Masked Heroes: endogenous anonymity in charitable giving[*]

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December 16, 2013

Abstract

Previous work on anonymous donations has looked almost exclusively at exogenous anonymity. This study considers endogenous anonymity, approaching it from two angles. We present stylised facts of anonymous giving, drawn from a large dataset of donations on behalf of runners in the London Marathon. We find not only that are anonymous donations likely to be larger than public ones, but that those who follow an anonymous donation donate around 4% more than had the same preceding donation been public. Our main contribution is to explain this phenomenon through a signalling model, where foregoing prestige through anonymity signals the charity's quality.

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"There are eight degrees of tzedaka (charity), each greater than the next...(the sixth) is one who knows to whom he gives, but the recipient does not know his benefactor. The greatest sages used to walk about in secret and put coins in the doors of the poor"

-Mainonides

"When you give to the needy, do not announce it with trumpets, as the hypocrites do in the synagogues and on the streets, to be honoured by others"

-Matthew, 6:2

1   Introduction

This paper is concerned with why people may choose to make large donations anonymously. Although rare, this phenomenon clearly occurs in practice; from the sages described by Maimonides to more recent examples; such as anonymous donations of more than £400,000 made to the RAF's campaign to restore a Vulcan Bomber (News.bbc.co.uk (2010)), and of $200million to Baylor University in Texas (the largest donation in the University's history) (Scoggins (2010)).

When and why people choose to give anonymously has not been addressed by existing literature on charitable giving. Those papers which do

look at anonymity have looked almost exclusively at the effect of exogenous anonymity on donations. The consensus of this literature is that the less social pressure an individual faces (the more anonymous they are), the less likely they are to donate, and the less they will donate (conditional on donating). Neither does existing theory offer a clear reason why an individual would *choose* anonymity rather than simply not donating. Large donors, such as George Soros & libertarian billionaires the Koch brothers have made large donations both anonymously and publicly (Mayer (2010)) - this cannot be explained by a preference for anonymity.

In this paper we investigate the circumstances of anonymous donations in a large dataset of over 70,000 donations made through the Virgin Money Giving website to fundraisers running in the 2010 London Marathon. We find that 'extreme' donations (particularly large, or particularly small) are more likely to be made anonymously than moderately sized ones. We find that early donations are more likely to be anonymous than are later ones, particularly for the first donation to a fundraising page. Importantly, we find that donations following a large anonymous donation are larger than those following a large public donation. This finding is the basis of a two-stage signaling model in which agents informed about some measure of charity quality choose to donate anonymously in order to signal to later, uninformed donors, that the charity is of high quality.

When the amount donated is revealed without the identity of the donor, the act of donating anonymously may act as a signal. Taking the case of well-known philanthropist George Soros, his reputation for investigating charities may mean that a donation specifically from *him* may be informative about

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the charity's quality. However, someone observing the donation is not just gaining information about the charity but also about the donor. If the observer believes that donating to a charity is good, their estimation of the donor will increase; if the donor values this estimation they benefit from making such a large donation, independently of the charity's quality. In instances where an individual donor is not known as an authority on charity quality, an anonymous donation may be more informative about quality than if their identity was revealed. Knowing this to be the case, a donor who wishes to see the charity succeed, and the public good provided, may choose to conceal their identity. Under these conditions, choosing to donate anonymously acts as a costly signal of charity quality.

The main contribution of this work is to present some stylized facts of anonymity in charitable giving, and to seek to explain what we observe with a simple signaling model, where motivated agents may wish to conceal their identity in order to inform others of the charity's quality and hence to prompt larger donations.

The next section will review the relevant literature on anonymity and signaling in charitable giving, and will identify our position within this. Section 3 presents our stylized facts of anonymity in giving, drawn from a large dataset of over 70,000 donations made on behalf of runners in the 2010 London Marathon. It identifies that very large donations are more likely to be made anonymously than very small donations, and that large anonymous donations are followed by larger donations than are large public donations. In section 4 we present a simple model of anonymity in charitable giving. In our model informed donors, motivated by the provision of a public good as well

as their own donation, trade off social rewards (from donating publicly) with increased donations by others as a result of anonymity. We expand on this in section 5 with a numerical example and a welfare comparison to a world where anonymity cannot be chosen. Finally, we present our conclusions.

