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Why Do People Give? Testing Pure and Impure Altruism†

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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. (*JEL* D64, L31)

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

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(Becker 1974).[1] 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 \$1 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). Securing complete crowd-out is a testable prediction of the pure altruism model.[2]

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 \$1 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 \$1, in turn increasing the charity's total output, generating less-than-complete crowd-out as 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.[3] This test has always been carried out around *one* level of the charity's 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

[1] 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 which fund-raisers use to solicit funds (for reviews, see, e.g., Vesterlund 2006, 2016; List 2011; and Andreoni and Payne 2013).

[2] Warr (1983), Bergstrom, Blume, and Varian (1986), and Andreoni (1988) 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 Kingma (1989); Steinberg (1991); Khanna, Posnett, and Sandler (1995); Payne (1998); Okten and Weisbrod (2000); Ribar and Wilhelm (2002); and Vesterlund (2006, 2016).

[3] 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 provide 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 et al. 2002; Sutter and Weck-Hannemann 2004; Eckel, Grossman, and Johnston 2005; Gronberg et al. 2012).

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.[4]

[4] See also Kessler and Vesterlund (2015).

I. 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. Here, $G = \sum_{i=1}^{n} g_i$ 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: $dG^*/dw_i = dG^*/dG_{-i} \triangleq q_1$.[5] 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. Individual i's response to the tax funded increase in giving-by-others is thus 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.[6] 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 giving-by-others: $G^* = q(w_i + G_{-i}, G_{-i})$.[7] 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: $dG^*/dG_{-i}\big|_{dw_i=0} = q_1 + q_2 = 1$. 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 \$1 lump-sum tax accompanied by a \$1 increase in the giving-by-others

[5] 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 $g_i^* = 0$.

[6] See also Cornes and Sandler (1984) and Steinberg (1987).

[7] 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., $-U_x(x_i, G, G - G_{-i}) + U_G(x_i, G, G - G_{-i}) + U_{gi}(x_i, G, G - G_{-i}) = 0$, when using $g_i = G - G_i$.

$(dG_{-i} = -dw_i = 1)$ 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 $(\mathrm{H}_0{:}\left|dg_i^*/dG_{-i}|_{dw_i=-dG_{-i}}\right| = 1)$. 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 $(\left|dg_i^*/dG_{-i}|_{dw_i=-dG_{-i}}\right| = 0.737)$, 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.[8]

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:

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

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 $\alpha = 0.40$ and $\beta = 0.10$, 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 (α) toward being influenced by warm-glow (β). 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.

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

[8] Andreoni (1993) finds 0.715 crowd-out and rejects pure altruism. Gronberg et al. (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 et al. (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 (Palfrey and Prisbrey 1996, 1997; Anderson, Goeree, and Holt 1998; Goeree, Holt, and Laury 2002).

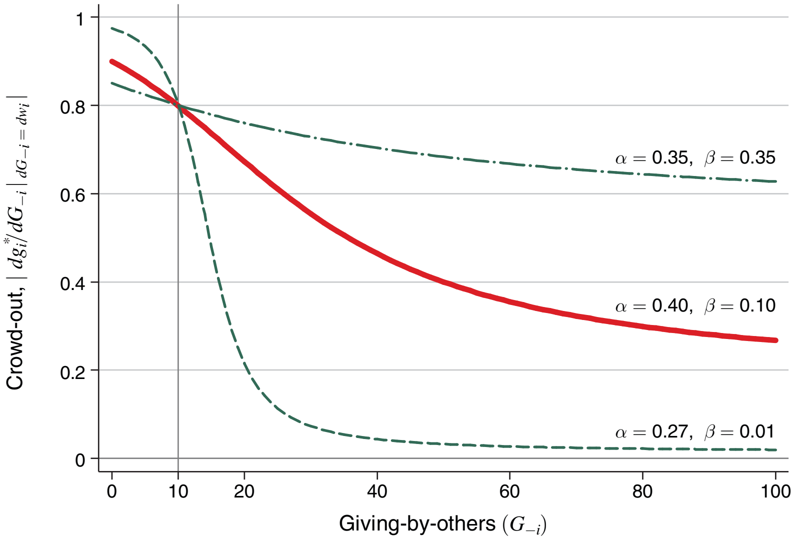

Figure 1. Crowd-Out as a Function of Giving-by-Others

Notes: $U = \alpha \log(G) + \beta \log(g_i) + (1 - \alpha - \beta) \log(x_i)$. Income is held constant at $w_i = \$40$.

