Differentiating the first-order condition (A.1) with respect to  $G_{-i}$  yields:

$$q_2 = (U_{gG} + U_{gg} - U_{gx}) / (U_{xx} + U_{gg} + U_{GG} - 2U_{Gx} - 2U_{gx} + 2U_{gG}) \quad (\text{A.3})$$

which for additively separable utility functions reduces to:

$$q_2 = U_{gg} / (U_{xx} + U_{gg} + U_{GG}). \quad (\text{A.4})$$

Differentiating the second derivatives with respect to  $G_{-i}$  yields:

$$\frac{dU_{xx}}{dG_{-i}} = U_{xxx} \frac{dx^*}{dG_{-i}} = U_{xxx} (1 - q_1 - q_2) > 0 \quad (\text{A.5})$$

$$\frac{dU_{GG}}{dG_{-i}} = U_{GGG} \frac{dG^*}{dG_{-i}} = U_{GGG} (q_1 + q_2) > 0 \quad (\text{A.6})$$

$$\frac{dU_{gg}}{dG_{-i}} = U_{ggg} \frac{dg^*}{dG_{-i}} = U_{ggg} (q_1 + q_2 - 1) < 0 \quad (\text{A.7})$$

where the inequalities follow from the assumed positive third derivatives. Now differentiating (A.4) with respect to  $G_{-i}$ :

<sup>22</sup> In addition there are several technical conditions: utility is twice continuously differentiable, has strictly positive first derivatives,  $U_G$  is finite for all  $g_i > 0$ , the second derivatives of  $U(\dots)$  with respect to the two private goods  $x_i$  and  $g_i$  are finite for all levels of  $G$ , and  $U_{xx} - 2U_{xg} + U_{gg}$  is bounded away from zero (again, for all levels of  $G$ ). The assumption that warm-glow is operative also is needed to secure that the impure altruism model, in contrast to the pure altruism model, can predict individual giving in a large economy (Andreoni, 1989). As in Andreoni (1989) it is also assumed that the giving-by-others is addressing a need, through the charity, that itself remains constant.

<sup>23</sup> In the analysis of risk, a positive third derivative corresponds to prudence, which can be interpreted as the disutility of being faced with a specified risk decreasing as wealth gets higher (Eeckhoudt and Schlesinger, 2006).

$$\frac{dq_2}{dG_{-i}} = \frac{\frac{dU_{gg}(U_{xx} + U_{GG}) - U_{gg} \left( \frac{dU_{xx}}{dG_{-i}} + \frac{dU_{GG}}{dG_{-i}} \right)}{dG_{-i}}}{(U_{xx} + U_{GG} + U_{gg})^2}. \quad (\text{A.8})$$

Concavity combined with the signs in (A.5)–(A.7) imply that  $\frac{dq_2}{dG_{-i}}$  is positive. ■

Monotonically decreasing balanced-budget crowd-out secures a testable prediction of the impure altruism, because monotonicity implies balanced-budget crowd-out decreases when increasing  $G_{-i}$  between any two finite levels  $G_{-i}^{Low}$  and  $G_{-i}^{High}$ . Cobb-Douglas preferences meet the conditions in Proposition 1, thus securing decreasing balanced-budget crowd-out as shown in Figure 1.

For Cobb-Douglas preferences we can also show our second result. Namely that Cobb-Douglas preferences also have monotonically decreasing unfunded crowd-out ( $\frac{dg_i^*}{dG_{-i}}|_{dw_i=0} \rightarrow 0$ ), and presents a set of conditions on preferences such that decreasing unfunded crowd-out is monotonic—hence the marginal motive for giving monotonically moves from impure altruism to warm-glow ( $q_1 + q_2 \rightarrow 1$ ).