2   Previous Work

Much of the previous literature on anonymity and altruism, with the notable exception of Andreoni and Petrie (2004), has been concerned with the effect of *exogenous* anonymity on whether and how much people give. A number of experiments in both the lab (e.g, Andreoni and Petrie (2004)) and the field (see Alpizar et al. (2008), List and Lucking-Reiley (2002), Soetevent (2005) and Landry et al. (2006)) have looked at the effect of anonymity on donation, and generally conclude that anonymity reduces donations to a public good.

Although Hugh-Jones and Reinstein (2012), provide reasons why a group or institution might choose anonymity (in order to elicit more honest signals of participant 'types' by credibly withdrawing the threat of punishment), they do not offer an explanation as to either why fundraisers should allow some donors to opt into anonymity, or why anybody would choose to do so.

Our work considers the case in which donors endogenously choose to give anonymously. This is investigated by Andreoni and Petrie (2004) who, in addition to their experimental work on exogenously altered levels of scrutiny, allow donors to select into anonymity. Although they observe a rise in contributions to the public good in this treatment, it is not significant (p=0.12)

and is driven almost entirely by a rise in revealed donations[1].

There are a number of possible explanations for why anonymity might lead to reduced donations. Harbaugh (1998a, 1998b), proposes and tests a model whereby donors are motivated by the prestige they receive from having their donations announced if they are above a certain level. Glazer and Konrad (1996), and Hawkes and Bliege Bird (2002), provide alternative mechanisms for the delivery of prestige through charitable giving (peers or partners, respectively). These models suggest that larger donors should have the most to gain from choosing to donate publicly, and so would be less likely to donate anonymously.

Individuals may choose their donation to conform to a social norm. Bernheim (1994), presents a model of conformity whereby individuals donate similar amounts in order to signal that they are of the same "type" as other donors to the same cause. If all donors wish to conform with the community (the mean), and the utility gained from conformity decreases with deviation from the mean, we might expect conformity-driven anonymity to be decreasing as donation size approaches the mean, and for conformity-motivated donations rarely to be much larger than the mean. Overall, the benefits from donating publicly in terms of signaling generosity appear to be increasing in the amount donated, and so previous work seems to predict that larger donors would be less likely to donate anonymously.

If there is uncertainty about the quality of the charity, and different information is available to different donors, there is an opportunity for signaling.

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[1]Under the information -and- photos treatment the average donation to the revealed public good was 48% of endowment (9.6 tokens); in only 21 of 1600 observations were amounts above this donated anonymously.

Under a binary public good (i.e. one that is either provided or is not), as in List and Lucking-Reiley (2002), an agent who knows the charity's quality has an incentive to donate, signaling to others that the charity is worth donating to, only if the expected (social) return to provision is greater than the cost.

Potters et al. (2005) present a model of endogenous *sequencing*, in which players in a public good game choose the order in which they make their donation, with one agent being informed about the return to the public good (analogous to the quality of a charity), and the other not. They find that in 81% of cases, players elect to move sequentially (with the informed agent moving first), and that in 85% of these cases, the uninformed agent follows the signal sent by the informed agent. In Potter et al's game, donations are binary (donate/don't donate), and so there is no consideration of the size of donation. However, to support the argument for sequential donations they give the example of famous philanthropist Brooke Astor, whose large donations were often followed by other major donors following her lead; from this it is implicit that signaling donations will typically be large ones. However, rather than 'star' donors, we are interested in the use of anonymity as a signaling device.

This poses a question: how are uninformed donors to identify informed ones if the former identities are kept secret? Even if the individual donating is not widely known to be informed, the fact of choosing to donate early may signal that they have information. Vesterlund (2003), presents a model in which early donors will engage in costly information search and subsequently signal the charity's quality to others, with the result that net donations are higher with hidden information than when the quality of the charity is

common knowledge.

