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**Does category reporting increase donations to charity? A
signalling game approach**

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Abstract

Many charities report donations using categories. We question whether such category reporting increases donations in a signalling game where a donor is either generous or not generous. Conditions are derived under which category reporting will increase giving or decrease giving. Category reporting will increase giving if the probability a donor is generous is low and/or donor preferences depend a lot on type. Category reporting will decrease giving if the probability a donor is generous is high and/or donor preferences depend little on type.

Keywords: Public good, charity, category reporting, signalling

JEL codes: C72, H41.

1 Introduction

Many charities and fund-raisers publicize the donations they receive. Sometimes the exact amount donated will be publicized as, for example, with on-line or paper sponsorship forms. More typically, however, donations are publicized using categories. To give two of many possible examples: Donors to the Royal Opera House are classified as Platinum, Gold or Silver Patrons depending on whether the donation is more than £19,600, £8,500 or £4,600; a list of donors at each category is available on their website. Donors to various projects at the University of Glasgow can have their name put on a donor wall with £5,000 buying a platinum brick, £2,000 a gold, £1,000 a silver, £500 a bronze and £250 a ‘noted gift’; a donation of more than £10,000 gives the chance to name a room or area of the building.

Many have suggested that giving to charity can be partly explained as signalling. A person may, for instance, donate more to charity than they otherwise might in order to signal wealth, altruism or even intelligence (Frank 1985, Glazer and Konrad 1996, Harbaugh 1998a and Millet and Dewitte 2007). Certainly we do observe people giving more when donations are publicly observable (Andreoni and Petrie 2004, Soetevent 2005 and Alpizar et al. 2008). A signalling explanation for giving means that category reporting should make a difference. Harbaugh (1998a, 1998b) reports evidence consistent with this by showing that alumni donations to a law school converged to the category thresholds when category reporting was introduced or changed. For example, a category threshold of \$250 increased the number donating \$250 while lowering the number donating \$200 or \$300 (Harbaugh 1998b).

The question we shall address in this paper is whether category reporting increases giving. In the law school example, for instance, intuition would suggest that category reporting increased the giving of some, those who donated \$250 rather than \$200, but may decrease the giving of others, someone who donates \$250 rather than \$300. Overall, should we expect this to increase or lower giving? To answer this question we consider a signalling game in which a donor, who can be either generous or not generous, gives to charity. The amount he gives is observed by others who try to infer his generosity. If he is inferred to be generous then he earns more esteem. We find a unique signalling equilibrium which details expected giving. This allows us to compare giving with exact reporting and giving with category reporting.

We find that category reporting will likely *increase* expected giving if there would be a separating equilibrium with exact reporting. This will

happen if the donor is generous with a relatively low probability and/or there are relatively large differences in the possible donor preferences. Either a *high* category threshold that increases the giving of the donor when generous or a *low threshold* that increases the giving of the donor when not generous are likely to increase expected giving. By contrast, we find that category reporting will likely *decrease* expected giving if there would be a pooling equilibrium with exact reporting. This will happen if the donor is generous with a relatively high probability and/or there are relatively small differences in the possible donor preferences. In this case the donor has insufficient incentive to signal generosity and category reporting will not change that, but it will lower the amount the donor will give if not generous. Overall, therefore, we find that category reporting can increase or decrease giving depending on the situation.

In relating our results to the previous literature it is most important to mention Harbaugh (1998b) and McCardle et al. (2009) who considered in detail whether category reporting can increase donations. The difference between our approach and that of these papers is we endogenize the inferences of observers. Specifically, previous work assumes that the more a person gives the more prestige he receives. In a signalling equilibrium where observers are trying to infer the motives of a donor, this may not occur. The approach taken by Harbaugh and McCardle et al. is easily defended as a first approximation, see p. 274 of Harbaugh, and appropriate if observers are naive, as we have suggested elsewhere they may be (Cartwright and Patel 2010). We would argue, however, that there are good reasons to want to endogenize inferences. For instance, it does not seem obvious to us that someone who gives \$250 when there is a category threshold of \$250 is going to receive the same prestige as someone who gives \$250 when there is exact reporting. Might we not think that the person has only given \$250 because of the category threshold at \$250?¹ The signalling game we use in this paper allows us to capture and answer such questions. We shall see that it does lead to important consequences for the results.

One of the more interesting consequences is that it can be desirable to set a low category threshold that lowers the giving of a generous type. In reducing the giving, or at least observed giving, of a generous type it becomes

¹On a related point, McCardle et al. (p 6, 2009) ask, but do not analyse, what would happen if prestige received for say donating in the top tier would depend on how many donors are in the top tier?

easier for a not generous type to appear generous. The extra giving of a not generous type may be enough to offset the loss from a generous type. Indeed, because category reporting will increase giving when the probability of a not generous type is relatively high a low threshold is often more effective at increasing giving, because it targets the not generous type. Interestingly others have suggested a contribution cap may increase contributions in contests such as political campaigning or political influence (Che and Gale 1998, Gavious et al. 2002, Drazen et al. 2007 and Baik 2008). In these settings a cap increases the chances of a less endowed individual or group winning, and so increases effort to win. This seems similar in spirit to our findings that a lower category threshold, which increases the chances a not generous type can appear generous, may increase the giving of a not generous type.

The rest of the paper is structured as follows. In Section 2 we present the model. In Section 3 we work through the baseline case of exact reporting. In Section 4 we add category reporting and compare with exact reporting. In Section 5 we conclude.

2 A signalling model of giving

We consider a standard signalling game in which there is a sender and receiver. We interpret the sender as a *donor* giving to charity and the receiver as representing friends, colleagues, etc. who observe the giving. The donor is either *generous*, type G , or *not generous*, type N . The probability that he is generous is p , for some real number $p \in (0, 1)$, and the probability he is not generous is $1 - p$. The donor can give any amount $x \in [0, \infty)$ to a charity. If he gives x then he receives an *intrinsic payoff* of $u_G(x)$ if generous and $u_N(x)$ if not generous, where u_G and u_N are real valued functions. As one might expect we shall assume that he intrinsically prefers to give more if he is generous.

Assumption 1: u_G is continuous, achieves a strict maximum at x_G , is strictly increasing for $x < x_G$ and weakly decreasing for $x > x_G$; u_N is continuous, achieves a strict maximum at x_N , and is strictly decreasing for $x > x_N$; $x_G > x_N$.

Throughout the following it will be useful to have an illustrating example

and we shall use a *quadratic example* where

$$\begin{aligned} u_N(x) &= -(x - a)^2, \\ u_G(x) &= -(x - b)^2 \end{aligned}$$

for some real numbers $a < b$.

The amount given by the donor is observed by the receiver who tries to infer whether or not the donor is generous. At this point we make the key distinction between category reporting and exact reporting. If there is *exact reporting* the *exact amount x given by the donor is observed*. If there is *category reporting* then there exists a *category threshold \hat{x}* such that it is only observed whether the donor gave *more than the threshold $x \geq \hat{x}$* or *less $x < \hat{x}$* .² The inferences of the receiver will be summarized by an *inference function q* that maps giving to a probability the donor is generous. That is, $q(x) \in [0, 1]$ is the inferred probability that the donor is generous if he gives x . Naturally, we shall require in the category reporting case that $q(x) = q(x')$ if $x, x' < \hat{x}$ or $x, x' \geq \hat{x}$.