by others equals \$10 ($= G_{-i}$). Figure 1 shows that this measurement of crowd-out is consistent with $\alpha = 0.40$, $\beta = 0.10$, where preferences place less weight on warm-glow than altruism.[9] 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., ($\alpha = 0.27$, $\beta = 0.01$) or ($\alpha = 0.35$, $\beta = 0.35$), respectively). In fact, there are infinitely many α, β parameterizations that generate this degree of crowd-out. 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 ($\alpha = 0$, $\beta = 0.80$) also generates an 80 percent crowd-out. While this single crowd-out 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 online Appendix A).[10] The test is direct because impure altruism is positioned as the

[9] The weight on warm-glow, β, relative to overall generosity, $\alpha + \beta$, is 0.2 ($= \beta/\alpha + \beta$).

[10] 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

null hypothesis and novel because it tests a prediction for which there did not exist supporting evidence at the time the theory was proposed.[11]

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.

II. 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 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.[12]

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 toward the child; this is the individualized charity's initial output level. The foundation's donation was independent of the participant's allocation, and the

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 et al. 2002; Sutter and Weck-Hannemann 2004; Gronberg et al. 2012). Third, beyond some level of G_{-i}, monotonically decreasing crowd-out becomes applicable to nonseparable 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).

[11] According to some, though not all, theories of confirmation, confirmation of a novel prediction provides stronger support for a theory (e.g., Musgrave 1974).

[12] Donations were made immediately after the fire along with the Southwestern Pennsylvania chapter of the American Red Cross's 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." Ms. Wraith kindly emailed this statement to us upon request for an explanation for why books would be helpful for the children.

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

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, Kariv, and Markovits (2007), we use a within-subject design to identify individual preferences.[13] 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.[14] One randomly selected decision was carried out for payment.

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

[13] The objective of these studies is to determine whether giving is consistent with the generalized axiom of revealed preference (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 (constant elasticity of substitution (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 (2016) for the much weaker condition under which such random problem selection (RPS) mechanisms are incentive compatible.

[14] 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.

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 0: $dg_i^*/dG_{-i}|_{dw_i=0} = 0$, 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.[15]

The procedures of the experiment were as follows. A total of 85 undergraduates at the University of Pittsburgh participated in 1 of 6 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 aloud. 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.

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 acknowledgment 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, Grossman, and Johnston (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 acknowledgments 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

[15] A pure altruist gives to influence the output, in this case the gift received, say moving from cheap scholastic paperbacks 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.

Table 2—Change in Crowd-Out between a Low and a High Level of Giving-by-Others

	Crowd-out $\left(\frac{dg_i^*}{dG_{-i}}\Big\vert_{dw_i = -dG_{-i}}\right)$					Unfunded crowd-out $\left(\frac{dg_i^*}{dG_{-i}}\Big\vert_{dw_i = 0}\right)$
	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[a] (0.09)	−0.77[b] (0.08)	−0.97[c] (0.09)	−0.82[d] (0.09)	−0.99[e] (0.09)	−0.64 (0.08)
Giving-by-others × high interaction	–	–	–	–	0.18[f] (0.12)	0.22[g] (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 et al. (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: [a]$p = 0.255$, [b]$p = 0.002$, [c]$p = 0.390$, [d]$p = 0.034$, and [e]$p = 0.477$. [f]Test of no decrease in crowd-out has $p = 0.07$. [g]Test of no decrease in unfunded crowd-out has $p = 0.013$.

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.

III. Results

Participants found the charitable cause worthy of donations. Average giving across the six budgets ($6 \times 85 = 510$ 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.

A. *Reduced-Form Measures of Crowd-Out: Altruism versus 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 \$1 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: $\left\vert dg_i^*/dG_{-i}\vert_{dw_i=-dG_{-i}}\right\vert \geq 1$ has $p = 0.255$). 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.

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 reestimate the models, taking into account corner decisions. Using the two-sided individual fixed effects censored estimator of Alan et al. (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.[16]

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.[17,18]

[16] 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.

[17] 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 0.40 and 0.41 at the low and high levels of giving-by-others. The two-sided fixed-effects censored estimates are slightly smaller (0.32 and 0.36); the hypothesis that the two income effects are the same cannot be rejected ($p = 0.583$). 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.