In both Potters et al. (2005) and Vesterlund (2003), sequential ordering takes place with informed agents moving first by design. Chamley and Gale (1994) present a model in which agents with different private information take investment decisions, with endogenous ordering of moves. The unique equilibrium is one in which an agent never invests before another who is more optimistic. Although delay is costly, uniformed agents find waiting (and hence acquiring more information) worthwhile.

What is revealed is of importance to signalling models. If it is common knowledge that the first agent is informed (either because of the Chamley and Gale (1994) result or the rules of the game as in Potters et al. (2005)), then their identity is not important; i.e. 'donating first' maps perfectly onto 'being informed'. Hence, an anonymous donor may be treated as an informed signaler. We now proceed to present some stylized facts of anonymous giving.

3 Data

We make use of a large dataset of donations made using the Virgin Money Giving service on behalf of fundraisers running in the 2010 London Marathon. Virgin Money Giving (VMG) was set up in 2009, at the same time as Virgin Money became the official sponsor of the London Marathon. This dataset was generated by Smith et al. (2012), to whom we are grateful for allowing its use. Although Virgin Money is a profit-making company, VMG is not-for-profit. It charges charities a one-off, set-up fee of £100 and takes two per cent of nominal donations (i.e. gross of tax relief).

Runners in the marathon can set up a fundraising page on the website, and can advertise the site to friends and family by word of mouth, email or social networking websites. Consequently, the majority of donors to a given page will be known to the fundraiser, and so it is reasonable to expect that donors on a single page will share characteristics.

Site users include individuals giving directly to charity but also, primarily, individual fundraisers who are raising money for charities. These latter fundraisers either seek sponsorship for taking part in events such as the London marathon, or set up pages to collect memorial donations or donations in lieu of gifts.

In our dataset invited donors arrive at a page assigned to a specific fundraiser, where they are able to see information about the runner, the charity for which they are running, and a history of past donations (see appendix for a screenshot of a page). They can also see previous donors' comments (if they have chosen to leave any), and identities (if they have chosen to reveal them). If identity is not revealed, the amount is shown and labeled "anonymous". If a fundraising target has been specified, progress towards this is also displayed on the page.

The dataset contains 73584 donations made to 3984 fundraisers. Donations of more than £1000 and pages to which more than 50 donations are made are excluded as outliers. Table 1 contains summary statistics of donations.

As Table 1 shows, there is considerable variation in the amount donated by the different groups, with anonymous donors donating more, on average, than those who make their donation publicly. However, the amount donated

Summary statistics

	Mean	St. Dev	Min.	1st pctile	Med.	99th pctile	Max
Public							
No. Donations	15.95	11.16	1	1	14	45	50
Amount	29.64	46.12	1	5	20	200	1000
Page Total	916	691.4	0	60	776.1	3491	9550
Target	1722	1824	1.5	250	1500	6000	100000
N	64596						
Anonymous							
No. Donations	14.93	11.39	1	1	12	45	50
Amount	39.48	75.78	1	5	20	390.5	1000
Page Total	955	771.7	0	50	795.3	3807	9520
Target	1815	2136	1.5	300	1500	6000	100000
N	8988						
All							
No. Donations	15.83	11.2	1	1	14	45	50
Amount	30.84	50.78	1	5	20	250	1000
Page Total	920.7	701.8	0	60	779.8	3519	9550
Target	1733	1866	1.5	250	1500	6000	100000
N	73584						

Table 1: Summary statistics

also varies widely within category, with the median anonymous and public donation each being £20. There is considerably also more variation in anonymous donations, which have a higher standard deviation (£75.78 vs. £46.12).