If the donor is perceived to be generous with probability q then he receives an *esteem payoff* of Eq , where E is a strictly positive real number. The total payoff of the donor is his intrinsic payoff plus any esteem payoff, i.e.

$$\begin{aligned} U(x, G, q) &\equiv u_G(x) + Eq(x), \\ U(x, N, q) &\equiv u_N(x) + Eq(x). \end{aligned}$$

A *pure strategy s* details what the donor will give if generous and not generous. Thus, $s(T)$ denotes the amount given by the donor if type T . A *strategy σ* is a randomization over the set of pure strategies. Given that the action set is non-countable some care is needed in defining a strategy. We shall see, however, that the donor would never have any incentive to randomize over a non-finite set of pure strategies. We, therefore, denote by $\sigma(x, T)$ the probability that the donor gives x if of type T .³

²Note that because the donor is one of two types it is without loss of generality that we assume there is a unique threshold with category reporting. This will become clear as we proceed.

³In the model, as described so far, the donor could represent a population of identical donors. By using the notation $\sigma(x, T)$ we depart from this somewhat by requiring symmetry, or that all donors use the same strategy. Jumping ahead of ourselves, there would always be a symmetric equilibrium, but this need not be the only one. For example, there

2.1 Signaling equilibrium

Given a strategy σ we shall say that an inference function is consistent with strategy σ if the type of the donor is correctly inferred. Specifically, if there is exact reporting we shall say that the *inference function is consistent with strategy σ* if

$$q(x) = \begin{cases} \frac{p\sigma(x,G)}{p\sigma(x,G)+(1-p)\sigma(x,N)} & \text{if } \sigma(x,G) > 0 \\ 0 & \text{otherwise} \end{cases} .$$

Note that this definition of consistency ties down ‘out of equilibrium beliefs’ by saying that if $\sigma(x,G) = 0$ then $q(x) = 0$ even if $\sigma(x,N) = 0$. Thus, any ‘unexpected’ amount of giving is inferred to be by a not generous type.⁴ If there is category reporting the requirement for consistency is revised to

$$q(x) = \begin{cases} \frac{p\sigma(x \geq \hat{x}, G)}{p\sigma(x \geq \hat{x}, G) + (1-p)\sigma(x \geq \hat{x}, N)} & \text{if } \sigma(x \geq \hat{x}, G) > 0 \text{ and } x \geq \hat{x}, \\ \frac{p(1-\sigma(x \geq \hat{x}, G))}{p(1-\sigma(x \geq \hat{x}, G)) + (1-p)(1-\sigma(x \geq \hat{x}, N))} & \text{if } \sigma(x \geq \hat{x}, G) < 1 \text{ and } x < \hat{x}, \\ 0 & \text{otherwise} \end{cases} .$$

where $\sigma(x \geq \hat{x}, T) = \sum_{x' \geq \hat{x}} \sigma(x', T)$.

A *signalling equilibrium* consists of a strategy σ and inference function q such that:

(1) The donor maximizes his payoff given the inference function q . That is,

$$U(x^*, T, q) \geq U(x, T, q)$$

for any $x \in [0, \infty)$, any x^* such that $\sigma(x^*, T) > 0$ and any $T = G, N$.

(2) The inference function q is consistent with the strategy σ .

Note that this definition of signalling equilibrium is slightly stronger than the normal definition because we have tied down out of equilibrium beliefs, as described above.

might be an equilibrium where a not generous type gives x with probability 0.5 and $x' \neq x$ with probability 0.5. This would be indistinguishable from an equilibrium where half the donors who are not generous give x and half give x' . Note, however, that expected giving, which is our interest in this paper, remains the same in both these equilibria.

⁴This requirement is stronger than we need to obtain our results but does significantly simplify the analysis.

3 Giving with exact reporting

We begin with the case of exact reporting and provide two useful preliminary results. Our first result details the optimal giving of the donor if not generous.

Lemma 1: If the donor gives x for sure when generous, i.e. $\sigma(x, G) = 1$ for some x , and the inference function will be consistent with strategy σ , then if not generous the donor should give x with probability $\beta(x)$ and x_N with probability $1 - \beta(x)$ where

$$\beta(x) = \begin{cases} 0 & \text{if } u_N(x_N) \geq u_N(x) + E \\ 1 & \text{if } u_N(x_N) \leq u_N(x) + p^2 E \\ \frac{p}{1-p} \left(\sqrt{\frac{E}{u_N(x_N) - u_N(x)}} - 1 \right) & \text{otherwise} \end{cases}$$

Proof: Assumption 1 and the consistency of inferences imply that the donor must give x_N or x if not generous; there can be no gain from giving any other amount because he will get no esteem and less intrinsic utility. Suppose that he gives x with probability β and x_N with probability $1 - \beta$. His payoff is

$$(1 - \beta)u_N(x_N) + \beta \left[u_N(x) + \frac{pE}{p + (1 - p)\beta} \right] \equiv \pi(x, \beta).$$

To search for an interior payoff maximum we note that

$$\begin{aligned} \frac{d\pi(x, \beta)}{d\beta} &= u_N(x) - u_N(x_N) + \frac{pE}{p + (1 - p)\beta} - \frac{\beta p(1 - p)E}{(p + (1 - p)\beta)^2} \\ &= u_N(x) - u_N(x_N) + \frac{p^2 E}{(p + (1 - p)\beta)^2}. \end{aligned}$$

So, at an interior maximum

$$\beta = \frac{p}{1 - p} \left(\sqrt{\frac{E}{u_N(x_N) - u_N(x)}} - 1 \right).$$

Clearly, we cannot have that $\beta \leq 0$. If $u_N(x_N) - u_N(x) > E$ the donor should give x_N . Also, we cannot have $\beta > 1$. If

$$\sqrt{\frac{E}{u_N(x_N) - u_N(x)}} > \frac{1}{p}$$

the donor should give x . ■

In interpretation, Lemma 1 shows that the donor may give more than he intrinsically prefers when not generous in order to try and appear generous. The incentive to do so is more esteem. Some important values of giving that it is useful to make note of are

$$\begin{aligned} x_H \text{ solves } u_N(x_N) &= u_N(x_H) + E; \\ x_L \text{ solves } u_N(x_N) &= u_N(x_L) + p^2 E; \end{aligned} \quad (1)$$

Note that by assumption 1 a unique value for x_H and x_L exists. In interpretation, if not generous, the donor will never give more than x_H or less than x_L . An immediate corollary of Lemma 1 is the following.

Lemma 2: If the inference function will be consistent with strategy σ and the donor will maximize his payoff if not generous then the payoff of the donor when generous is

$$U(x, G, q) = \begin{cases} u_G(x) + E & \text{if } x \geq x_H \\ u_G(x) + Ep & \text{if } x \leq x_L \\ u_G(x) + \sqrt{E(u_N(x_N) - u_N(x))} & \text{if } x \in (x_L, x_H) \end{cases} \quad (2)$$

Proof: Given Lemma 1, and consistency of beliefs, the payoff of the agent when a generous type will be

$$U(x, G, q) = u_G(x) + \frac{Ep}{p + (1 - p)\beta(x)}.$$

Substituting in for $\beta(x)$ gives the desired result. ■

Lemma 2 is an important result because it shows that giving more need not earn more esteem. Specifically, if $x \leq x_L$ then esteem is Ep and if $x \geq x_H$ then esteem is E . If, therefore, $x \notin [x_L, x_H]$ an increase in giving will not cause an increase in esteem. This will prove crucial, and the factor that distinguished our approach from that of Harbaugh (1998b). For now we make an additional assumption.

Assumption 2: Both u_N and u_G are differentiable and the ratio $u'_N(x)/u'_G(x)$ is a weakly decreasing function of x for $x > x_G$.