[18] The zero unfunded crowd-out prediction of pure warm-glow is rejected at both the low and the high level of giving-by-others ($p < 0.001$).

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.

B. *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

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

where $i = 1, \ldots, 85$ indexes the participants, $b = 1, \ldots, 6$ 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 α (altruism) and β (warm-glow), we first use a representative-agent approach.

Estimation of (2) presents three econometric problems: nonlinearity in the parameters α and β, 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 nonlinear random effects Tobit estimator permitting both lower and upper corner solutions, and use it to estimate (2).[19]

Table 3 reports the estimates. Consistent with our crowd-out results, the significant coefficients on both α and β 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 ($\beta/\alpha + \beta$).[20] The 0.902 estimate of the correlation coefficient ρ indicates that there is substantial heterogeneity in participants' random deviations from the

[19] Estimates of α and β 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.

[20] 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., α and β). 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 \$153.55.

Table 3—Estimated Representative-Agent Cobb-Douglas Preferences

	Coefficient	Standard error	p-value
α	0.594	0.027	0.000
β	0.021	0.010	0.022
ρ	0.902	0.016	0.000

Notes: Nonlinear random effects Tobit estimates of (2). ρ is the correlation coefficient of the error term across decisions within-individuals. The log-likelihood is -1466.9. $N = 85$ participants, 6 decisions per participant.

Cobb-Douglas model. Next, we look at individual choices to explore the heterogeneity across participants in their α and β parameter values.

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 α_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 (37.7 percent; $N = 32$). Eleven percent ($N = 9$) were motivated only by warm-glow.[21] 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 $\alpha_i < \beta_i$. 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.[22]

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.

[21] Three of the pure warm-glow participants have $\alpha_i = 0$ and $\beta_i = 0.5$ and are indistinguishable in Figure 2. Estimates of α_i and β_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.

[22] 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.

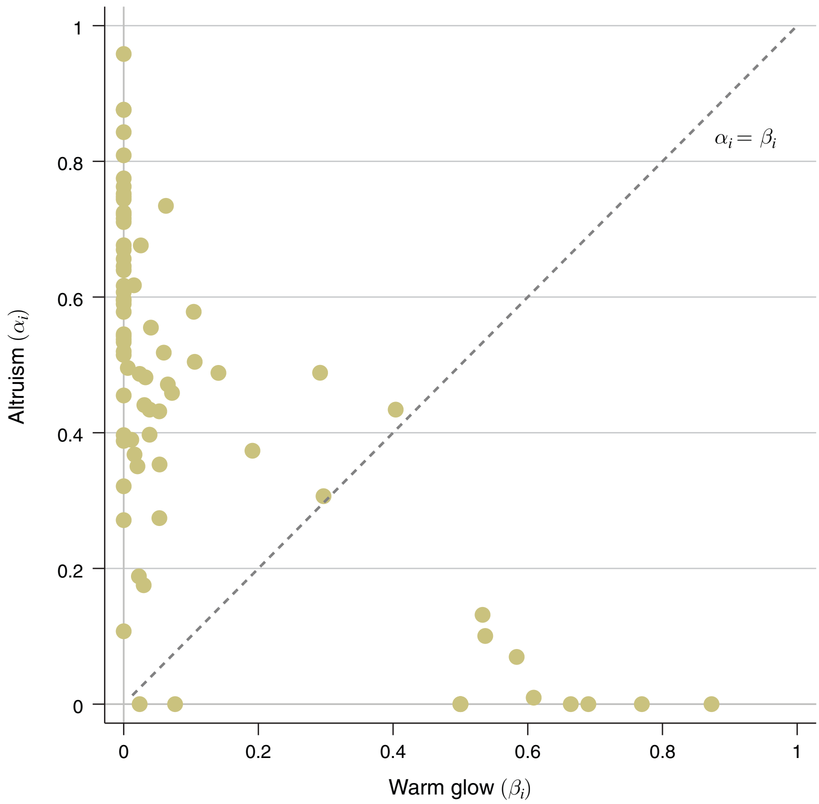

Figure 2. Estimated Individual-Specific Cobb-Douglas Preferences ($N = 78$)

IV. 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 used 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 nonprofit will be predictive of preferences for contributing to all nonprofits. 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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