It is notable that the majority (75%) of donations are of round amounts (£10, £20, £50 or £100). While this may reflect individual donors' preferences, it may in part be a result of menu effects on the VMG donation pages, as described by Smith et al. (2012). Due to the nature of anonymous donation, it is not possible to identify characteristics of anonymous donors themselves. 8988 donations were made anonymously, 12% of total donations. 27 fundraising pages had all of their donations made anonymously, while 552 had none.
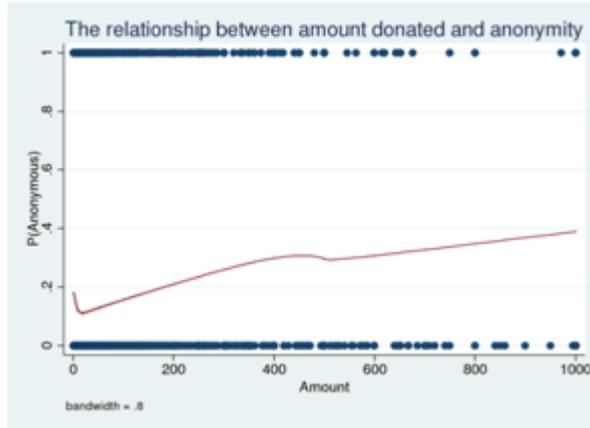
Figure 1: The relationship between amount donated and anonymity

3.1   Anonymity and Amount Donated

We look first at the relationship between endogenous anonymity and amount donated. In the context of Virgin Money Giving, individuals choose whether to donate, how much to donate and whether to donate anonymously. The latter two decisions are made on the same page of the VMG website, and so are plausibly simultaneous. Existing theory and experimental data do not suggest a particular outcome for this situation. Figure 1 is a locally weighted smooth scatterplot of the relationship between amount donated and anonymity.

As shown in Figure 1 small donations are often made anonymously (around 18% of donations at this level are made anonymously). Anonymity grows steadily less likely as donations approach the mean, with donations at the mean least likely to be anonymous. Donations larger than the mean show the reverse relationship: they are more likely to be anonymous the larger they become.

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Within the existing literature it is difficult to find a model to explain this behavior. The prestige motive (Harbaugh (1998a)) or the desire to signal one's own affluence (Glazer and Konrad (1996)) suggests that the lower a donation, the less there is to be gained from making it publicly. If there are donation levels for which the private reward (in terms of warm glow, for instance), is positive, but the public reward (prestige or similar) is negative, donors may prefer to donate anonymously. This is consistent with the negative correlation between amount donated and anonymity as donation size approaches the mean for a given page. It does not, however, explain the positive correlation between above average donations and anonymity.

Other explanations, such as the desire to conform to a social norm (Bernheim (1994)), or inequality aversion (Fehr and Schmidt (1999)), seem more plausible given the overall shape of this relationship. The shallower slope could be interpreted as being consistent with Fehr & Schmidt's kinked inequality aversion curve, suggesting that people dislike being advantaged less than they dislike being disadvantaged. We argue that this model does not apply here, however, as it is concerned with endowments, and not with consumption. An interpretation of charitable giving as giving money to those less fortunate than yourself would predict decreasing anonymity as donations get larger. To the extent that donors to the same page are of roughly the same level of wealth, larger donations are more redistributive, and so should be more utility-yielding under Fehr & Schmidt's model of inequality aversion. Moreover, as a donor's decision about amount and anonymity are made simultaneously, the benefits of donating a smaller amount publicly would seem to exceed those of donating a large amount anonymously under the Fehr and

Schmidt (1999) framework. Donors receive conformity benefits and prestige, and retain income to be used for private consumption. Hence, a different hypothesis must be suggested.

3.2 Estimation

We now estimate a series of models to determine which factors are correlated with anonymity, using a panel with fundraising page as the cross-sectional unit of observation, and a donation's order within a page as the time dimension. So the first donation to a given fundraising page is at time 1, and the second at time 2, regardless of actual time passing between the two points. This formulation makes intuitive sense, as we are considering timings in terms of various players' moves in a game, responding to information provided by previous players. Model 1, below, shows the fixed effects estimate of the relationship between amount donated, place in the order of donation, and anonymity, including time varying controls.

$$Y_{it} = \alpha + \beta_1 D_{it} + \beta_2 \theta_{it} + \phi_i + \epsilon_{it} \tag{1}$$