Differentiability is fairly innocuous. The requirement of a decreasing ratio in the gradients is suggested by concavity of the intrinsic utility functions. Assumption 2 is useful to guarantee the uniqueness of a third important value of giving,

$$x_M \text{ solves } u_N(x_N) = \left(\frac{u'_N(x_M)}{2u'_G(x_M)} \right)^2 E + u_N(x_M). \quad (3)$$

Assumption 2 implies that a unique x_M will exist, as discussed in the proof of our next result.⁵ For those who wish to skip the proof we note that the value of x_M will prove important because it is a candidate interior optimum to (2). With this we can state the main result of this section which details equilibrium giving when there is exact reporting.

Proposition 1: If there is exact reporting then there exists a unique signalling equilibrium. This equilibrium can take five possible forms:⁶

(i) *Trivially separating.* The donor gives x_G when generous and x_N when not generous if $x_G \geq x_H$.

(ii) *Separating.* The donor gives x_H when generous and x_N when not generous if $x_M \geq x_H$ and either $x_L < x_G$ or $E(1-p) > u_G(x_G) - u_G(x_H)$.

(iii) *Hybrid 1.* The donor gives $x_M > x_G$ when generous and x_M with probability $\beta(x_M) > 0$ and x_N with probability $1 - \beta(x_M) > 0$ when not generous if $x_M \in (x_L, x_H)$ and either $x_L < x_G$ or $E(u'_N(x_M)/2u'_G(x_M) - p) > u_G(x_G) - u_G(x_M)$.

(iv) *Hybrid 2.* The donor gives x_G when generous and x_G with probability $\beta(x_G) > 0$ and x_N with probability $1 - \beta(x_G) > 0$ if not generous when $x_L < x_G$.

(v) *Pooling.* Otherwise the donor gives x_G whether generous or not.

Proof: Given Lemma 1 it remains to show what the donor will do if generous.

(i) If $x_G \geq x_H$ then $\beta(x_G) = 0$ implying the donor can give x_G and get

⁵Assumption 2 is stronger than required to guarantee this, and we can work without uniqueness, but Assumption 2 still appears relatively weak and so we use it.

⁶This statement should be read from top to bottom, so, for example, because (i) requires $x_G \geq x_H$ we know that (ii)-(v) require $x_G < x_H$.

maximum esteem and intrinsic utility. This is clearly optimal, so the donor should give x_G if generous and x_N if not generous.

When $x_G < x_H$ we know that $\beta(x_G) > 0$ and so the donor must sacrifice either intrinsic utility or esteem. From (2) we know that if $x \in (x_L, x_H)$

$$\frac{d}{dx}U(x, G, q) = u'_G(x) - \frac{u'_N(x)\sqrt{E}}{2\sqrt{(u_N(x_N) - u_N(x))}}.$$

Thus, noting that $u'_G(x) < 0$ for $x \geq x_G$,⁷

$$\frac{d}{dx}U(x, G, q) \geq 0 \text{ as } \left(\frac{u'_N(x)}{2u'_G(x)}\right)^2 E + u_N(x) \geq u_N(x_N). \quad (4)$$

Assumptions 1 and 2 imply that the left hand side of (4) is strictly decreasing in x . If therefore, $x_M \in (x_L, x_H)$ we know that utility is strictly increasing for $x < x_M$ and decreasing for $x > x_M$. In other words x_M is a local optimum. Furthermore, if $x_M \geq x_H$ then x_H is a local optimum and if $x_M \leq x_L$ then giving x_L implies a higher payoff than giving $x > x_L$. With this we can cover the remaining four conditions.

(ii) If $x_M \geq x_H$ then it appears the donor is willing to sacrifice intrinsic utility for esteem. But we do need to check this gives a higher payoff than the ‘corner solution’ of giving x_G . If $x_G \in (x_L, x_H)$ then we have already shown this by the optimality of x_M . If $x_G < x_L$ then we need to compare the payoff of $u_G(x_H) + E$ he gets from giving x_H versus the payoff of $u_G(x_G) + Ep$ he gets from giving x_G . This gives the added condition $E(1-p) > u_G(x_G) - u_G(x_H)$.

(iii) If $x_M \in (x_L, x_H)$ then we have a candidate interior optima. Using Lemma 2, this gives payoff

$$u_G(x_M) + E \left(\frac{u'_N(x_M)}{2u'_G(x_M)}\right).$$

We again need to check this is a higher payoff than giving x_G (when $x_G < x_L$) and getting $u_G(x_G) + Ep$. This gives the added condition $E(u'_N(x_M)/2u'_G(x_M) - p) > u_G(x_G) - u_G(x_M)$.

⁷There may be a concern in deriving this inequality of what happens if $u'_G(x) = 0$, as may be the case, for example, when $x = x_G$. Note, however, that this would mean $dU/dx \geq 0$ because an increase in x does not decrease intrinsic utility but does weakly increase esteem. So, it is a technical rather than real problem in interpreting (4).

(iv and v) In all other cases the best option for the donor is to give x_G . It remains to see with what probability the donor will give x_G if not generous.

We have not yet discussed uniqueness of the equilibrium but generically it can be seen this must be the case. ‘Generically’ merely reflects that if the donor is indifferent between say giving x_H or x_G then clearly there are multiple equilibria. ■

Proposition 1 shows that the donor could give different amounts depending on his type (separating), the same irrespective of type (pooling), or randomize when not generous (hybrid). The form of equilibrium will depend on the differences in preferences and importance of esteem. This is what we would expect in a signalling framework and illustrates the complex strategic incentives at work. The parameter boundaries between forms of equilibria are not particularly transparent in the general case but do simplify nicely in the quadratic example.⁸

Corollary 1: In the quadratic example with exact reporting there exists a unique signalling equilibrium:

(i) *Trivially separating.* A generous agent will give b and a not generous a if $b - a \geq \sqrt{E}$. Expected giving is $pb + (1 - p)a$.

(ii) *Separating.* A generous agent will give $\sqrt{E} + a$ and a not generous agent a if $\sqrt{E} > b - a \geq \max \left\{ \sqrt{E}/2, \sqrt{E}(1 - \sqrt{1 - p}) \right\}$. Expected giving is $a + p\sqrt{E}$.

(iii) *Hybrid.* A generous agent will give $\sqrt{E}/2 + b$ and a not generous agent will give $\sqrt{E}/2 + b$ with probability $\beta(\sqrt{E}/2 + b)$ and x_N with probability $1 - \beta(\sqrt{E}/2 + b)$, if $\sqrt{E}/2 \geq b - a > \sqrt{E}(p - 1/4)$. Expected giving is $a + p\sqrt{E}$.

⁸In interpreting the general case it may be useful to note that

$$x_M \geq x_H \text{ as } \frac{u'_N(x_H)}{2u'_G(x_H)} \geq 1$$

and

$$x_M \geq x_L \text{ as } \frac{u'_N(x_L)}{2u'_G(x_L)} \geq p.$$

This follows from (1) and (3).

(iv) *Pooling*. Both generous and not generous agents invest b otherwise. Expected giving is b .