For the Cobb-Douglas result  $i$ 's voluntary contribution is given by

$$g_i^* = -G_{-i} + \frac{1}{2} [(1 - \beta) G_{-i} + (\alpha + \beta) Z_i + \{[(1 - \beta) G_{-i} + (\alpha + \beta) Z_i]^2 - 4 \alpha G_{-i} Z_i\}^{1/2}]. \quad (\text{A.9})$$

Differentiating with respect to  $G_{-i}$  to get unfunded crowd-out  $\frac{dg_i^*}{dG_{-i}}|_{dw_i=0} = -1 + q_1 + q_2$ , yields:

$$q_1 + q_2 = \frac{1}{2} \left[ 1 + \alpha + \frac{N}{S^{1/2}} \right] \quad (\text{A.10})$$

where:

$$N \equiv (1 - \alpha)^2 G_{-i} + [(\beta - \alpha) + (\alpha + \beta)\alpha] w_i \quad (\text{A.11})$$

$$S \equiv (1 - \alpha)^2 G_{-i}^2 + 2[(\beta - \alpha) + (\alpha + \beta)\alpha] G_{-i} w_i + (\alpha + \beta)^2 w_i^2. \quad (\text{A.12})$$

Differentiating (A.10) with respect to  $G_{-i}$  indicates that:

$$\text{sign} \left[ \frac{d(q_1 + q_2)}{dG_{-i}} \right] = \text{sign} \left[ S \frac{dN}{dG_{-i}} - N \left( \frac{1}{2} \right) \frac{dS}{dG_{-i}} \right] \quad (\text{A.13})$$

Noting that  $\frac{dN}{dG_{-i}} = (1 - \alpha)^2$  and  $\frac{dS}{dG_{-i}} = 2N$ , the term in square brackets on the right-hand side of (A.13) reduces to  $S(1 - \alpha)^2 - N^2$ , and (A.11) and (A.12) used to show:

$$\begin{aligned} S(1 - \alpha)^2 - N^2 &= \{(\alpha + \beta)^2(1 - \alpha)^2 - [(\beta - \alpha) + (\alpha + \beta)\alpha]^2\} w_i^2 \\ &= 4\alpha\beta(1 - \alpha - \beta) w_i^2 \end{aligned} \quad (\text{A.14})$$

If (and only if)  $\alpha + \beta < 1$ ,  $\alpha > 0$ , and  $\beta > 0$ , the right-hand side of (A.14) is strictly positive, implying  $\frac{d(q_1 + q_2)}{dG_{-i}}$  is positive and  $\frac{dg_i^*}{dG_{-i}}|_{dw_i=0}$  monotonically decreases as  $G_{-i}$  increases. ■

PROPOSITION 2. Consider a concave impurely altruistic utility function, with strictly operative warm-glow, that satisfies the technical conditions described in footnote 22, and further is additively separable.  $q_1 + q_2$  is monotonically increasing in  $G_i$  if and only if  $\frac{U_{GGG}}{U_{GG}^2} > \frac{U_{xxx}-U_{ggg}}{(U_{xx} + U_{gg})^2}$ .

Proof: In fashion parallel to obtaining equation (A.3), partially differentiating the first-order condition (A.1) with respect to social income  $Z_i$  yields:

$$q_1 = (U_{xx} - U_{xG} - U_{xg}) / (U_{xx} + U_{gg} + U_{GG} - 2 U_{Gx} - 2 U_{gx} + 2 U_{gG}) \quad (\text{A.15})$$

which for additively separable utility functions reduces to:

$$q_1 = U_{xx} / (U_{xx} + U_{gg} + U_{GG}), \quad (\text{A.16})$$

which adding to (A.4):

$$q_1 + q_2 = (U_{xx} + U_{gg}) / (U_{xx} + U_{gg} + U_{GG}), \quad (\text{A.17})$$

Differentiating (A.17) with respect to  $G_i$ :

$$\frac{d(q_1 + q_2)}{dG_i} = \frac{U_{GG} \left( \frac{dU_{xx}}{dG_i} + \frac{dU_{gg}}{dG_i} \right) - (U_{xx} + U_{gg}) \frac{dU_{GG}}{dG_i}}{(U_{xx} + U_{GG} + U_{gg})^2}.$$

Using equations (A.5)–(A.7), the numerator of the right-hand side reduces to:

$$\begin{aligned} \text{Numerator} \left\{ \frac{d(q_1 + q_2)}{dG_i} \right\} &= U_{GG} (U_{xxx} - U_{ggg})(1 - q_1 - q_2) - (U_{xx} + U_{gg}) U_{GGG} (q_1 + q_2) \\ &= \frac{1}{U_{xx} + U_{gg} + U_{GG}} \left[ U_{GG}^2 (U_{xxx} - U_{ggg}) - (U_{xx} + U_{gg})^2 U_{GGG} \right]. \end{aligned} \quad (\text{A.18})$$