Where Y_{it} is a binary variable set to 1 if donation t to fundraiser i is anonymous and 0 otherwise, D_{it} is the amount donated by donor t to page i, θ_{it} is the place of the donation within the fundraising page, i, ϕ_i is a page specific fixed effect, and ϵ_{it} is an i.i.d. error term. Model (2) estimates the same relationship, with the addition of a squared term on amount donated, while model (3) contains a set of place in order dummies. Results from these regressions, shown in Table 2, are consistent with Figure 1. This shows

Linear probability model: whether donation is anonymous					
	(1)	(2)	(3)	(4)	(5)
Log amount	0.009***	-0.127***	-0.126***	0.003	-0.026***
	(0.002)	(0.008)	(0.008)	(0.003)	(0.003)
Place in order	-0.008***	-0.007***	-0.005***	-0.005***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log amount squared		0.021***	0.020***		
		(0.001)	(0.001)		
First donation			0.048***	0.051***	0.048***
			(0.006)	(0.006)	(0.006)
Large donation				0.012**	-0.207***
				(0.004)	(0.014)
Large donation squared					0.066***
					(0.004)
Constant	0.107***	0.314***	0.308***	0.116***	0.191***
	(0.006)	(0.013)	(0.013)	(0.007)	(0.009)
N	67966	67966	67966	67966	67966
Standard errors in parentheses, *** p<0.01, ** p<0.05, *p<0.10					

Table 2: Linear probability model: whether donation is anonymous

that anonymity is decreasing in probability as the amount donated increases, but that at some point this relationship switches. It also shows that early donations are more likely to be made anonymously.

Figure 1 suggests more clearly a functional form for the relationship between anonymity and donation amount: that it changes sign at the mean. We define a binary variable, L, to equal 1 when the amount donated is above the mean for that page, and 0 otherwise, and estimate:

$$Y_{it} = \alpha + \beta_1 L_{it} + \beta_2 D_{it} + \beta_3 \theta_{it} + \phi_i + \epsilon_{it} \tag{2}$$

Model (4) estimates this same model, while Model (5) interacts L and the amount donated.

These results show that larger donations are more likely to be made

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anonymously than smaller ones. More specifically we find that although donations above the mean are initially less likely to have been made anonymously, the rate of anonymity among these donors increases more steeply than the fall in anonymity below the mean. We also find that early donors are more likely to give anonymously than are later ones. As shown in models 3-5, there is a large (around five percentage points) tendency for first donors to donate anonymously. These results are robust to the use of logistic regression (found in the appendices).

The relationship this describes is arguably similar to that described by a conformity type story of charitable giving, in which individuals experience negative social returns from donating amounts above the mean, and so conceal their identities. However, as argued above, we believe that a different model is needed to explain the data.

3.3   Signaling

If donors are altruistic their choice of donation strategy will be in part determined by a desire to influence subsequent donors. That early donors can influence the behavior of later ones is consistent with the findings of Vesterlund (2003), Potters et al. (2005) and List and Lucking-Reiley (2002). The question of how anonymity influences future donors is an empirical one. To answer this, we follow the strategy adopted by Smith et al. (2012) in attempting to determine the effect of a large anonymous donation on subsequent donations within that page.

Our identification strategy is therefore to focus on a narrow window in

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which we can reasonably assume that the exact timing of a large donation is random (i.e. that a large donation is as likely to have been the 14th donation as it is to have been the 15th). Exploiting this assumption, we investigate the size of donations following an anonymous donation relative to the size of those that came before, and how this differs from the response to a revealed donation of the same size. We estimate:

$$\frac{1}{n}\sum_{s=1}^{n} lnD_{t+s} - \frac{1}{n}\sum_{s=1}^{n} lnD_{t-s} = \alpha + \beta_1 ln(D_t) + \beta_2 ln(D_t)(Y_t) + \theta_t + u_t \quad (3)$$

where D_t is a donation of £D at place t in the order of donations, Y_t is a binary variable for anonymity set to 1 if the donation is anonymous or 0 else, and n is the size of the bandwidth used.