Proof: In the quadratic example,

$$x_G = b, \quad x_N = a, \quad x_H = \sqrt{E} + a, \quad x_L = p\sqrt{E} + a, \quad x_M = \frac{\sqrt{E}}{2} + b. \quad (5)$$

(i) We need $x_G = b \geq x_H$. (ii) That $x_M \geq x_H$ implies $b - a \geq \sqrt{E}/2$. That $x_L < x_G$ implies $b - a > p\sqrt{E}$. That $E(1 - p) \geq u_G(x_G) - u_G(x_H)$ implies that $E(1 - p) \geq (\sqrt{E} + a - b)^2$ which simplifies to $b - a > \sqrt{E}(1 - \sqrt{1 - p}) \geq p\sqrt{E}$. (iii) That $x_M > x_L$ implies $b - a > \sqrt{E}(p - 1/2)$. That $E(u'_N(x_M)/2u'_G(x_M) - p) > u_G(x_G) - u_G(x_M)$ implies

$$\sqrt{E} \left(\frac{\sqrt{E}}{2} + b - a \right) - pE > \frac{E}{4}$$

which simplifies to $b - a > \sqrt{E}(p - 1/4)$. The amount of expected giving is obvious in all bar the hybrid case. There expected giving is

$$a + (p + (1 - p)\beta) \left(\frac{\sqrt{E}}{2} + b - a \right)$$

where

$$\beta = \frac{p}{1 - p} \left(\frac{\sqrt{E}}{\frac{\sqrt{E}}{2} + b - a} - 1 \right).$$

Simplifying gives $a + p\sqrt{E}$. ■

Figures 1 and 2 illustrate this result. Figure 1 shows the parameter ranges that give rise to each form of equilibrium. Given that $b - a$ is a measure of the differences between the generous and not generous type it is no surprise that an increase in $b - a$ leads to increased separation. The effect of p requires a bit more thought but primarily reflects the benefits of signalling type. If p is lower then there is more to be gained by the donor from signaling his type if he is generous. Thus, a lower p leads to more separation. These two effects are also apparent in Proposition 1. Note that in the quadratic case we do not observe a hybrid 2 equilibrium because $u'_G(x_G) = 0$ and so if generous the donor is always willing to sacrifice a little intrinsic utility for more esteem. More generally, when $u'_G(x_G) \neq 0$, this need not be the case.

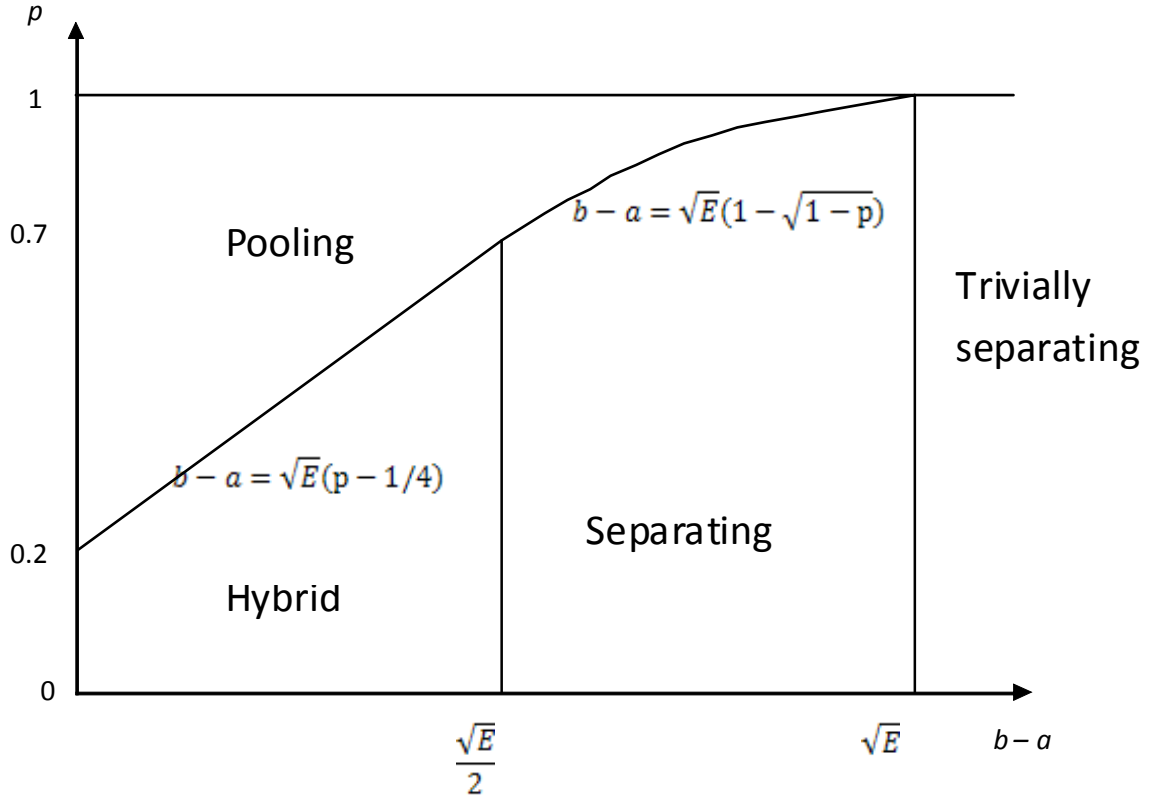


Figure 1: Signaling equilibria in the quadratic example.

Figure 2 looks at expected giving. This is important for us to look at because it provides the benchmark with which category reporting has to compete. One problem is that giving depends on the donor's preferences and so we somehow need to normalize expected giving. We do this by asking how much is expected giving relative to the expected giving there would be if the donor gave his intrinsically preferred amount, i.e. $pb + (1 - p)a$. Thus we are effectively comparing giving when the donation is observed versus giving when the donation is not observed. We see that expected giving is increased most when there is a hybrid and separating equilibrium and increases by up to 30%. In a pooling equilibrium the donor does give more if not generous. This ultimately does not increase expected giving much because the probability the donor is not generous is small and/or the differences in intrinsic

preferences are small, so the donor does not have to give much to appear generous. When there is a hybrid or separating equilibrium we see that giving is relatively unchanged the smaller is p and the greater the differences in intrinsic preferences. This is because we get nearer to a trivially separating equilibrium where giving is not influenced by exact reporting.

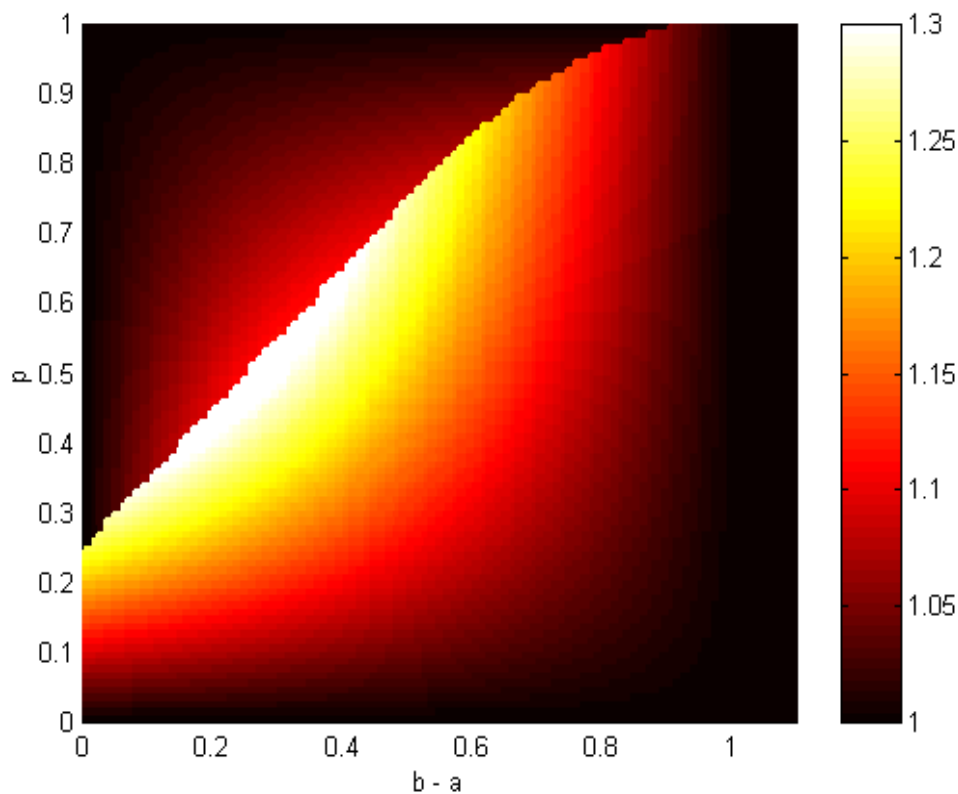


Figure 2: Expected giving with exact giving relative to when giving is not observed, with $a = 1$ and $E = 1$.