The (A.18) right-hand side term in square brackets is negative, implying  $\frac{d(q_1 + q_2)}{dG_i}$  positive, if and only if

$$\frac{U_{GGG}}{U_{GG}^2} > \frac{U_{xxx}-U_{ggg}}{(U_{xx} + U_{gg})^2}. \quad \blacksquare$$

Remark: Positive third derivatives and  $U_{ggg} > U_{xxx}$  would satisfy the condition in Proposition 2 and therefore lead to  $q_1 + q_2$  monotonically increasing in  $G_i$ . Positive third derivatives ensure that the (negative) second derivatives monotonically move toward zero as  $G_i$  increases. That combined with  $U_{ggg} > U_{xxx}$  ensures that the second derivative with respect to giving moves toward zero faster than does the second derivative with respect to own consumption.

## Online Appendix B: Instructions

Claim Check\_\_\_\_\_

### Welcome

Thank you for agreeing to participate in our study on decision making. There are two parts of the study today. In the first part you are asked to make six decisions and in the second part you are asked to fill out a survey. When you have completed your decisions we will randomly select one of your six decisions for payment. Your total payment from the study will be the sum of the payment that results from your decision and \$5 for showing up to the study. The entire study should take about an hour, and at the end you will be paid privately and in cash. A research foundation has provided the funds for this study.

We ask that you do not speak to each other or make comments, except to ask questions about the procedures of the study. We also ask that you do not discuss the procedures of the study with others outside this room.

### Your Identity

Your identity is secret. You will never be asked to reveal it to anyone during the course of the study. Your name will never be associated with your decisions or with your answers on the survey. Neither the assistants nor the other participants will be able to link you to any of the decisions you make. In order to keep your decisions private, *please do not reveal your choices to any other participant.*

### Claim Check

Attached to the top of this page is a yellow piece of paper with a number on it. This is your Claim Check. Each participant has a different number. We use claim checks to maintain secrecy about your decisions, payment, and identity. You will present your Claim Check to an assistant at the end of the study to receive your cash payment.

Please remove your claim check now, and put it in a safe place.

### Decision Tasks

For the decision tasks you will be paired with a child in Southwestern Pennsylvania (Allegheny, Washington, Greene, and Fayette Counties). The child is between 1 and 12 years old, and the child's family home has suffered extensive fire damage. Most or all of the family's possessions have been lost. For each of your decisions you will be given an amount of money which you will be asked to allocate between the child and yourself. The money allocated towards the child will be spent on children's books. These books will be distributed to the child by the American Red Cross of Southwestern Pennsylvania, immediately after the child has been affected by a severe fire.



As soon as a fire is reported in Southwestern Pennsylvania, the American Red Cross is contacted and volunteers are dispatched to the site. They help the affected families find temporary shelter, provide them with clothing, a meal, and give them a comfort bag with essential toiletries. Each day an average of one family in Southwestern Pennsylvania experiences a severe fire. These families depend on the American Red Cross for emergency help to cope with the sudden loss of their home and belongings. Unfortunately the American Red Cross only has funds to provide these families with the bare essentials, and they do not provide any “comfort” items for the children of the affected families.

For the study today we have joined the American Red Cross of Southwestern PA to collect funds to buy books for the affected children. In each of the six decisions you will be given an amount of money which you are asked to allocate between the child you are paired with and yourself. In addition the foundation has agreed to donate a fixed amount of money towards the child independent of your allocation. Thus the total amount to be spent on the child is the sum of the foundation’s fixed donation and the allocation you make to the child. The amount of money that you can allocate between the child and you, as well as the foundation’s fixed donation to the child, will vary across the six decisions.

The American Red Cross will use the funds collected from your allocation and that of the foundation to purchase the child books. Each participant in this study is paired with a different child. If you choose not to allocate any funds to the child, then the money to be spent on the child will be limited to the research foundation’s fixed donation. Only you have the opportunity to allocate additional funds to the child. Neither the American Red Cross nor any other donors provide books to the child. Your decision alone determines how much will be spent on the child.