Analysis using the full sample of donations shows no significant effect of anonymity on subsequent donations for any bandwidth. However we are interested in the specific effect of large donations on subsequent donations, as intuitively these are more visible to subsequent donors and hence more likely to have an effect. These are also the donations which we believe are unexplained by existing literature. Following Smith et al. (2012), we define a large donation as one above £60 (twice the sample mean). By limiting our analysis to these plausibly visible individuals, the results are altered significantly (as in models 6-9). Table 3 shows the results of estimating this model for a number of bandwidths (BW). Model (10), in the far right hand column, makes use of the entire sample of donations, and shows a substantial (5%) increase in donations following a donation that is both large and anonymous.

The effects of anonymous large donations on subsequent donors					
Bandwidth	3	4	5	10	5
	(6)	(7)	(8)	(9)	(10)
Ln(Amount)	0.030	-0.007	-0.005	-0.007	-0.007**
	(0.022)	(0.017)	(0.016)	(0.013)	(0.002)
Anonymous	0.028	0.043*	0.041*	0.035*	-0.004
	(0.026)	(0.020)	(0.019)	(0.016)	(0.006)
Timing	0.001*	0.001**	0.001*	0.000	0.011***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Large					0.165*
					(0.074)
Large & Anonymous					0.047**
					(0.019)
Constant	-0.196	-0.032	-0.036	-0.020	-0.778***
	(0.104)	(0.082)	(0.076)	(0.064)	(0.096)
N	3363	3043	2751	1458	35848
Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, *$p < 0.10$					

Table 3: The effects of anonymous large donations on subsequent donors

For large anonymous donations, the effect on donors in a locality of three or more is both consistently positive and statistically significant[2]. This finding, that large anonymous donations lead to larger subsequent donations, is interesting and perhaps counter-intuitive.

Interestingly, small anonymous donations appear to have no impact on subsequent donations, while donations following a donation which is both large and anonymous are around 5% larger than those before. If we limit our analysis to only the first large donation to a given fundraising page, the effect declines to an insignificant 2.5% increase in donation size among followers. However, the comparative scarcity of observations in this case is a likely cause for the loss of significance.

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[2]We believe that narrow bandwidths are underpowered to significantly effect our response to signaling behavior due to the low incidence of *conditional co-operators* (hence more observations are needed to detect their behavior above that of other donors). This idea is consistent with Fischbacher et al. (2001).

In this section we have presented evidence from over 70,000 donations, which shows that there is a correlation between the likelihood of donating anonymously and the difference from the average donation. We find that large anonymous donations appear to induce subsequent donations to be larger than if they had been made publicly. Given that these results are (to the best of our knowledge) unique in the literature, in the next section we present a signaling model consistent with their implications.

4 Model

In our data we observe two trends of interest: first, donation size and anonymity are correlated; second, that large anonymous donations appear to elicit greater subsequent donations than do revealed donations of the same size.

Before proceeding to formal modeling, it is worth sketching our narrative in simple terms. We show how, without anonymity, information asymmetry can lead to low donation levels and inefficient outcomes. When anonymity is available, outcomes may be improved through signaling.

Our narrative is one of information transmission, where the quality of the charity is only known by some of the population. The quality of the charity, together with the donations received, will determine the benefit of the public good. We suggest that individuals without information will view actions taken by individuals with information as a signal of the charity's quality.

Starting with a world where anonymity is not possible, when an individual makes a donation they receive some benefit from the public good (from warm

glow and/or their receipt from the good itself) and some 'prestige' in the form of social recognition. The return on contributions to the public good (the quality of the charity) is known to some donors, but not to others. Informed donors can signal charity quality through the size of their donation - foregoing private consumption in order to show that the charity is of high quality.

In our model, individuals will consider two factors when donating to charity; their total benefit from the public good and the prestige received from donating. Thus any donation made publicly offers only weak information about the quality of the charity, as any signal of this kind is mixed in with the prestige-seeking behavior of the donor.

If, however, a donor has the choice to donate *anonymously*, a stronger signal can be sent. Subsequent donors may infer a higher quality from a private donation than from a public one of the same size, as the donor has chosen to forgo prestige. Individuals learn more about the quality of the charity than if a donation of the same size had been made publicly.