4 With category reporting

We now turn to the main motivation for the paper: can a well set category threshold increase giving. Let $V(\hat{x})$ denote the expected giving with a cate-

gory threshold of \hat{x} and $V(ex)$ denote expected giving with exact reporting. We begin with some simple observations.

Corollary 2: If there is category reporting the donor will give either x_G or the category threshold \hat{x} if he is generous and either x_N or \hat{x} if he is not generous. There exists a category threshold \hat{x} such that $V(\hat{x}) = V(ex)$.

Proof: Given that the inference function q is such that $q(x) = q(x')$ whenever $x, x' \geq \hat{x}$ or $x, x' < \hat{x}$ the donor will only ever have incentive to give the amount he intrinsically prefers or the minimum necessary to meet the category threshold. If \hat{x} is set equal to the amount a generous agent would give with exact reporting then category reporting will make no difference. ■

This result tells us that category reporting will likely influence the amount given but can be designed in way that giving does not fall. The question we want to ask now is whether category reporting can increase giving? We answer this question in three parts.

4.1 Category reporting can increase giving

We begin by showing that category reporting can potentially increase giving. Let

$$x_{GH} \text{ solve } u_G(x_G) - u_G(x_{GH}) = E(1 - p).$$

Note that $x_{GH} > x_G$ and in interpretation is the maximum the donor will give in order to signal generosity. Our next result shows that category reporting can increase giving if there would be a separating equilibrium with exact reporting.

Proposition 2: If there is a (trivially) separating equilibrium with exact reporting then category reporting can *increase giving*. Specifically, If $\hat{x} \in (x_G, x_{GH})$ then $V(\hat{x}) > V(ex)$ because the donor gives more if generous. Further, if there exists a trivially separating equilibrium with exact reporting and $\hat{x} \in (x_N, x_H)$ then $V(\hat{x}) > V(ex)$ because the donor gives more if not generous.

Proof: If there is a trivially separating equilibrium with exact reporting the donor gives x_G if generous and x_N if not generous. This must mean that $x_{GH} \geq x_H$. Suppose that the category threshold is set at $\hat{x} \in (x_G, x_{GH})$. If

the donor gives x_G then he is inferred as a generous type with probability p and gets payoff $u_G(x_G) + Ep$. If he gives \hat{x} then he is inferred as a generous type and gets payoff $u_G(x_{GH}) + E$. The definition of x_{GH} (together with assumption 1) means he must prefer to give \hat{x} and expected giving has increased. If there is a (non trivial) separating equilibrium with exact reporting the donor gives $x_H > x_G$ if generous and x_N if not generous. It must be that $x_{GH} > x_H$ and so the above argument can be repeated. If $\hat{x} \in (x_N, x_H)$ then, by Lemma 1, the donor will give more than x_N if not generous. He will give x_G if generous. So, giving would increase. ■

Proposition 2 shows that category reporting can potentially increase giving in two very different ways. In explaining this it is simplest to consider the case where there is a trivially separating equilibrium with exact reporting. Recall that in this case the donor would give x_G if generous and x_N if not generous. The two ways are:

(i) The category threshold is set *high* so that the donor has to give more when *generous* to signal his generosity. The donor will give the threshold level $\hat{x} > x_G$ if generous and continue to give x_N if not generous. This increases expected giving because *the donor gives more if generous and the same if not generous*.

(ii) The category threshold is set *low* so that the donor will give more if *not generous*. The low threshold means the donor now has the means to appear generous. The generous type will still give x_G , because this is what he intrinsically prefers, and the not generous type will give $\hat{x} > x_N$. This increases expected giving because *the donor gives more if not generous and the same if generous*.

The main reason that the category threshold works is that it can be used to increase the giving of one type of donor without affecting the giving of the other type.⁹ This is possible because the giving of the donor signals his type when there is exact reporting and so it is possible to influence the giving of the donor when of one type without influencing giving when of the other type. We shall now see that this is not generally the case.

⁹An interesting question is whether a critical threshold exists that increases the giving of the donor irrespective of type. For the most part it is not, but when there would be a hybrid equilibrium with exact reporting it is a theoretical possibility.

4.2 Category reporting can decrease giving

We next turn to the opposite extreme of pooling with exact reporting. In this case we show that category reporting will not increase giving and will generally *lower* it.

Proposition 3: If there is a pooling equilibrium with exact reporting then category reporting *cannot increase giving*. If $\hat{x} = x_G$ then $V(\hat{x}) = V(ex)$ but if $\hat{x} \neq x_G$ then $V(\hat{x}) < V(ex)$. Further, if there is a hybrid 2 equilibrium with exact reporting then a low category threshold will lower giving, that is $V(\hat{x}) < V(ex)$ if $\hat{x} < x_G$.

Proof: In a pooling equilibrium the donor gives x_G irrespective of type. If $\hat{x} = x_G$ then giving will not change and so $V(\hat{x}) = V(ex)$. Now suppose that $\hat{x} > x_G$. If the donor gives x_G when generous then he gets the same payoff as with exact reporting. If he gives \hat{x} he gets the same payoff as he would have by giving \hat{x} with exact reporting. That he prefers to give x_G with exact reporting tells us, therefore, that he would also prefer to give x_G with category reporting. Thus, the donor continues to give x_G if generous. The donor, however, no longer needs to give x_G if not generous but can instead give x_N . Thus expected giving is lower. Now suppose that $\hat{x} < x_G$. Clearly, the donor will continue to give x_G if generous. If not generous, however, he only has to give \hat{x} . Again, expected giving is lower. The last argument extends to the case of a Hybrid 2 equilibrium. ■

Category reporting proves ineffective because it will not change the giving of the donor if he is generous but will lower it if he is not generous. To understand this we note that the existence of a pooling equilibrium with exact reporting indicates that it is too costly for the donor to signal his generosity. If generous, he, therefore, gives the amount he intrinsically prefers x_G and accepts he will get low esteem. Category reporting will not, in any way, change this. It will, however, decrease the incentive of the donor to give if not generous. For example, if $\hat{x} < x_G$ he only has to give \hat{x} to give an amount indistinguishable from that he would do if generous. Similarly, if $\hat{x} > x_G$ he only has to give x_N . Essentially, if the donor, when not generous, is determined to give in a way that he does not appear not generous, giving is maximized if he has to give the exact amount the donor would give if generous. This is what he does anyway with exact reporting.

4.3 The hybrid equilibrium case

So far we have shown that (i) If there is a separating equilibrium with exact reporting the giving of the donor can be increased if generous without changing his giving when not generous and vice-versa, and (ii) If there is a pooling equilibrium with exact reporting there is no way to increase the giving of the donor whether generous or not generous. As one might expect between these two extremes we find that category reporting may or may not increase giving to varying extents. We illustrate with two scenarios before providing a more general result.