In explaining why the American Red Cross is seeking funds for books, their Emergency Preparedness Coordinator Sandi Wraith states “Children's needs are often overlooked in the immediate aftermath of a disaster because everyone is concerned primarily with putting the fire out, reaching safety, and finding shelter, food and clothing...just the basics of life. So many times, I've seen children just sitting on the curb with no one to talk to about what's happening...for this reason I've found trauma recovery experts in the community to work with us to train our volunteer responders in how to address children's needs at the scene of a disaster.....being able to give the children fun and distracting books will provide a great bridge for our volunteers to connect with kids and get them talking about what they've experienced.”

Once we are ready to proceed to the decisions, you will be given a decision folder and a calculator. The folder contains a decision task with six decisions on it, and an envelope. For each decision you will have to enter your preferred allocation. If you wish to receive a receipt from the American Red Cross for your allocation to the child, you will need to fill out the acknowledgment form. Note however that by doing so you will relinquish your anonymity. If you wish to remain anonymous, leave the acknowledgment form blank. When you have completed the decision form please place it in the envelope along with the acknowledgment form, instructions and the calculator.

When we have collected all the envelopes we will draw a number between 1 and 6 to determine which one of the decisions counts for payment. Since one decision is randomly selected for payment, you should be making your decision as if every decision counts.

## Sample Decisions

Here is an example of the type of decision you will have to make. This is just an example to demonstrate how everything is calculated. The example is not meant to guide your decision in any way. On the actual decision sheets we want you to select the allocation that you like best.

*Example:* You have been given \$20 to allocate between the child and yourself. The research foundation's fixed donation towards the child is \$5. You must choose how much money to allocate towards the child and yourself.

You may choose to allocate nothing towards the child's books and \$20 to yourself. If this decision is selected for payment the foundation's fixed donation of \$5 is spent on the child and your payment from the decision will be \$20.

Alternatively you may choose to allocate \$20 towards the child and nothing to yourself. The money to be spent on the child's books will be  $\$20 + \$5 = \$25$ , and your payment from the decision is \$0.

Finally, you may choose to allocate any amount between \$0 and \$20 to the child and the remainder to yourself. Suppose you choose to allocate \$8 towards the child and \$12 to yourself. If selected for payment the American Red Cross will receive  $\$8 + \$5 = \$13$  to spend on the child's books and your payment for the decision will be \$12.

## **Monitor Role**

To verify that all the procedures of this study are followed we will select a participant to be the monitor of the study. If your Claim Check number is 8 you will be the monitor. The monitor will follow the assistants around to see that everything takes place as explained in these instructions. The monitor will receive a fixed payment for his or her time.

Once all decision forms have been collected all participants will be given a survey. While you are completing the survey the monitor will walk with two assistants to a separate room to oversee that the calculation of the funds for the child and you are performed as described in the instructions. Your payment will be placed along with a receipt in an envelope that has your claim check number on the face of it. The assistant will make out a check to the American Red Cross of Southwestern PA for the amount corresponding to the funds for the child determined by your allocation. One check will be made out for each child. This check as well as any relevant acknowledgment form will be placed in an addressed and stamped envelope to the American Red Cross. Once all the calculations have been completed an assistant will walk the monitor back to this room. A box of envelopes with your payments will be given to an assistant who has not seen your decision sheets. The monitor will then make a statement to you on the extent to which the instructions were followed as described in the instructions. Once you have completed your survey you may come to the front to collect your payment by showing your claim check. An assistant who has not seen your decision form will hand you the sealed envelope with your payment.

After the study is completed the monitor and an assistant will walk to the nearest mailbox (on Forbes next to the Hillman Library) where the monitor will drop the envelope in the mailbox. To prove that all procedures are followed the monitor will be asked to sign a certificate to that effect. This certificate will be posted outside 4916 Posvar Hall.

Upon receipt of the check and acknowledgment form the American Red Cross will send a letter affirming that the check has been used to buy books for the child according to the description above. This letter will be posted outside 4916 Posvar Hall.

If you are the monitor of this study please identify yourself by coming to the front of the room now.

If you have any questions about the procedures, please raise your hand now and one of us will come to your seat to answer your question.

Before we proceed to the decision task we want you to complete a brief quiz, to make sure you know how everything will be calculated.