First, suppose that there would be a (non trivially) separating equilibrium with exact reporting. Recall that in this case that the agent gives $x_H > x_G$ if generous and x_N if not generous. Consider a category threshold of $\hat{x} = x_L < x_H$. With this threshold the donor will *increase* giving from x_N to \hat{x} if not generous but *decrease* giving from x_H to x_L (or x_G if $x_G > x_L$) if generous. The lowering of the threshold makes it easier for the donor to hide being not generous but gives less incentive to signal generosity. Overall, expected giving will increase if

$$p(x_H - x_L) < (1 - p)(x_L - x_N).$$

This may or may not be the case. Thus, a low category threshold may or may not increase giving.

Next, suppose that there would be a hybrid 2 equilibrium with exact reporting. Recall in this case that the donor gives x_G if generous and x_G with positive probability and x_N with positive probability if not generous. Suppose that the category threshold is set at $\hat{x} = x_H > x_G$. The donor may now find it worthwhile to give \hat{x} if generous. This is because he gets less esteem from giving x_G with category reporting than without.¹⁰ So, suppose the donor gives \hat{x} if generous. Expected giving will increase if

$$p(x_H - x_G) > (1 - p)\beta(x_G)(x_G - x_N).$$

Again, this may or may not be the case. Thus, a high category threshold may or may not increase giving.

¹⁰Specifically, with category reporting his esteem for giving \hat{x} would be pE and for giving x_G would be $\frac{p}{p+(1-p)}E$. With exact reporting his esteem for giving \hat{x} would be pE and for giving x_G would be $\frac{p\beta(x_G)}{p+(1-p)\beta(x_G)}E$.

These two examples show that in many cases category reporting will likely *increase the giving of the donor when of one type and decrease giving if the other type*. Overall, therefore it may or may not increase expected giving. Deriving precise conditions under which giving will go up and down is a tedious and largely uninformative exercise. We shall therefore, restrict ourselves to deriving a sufficient condition that category reporting can increase giving. As we shall see this condition is very easy to check given specific utility functions.

Proposition 4: If there is a hybrid 1 equilibrium with exact reporting category reporting *can increase giving* if

$$DR := 2(u_N(x_N) - u_N(x_M)) + (x_M - x_N)u'_N(x_M) \neq 0. \quad (6)$$

If $DR < 0$ then a category threshold below x_M will increase giving and if $DR > 0$ a category threshold above x_M will increase giving.¹¹

Proof: Using Lemma 1 we know that if the donor gives $\hat{x} \in (x_L, x_H)$ when generous then he gives \hat{x} with probability $\beta(\hat{x})$ when not generous. Expected giving is thus

$$\begin{aligned} V(\hat{x}) &\equiv x_N + (p + (1-p)\beta(\hat{x}))(\hat{x} - x_N) \\ &= x_N + p(\hat{x} - x_N) \left(\sqrt{\frac{E}{u_N(x_N) - u_N(\hat{x})}} \right) \end{aligned}$$

Note that this is continuous in \hat{x} . That with exact reporting we obtain a hybrid 1 equilibrium where the donor gives x_M if generous means that if a category threshold \hat{x} is set sufficiently close to x_M , either above or below, the donor will give \hat{x} if generous.¹² Observe that

$$\frac{dV(\hat{x})}{d\hat{x}} = p \sqrt{\frac{E}{u_N(x_N) - u_N(\hat{x})}} + \frac{p(\hat{x} - x_N)}{2} \frac{u'_N(\hat{x})\sqrt{E}}{(u_N(x_N) - u_N(\hat{x}))^{1.5}}.$$

¹¹Note that a critical threshold, respectively, above or below x_M may also increase giving but we leave this question open.

¹²If $\hat{x} = x_M - \varepsilon$ for some small ε then this is relatively trivial because he still wants to signal his generosity but is constrained by the threshold. If $\hat{x} = x_M + \varepsilon$ it is less clear that he would be willing to sacrifice more intrinsic utility to earn esteem. Note, however, that the esteem he would get from giving less than \hat{x} if there is category reporting is strictly less than he would get from giving x_M with exact reporting (see footnote 10). If it was optimal to give x_M with exact reporting then this discontinuous change in esteem, coupled with continuity of the intrinsic utility function, means that he should be willing to give more than x_M if there is category reporting.

Simplifying we get

$$\frac{dV(\hat{x})}{d\hat{x}} \geq 0 \text{ as } 1 + \frac{(\hat{x} - x_N)}{2} \frac{u'_N(\hat{x})}{u_N(x_N) - u_N(\hat{x})} \geq 0.$$

Thus expected giving can be increased by setting a category threshold slightly above x_M if $DR > 0$ and by setting a category threshold slightly below x_M if $DR < 0$. ■

The condition (6) appears relatively weak suggesting that category reporting can increase giving. Interestingly the quadratic example is one case where $DR = 0$. Explaining why this is the case will better inform on what Proposition 4 does mean. Recall that in the quadratic example $x_L = p\sqrt{E} + a$, $x_H = \sqrt{E} + a$ and, if the donor gives $x \in [x_L, x_H]$ when generous he will give x with probability

$$\beta(x) = \frac{p}{1-p} \left(\frac{\sqrt{E}}{x-a} - 1 \right).$$

when not generous. Expected giving will, therefore, be

$$a + (p + (1-p)\beta(x))(x-a) = a + p\sqrt{E}.$$

The crucial thing for our purposes is that x drops out of this equation and so *expected giving is not a function of how much the donor gives when generous* (as long as $x \in [\max\{x_L, x_G\}, x_H]$). In other words, if a category threshold increases the giving of the donor when generous the giving of the donor when not generous will decrease by exactly the same amount, and vice versa. This is why $DR = 0$. The quadratic example is not, therefore, captured by Proposition 4 but with good reason because a critical threshold near x_M would not increase giving.

The discussion so far leaves open the possibility to increase giving by setting a category threshold above x_H or between x_L and x_G . Working through these possibilities gives our next result.

Corollary 3: In the quadratic example category reporting can increase giving if $b - a > \sqrt{E}(1 - \sqrt{1-p})$ and cannot increase giving otherwise.

Proof: In the quadratic case

$$x_{GH} = \sqrt{E(1-p)} + b.$$

So, $x_{GH} > x_H$ if $b - a > \sqrt{E}(1 - \sqrt{1-p})$. In this case a threshold $\hat{x} \in (x_H, x_{GH})$ means the donor will give x_N if not generous and \hat{x} if generous so expected giving will be maximized by setting $\hat{x} = x_{GH}$. Expected giving is $px_{GH} + (1-p)a$. With exact reporting giving would be $a + p\sqrt{E}$ and so giving is higher with a category threshold if and only if $b - a \geq \sqrt{E}(1 - \sqrt{1-p})$. Coupled with Corollary 1 and Proposition 2 this gives the sufficient condition for a category threshold to potentially increase giving. It remains to prove necessity. To do this we need check whether a low critical threshold can increase giving. If $\hat{x} \in [x_L, x_G]$ then lowering x increases the giving of the donor when not generous but does not change the giving of the donor if generous (because he gives x_G) so expected giving increases. This clearly only works, however, if $x_G > x_L$ which requires $b - a \geq p\sqrt{E} \geq \sqrt{E}(1 - \sqrt{1-p})$. This, together with Proposition 3 demonstrates necessity. ■

This clearly shows that Proposition 4 provides a sufficient rather than necessary condition. We have also, however, done enough to show that the condition in Proposition 4 does have some bite. Specifically, it is possible in the quadratic example to have a hybrid equilibrium with exact reporting and a category threshold not be able to increase giving. More generally, we could consider utility functions that are quadratic when $x \in (x_G, x_H)$ but drop steeply when $x \leq x_G$ and $x \geq x_H$.¹³ In this case a generous agent would never give less than x_G or more than x_H and we have already shown, this is what Proposition 4 picks up, that expected giving would not increase with a category threshold $\hat{x} \in [x_G, x_H]$, so category reporting need not increase giving.

Our next question is whether $DR = 0$ for utility functions that are not quadratic. Intuitively, it would seem that the quadratic example is a special limiting case where the extra giving of one type of agent is exactly offset by the decreased giving of the other. To back this intuition up we provide two examples. First, suppose that $u_N(x) = -|x - a|$. In this case $DR = x_M - a > 0$. Next, suppose that $u_N(x) = -(x - a)^4$. In this case $DR = -2(x_M - a)^4 < 0$. These two examples hopefully illustrate that Proposition

¹³For example let

$$u_G(x) = \begin{cases} -(x - b)^2 - LE(x - p\sqrt{E} - a) & \text{if } x < b \\ -(x - b)^2 & \text{if } x \in [p\sqrt{E} + a, \sqrt{E} + a] \\ -(x - b)^2 - LE(x - \sqrt{E} - a) & \text{otherwise} \end{cases}$$

for some large number L .

4 provides a simple way to check whether category reporting can increase giving and in most cases it can. They also make clear that the curvature of u_N determines whether or not category reporting can increase giving and whether a low or high threshold will be appropriate. The form of u_G does, in principle, matter through its effect on x_M but in both of these examples that actually proves irrelevant.

4.4 The consequences of category reporting

To draw things together somewhat we finish our analysis by illustrating how much a category threshold can affect giving in the quadratic example. Rather than finding the optimal category threshold for all parameter values we shall impose two rather arbitrary category thresholds, one high and one low. This is perhaps a more realistic reflection of the options actually available to an imperfectly informed charity. We shall see it also provides an interesting snapshot of how much category reporting can increase or decrease giving if not too much thought goes into setting the threshold.

We begin with a low threshold of

$$\hat{x} = \frac{a+b}{2}.$$

In this case, the donor will give b if generous and will give \hat{x} with probability

$$\beta(\hat{x}) = \begin{cases} 0 & \text{if } b - a \geq 2\sqrt{E} \\ 1 & \text{if } b - a \leq 2p\sqrt{E} \\ \frac{p}{1-p} \left(\frac{2\sqrt{E}}{b-a} - 1 \right) & \text{otherwise} \end{cases}$$

if not generous. From this we can work out expected giving. The ratio between giving with exact and with category reporting is plotted in Figure 3. As we would expect (given Propositions 2 and 4 and Corollary 3) in the top left half of the figure we see that category reporting lowers giving. Recall that this is where we observe a pooling or hybrid and separating equilibria with the most giving if there is exact reporting. In the bottom right half of the figure we see that category reporting increases giving. Referring back to Figure 2 we recall that in this region expected giving was relatively low with exact reporting. A low category threshold and category reporting will increase the giving of the donor when not generous and this ultimately increases expected giving. Note that because p is relatively low in this region something that

increases the giving of the donor when not generous has a good chance to increase expected giving.

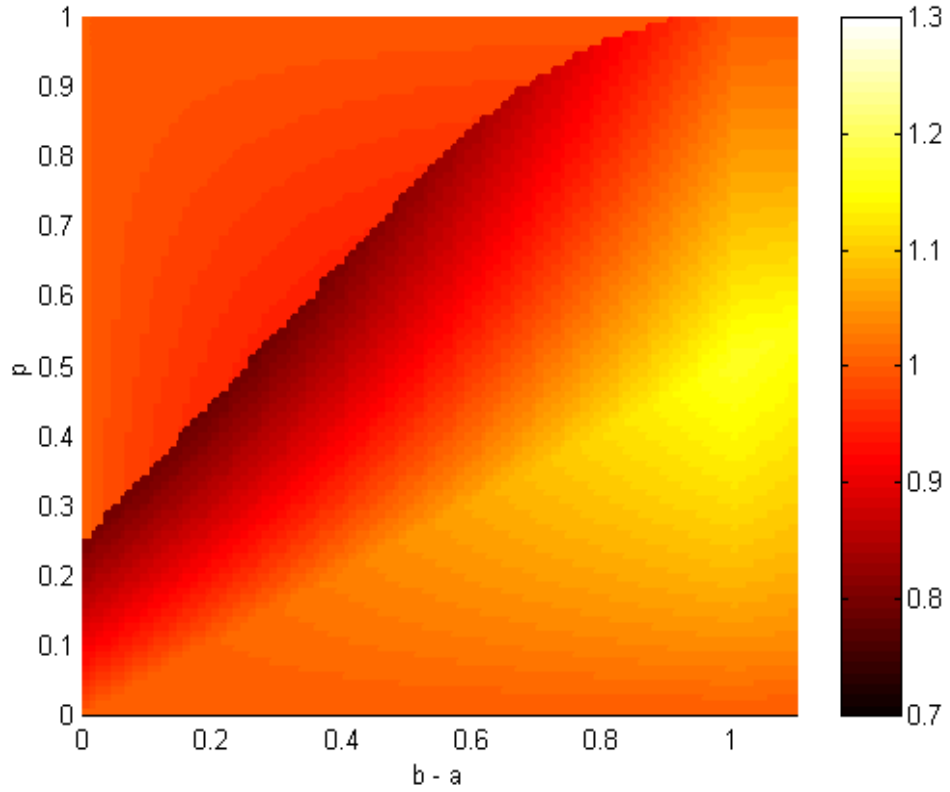


Figure 3: Expected giving with a low category threshold relative to when exact reporting, with $a = 1$ and $E = 1$.

We next consider a high threshold of

$$\hat{x} = \frac{3b - a}{2}.$$

Now, *if* the donor gives \hat{x} when generous he will give \hat{x} when not generous with probability

$$\beta(\hat{x}) = \begin{cases} 0 & \text{if } b - a \geq \frac{2}{3}\sqrt{E} \\ 1 & \text{if } b - a \leq \frac{2}{3}p\sqrt{E} \\ \frac{p}{1-p} \left(\frac{2}{3} \frac{\sqrt{E}}{b-a} - 1 \right) & \text{otherwise} \end{cases}$$

We then need to ask whether the donor will give \hat{x} or x_G when generous. He will give \hat{x} if the payoff from giving \hat{x} and possibly receiving more esteem exceeds the payoff from giving b and receiving esteem Ep . Solving this implies the donor will give \hat{x} when generous if and only if,¹⁴

$$b - a \in \left(\sqrt{E}(3 - \sqrt{9 - 4p}), 2\sqrt{E(1 - p)} \right).$$

We can then solve for expected giving and obtain figure 4. Again we see category reporting lowering giving on the top left of the figure and increasing giving on the bottom right. This time it is primarily the giving of the donor when generous that increases. This explains why, comparing to a low threshold, we observe less of a gain when p is relatively low but more of a gain when p is relatively high. Note, however, that if p is too high the donor will not increasing giving if generous, because he will be inferred as generous with high probability whatever he does, so the incentives to signal are less.

¹⁴When $\beta(\hat{x}) = 0$ we need

$$-\left(\frac{3b - a}{2} - b\right)^2 + E > Ep$$

which simplifies to $b - a < 2\sqrt{E(1 - p)}$. When $\beta(\hat{x}) = 1$ it is clear that the donor will give b if generous. when $\beta(\hat{x}) \in (0, 1)$ we need

$$-\left(\frac{b - a}{2}\right)^2 + \frac{Ep}{p + (1 - p)\beta(\hat{x})} > Ep$$

which simplifies to

$$\frac{(b - a)^2}{4} - \frac{3}{2}\sqrt{E}(b - a) + Ep < 0.$$

Finding the appropriate root gives

$$b - a > \sqrt{E}(3 - \sqrt{9 - 4p}).$$

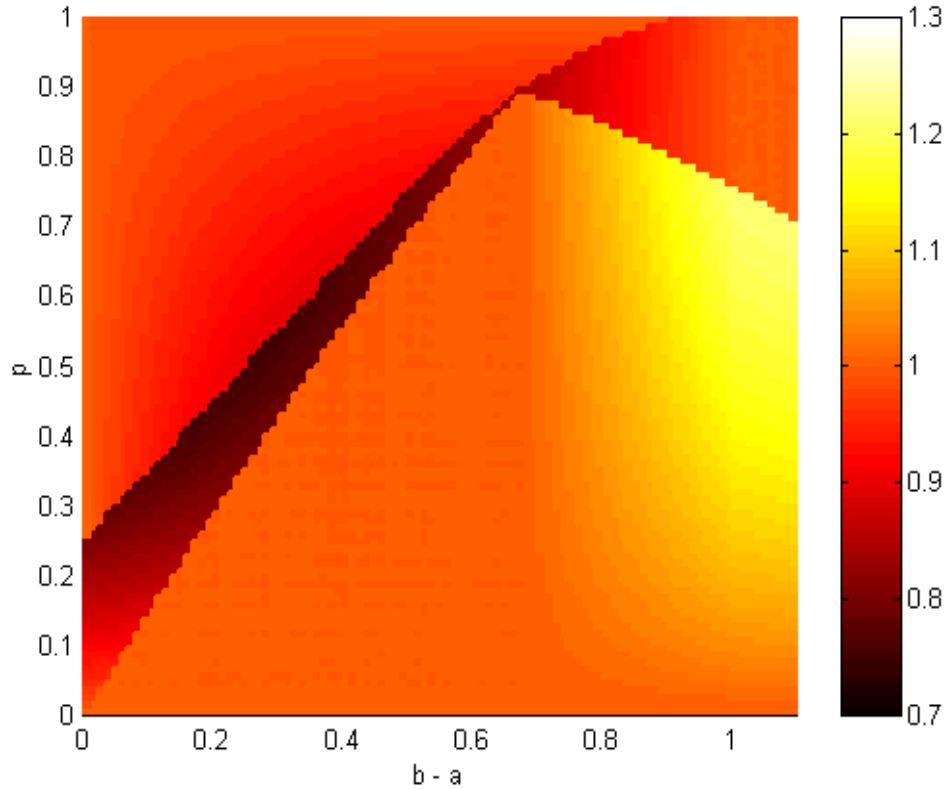


Figure 4: Expected giving with a high category threshold relative to when exact reporting, with $a = 1$ and $E = 1$.

We see in figures 3 and 4 that a low or high category threshold could result in a decrease or increase of up to 30% in expected giving depending on p and $b - a$. Playing around with different thresholds can increase this percentage and reduce the area where giving is lowered. Category reporting clearly, therefore, can have significant consequences for giving. In comparing figures 3 and 4 there is no way to say that a high category threshold is any more likely to increase giving than a low category threshold, or vice versa. This, in itself, however, is interesting because intuition might be that a high category threshold is more likely to increase giving. If anything our analysis points towards a low category threshold being more likely to increase giving. This is because category reporting can only increase giving when p is low

and/or $b - a$ is large and if p is low the donor is not generous with a high probability so a low threshold is likely to be more successful.

5 Discussion and conclusion

The objective of this paper was to question whether category reporting of donations would increase donations. To address this question we considered a signalling game in which a donor is either generous or not generous and giving is observed by others who try to infer his type. Our main result is that category reporting will likely *increase* giving if the probability a donor is generous is low and/or the differences in preferences between types are large, and it will likely *decrease* giving if the probability a donor is not generous is high and/or the differences in preferences between types are small. A secondary result is that it may be optimal to set of *low category threshold* in which the observed giving of a generous type is reduced in order that the giving of a not generous type will increase.

In discussing how to interpret this result it is interesting to compare our results to those of Harbaugh (1998b) and McCardle et al (2009). Both these studies modelled category reporting assuming (i) a strictly increasing relation between giving and esteem, and that (ii) category reporting does not change the relation between observed giving and esteem.¹⁵ With these two assumptions they show that under very general conditions category reporting can increase giving. In our framework we endogenize the esteem a donor receives by making inferences consistent with donor behavior. This means that neither assumptions (i) or (ii) need hold. The two consequences of this, which distinguish our results from those of these two models, are that (a) category reporting may easily decrease giving, and (b) it may be appropriate to purposely lower the giving of one type to increase the giving of another.

To explain this distinction further we note that if types *separate* then our analysis is similar to that of both Harbaugh (1998b) and McCardle et al (2009). For instance, our Proposition 2, and Section 3.1, is very similar to the general result obtained by Harbaugh. This is because when types separate category thresholds can be set in a way to target the giving of one type of donor without affecting the giving of another. If, however, there is *pooling* then things are different. Pooling means that a not generous type will copy

¹⁵Meaning that someone giving $\$x$ when there is a category threshold of $\$x$ gets the same esteem as someone giving $\$x$ when there is exact reporting.

the giving of a generous type, and observers know this, so assumption (i) no longer holds. A generous type, therefore, has no incentive to give more to signal his generosity and category reporting is not going to change this. Category reporting may, however, influence the not generous type. *If* there was pooling with exact reporting then category reporting can only lower the giving of a not generous type because it lowers the amount he needs to give to copy the generous type. This is why we find (a) that category reporting may decrease giving. If there was *not* pooling with exact reporting then a low category threshold, which allows the not generous type to more easily copy the generous type, may increase giving. This is why we find (b) that it may be appropriate to lower the observed giving of a generous type.

This clearly illustrates an important distinction between pooling and separating within our framework. The likely success of, and appropriate form of, category reporting will be different depending on whether there is likely to be pooling or separating of types. This is something we would argue will generally emerge in a signalling model of giving. In particular, our framework was very general with one exception, an assumption of two types. It is clear, however, that our results, particularly Propositions 2 and 3, can be generalized to an arbitrary number of donor types.¹⁶ Thus, the important contrast between pooling and separating is not an artefact of our model but something to be expected of signalling equilibria.

This raises the issue of whether we should expect pooling or separating. This is an empirical question that we shall not attempt to address here, but one might suggest that if charities do use category reporting then they must think it works. It is interesting, however, to note the diverse ways in which category reporting is used. For example, the University of Warwick annually sends its alumni a brochure containing a list of donors split into those who donated more or less than £1000. In this example there is only *one* category threshold. As a second example we recall the University of Glasgow donor wall, see the introduction, had *six* category thresholds ranging from £250 to £10000. The more categories there are the more closely is approximated exact reporting of donations. Indeed, given that there may be ethical or practical difficulties in publishing the exact donation of all donors it could

¹⁶ Adding types significantly complicates the analysis because the possible permutations of separating, pooling and hybrid equilibrium grow exponentially. Propositions 2 and 3, and their proofs, do, however, easily extend to an arbitrary number of types. Of course, the more types there are the less likely we might think it would be to get the polar extremes where all types pool or all types separate.

be argued that many categories is as close to exact reporting as it is possible to get. Also, charities do express concern about artificial giving thresholds, such as a million pounds, and look for ways to break down such thresholds (Breeze 2009). It is, therefore, not clear whether and when charities do prefer category rather than exact reporting.

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