Our model is a two-stage signaling game with two players, a sender (S) and a receiver (R), who sequentially choose whether to make a donation $d_i \in \{0, D\}, D \in [\underline{d}, \overline{d}]$ to a single charity[3]. The charity provides a public good, so any donation given to the charity will result in both a direct payoff to the donor and a positive externality to the other player. The charity's quality, the distribution of which is assumed to be common knowledge, is

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[3]$\underline{d}$ is analogous to a minimum donation required to receive prestige. In practice, this will vary from fundraising environment to fundraising environment, but may be considered as similar to the established 'social norm' of a group (for similar intuition on this, see Smith et al. (2012)). $\overline{d}$, conversely, is a simplification of the concept of a large donation discussed earlier.

denoted $q \in (\underline{q}, \overline{q})$. The realized value of q is known only to S[4]. Otherwise each player is identical, with utility function:

$$U_i(d_i, d_j; q, \psi) = \begin{cases} qd_i + qd_j - d_i + \psi, & \text{if donation is public} \\ qd_i + qd_j - d_i, & \text{if donation is private} \end{cases} \tag{4}$$

In addition to the benefit from the provision of the public good, a player is assumed to experience (positive) prestige, ψ, whenever donating publicly (denoted by $\gamma = 1$). If they choose to donate privately ($\gamma = 0$) the only benefit is the provision of the public good. The linear assumption placed on the utility function means that, although the donation space is continuous, individuals will in practice choose donations from a discrete set. This specification is used for mathematical simplicity, whilst alternative specifications are discussed in the appendix.

In the first stage of the game, S chooses whether and how much to donate. If he chooses to donate he can either donate publicly or privately. S chooses a strategy $\sigma_S : \Omega \to \{0, \underline{d}, \overline{d}\} \times \{0, 1\}$. Even if the donation is given privately, it is revealed to R and so R knows exactly which strategy player S has chosen. We denote (d_S, γ_S) and (d_R, γ_R) as the decision choice of S and R respectively.

Since we have a signaling game, we use the Bayesian Nash equilibrium concept. R's beliefs about E[q] will be updated from (d_S, γ_S), and hence R's strategy will depend on (d_S, γ_S). We denote R's posterior belief about the distribution of q as μ_R.

We are interested in separating equilibria in which S takes different strate-

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[4]This follows Potters et al. (2005), Vesterlund (2003) and Chamley and Gale (1994).

gies for different values of q.

4.1 Equilibrium

There are many possible separating equilibriums depending on the posterior belief profile. We propose a separating equilibrium in which R believes anonymity provides a credible signal of a higher quality.

In this equilibrium, R believes that S will restrict her strategies to one of three. The strategies will be conditional on q and hence there are two cutoff values for which S's strategy will change: q^* and q^{**} (Figure 2).

$$\mu_R = \begin{cases} \mu_{R0} = q \sim U(\underline{q}, q^*), & \text{if } (d_S, \gamma_S) = 0 \\ \mu_{R1} = q \sim U(q^*, q^{**}), & \text{if } (d_S, \gamma_S) = (\underline{d}, \gamma = 1) \\ \mu_{R2} = q \sim U(q^{**}, \overline{q}), & \text{if } (d_S, \gamma_S) = (\overline{d}, \gamma = 0) \\ \mu_{R3} = q = 0 & \text{otherwise} \end{cases} \tag{5}$$

where $q \sim U(A, B)$ denotes q is uniformly distributed over the interval (A, B).

Given these beliefs, we consider the strategy R chooses. R is unable to signal, and so will never incur the cost of donating anonymously[5]. Thus, R will only choose one of three strategies $\{0, (\underline{d}, \gamma = 1), (\overline{d}, \gamma = 1)\}$. Which of these strategies is chosen (that is, how much R donates) is contingent on his belief about the quality of the charity.

To show that this is an equilibrium we need to verify the incentive com-

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[5]In our sample we observe that only 1.4% of final donations to a page are both large by our definition and anonymous.
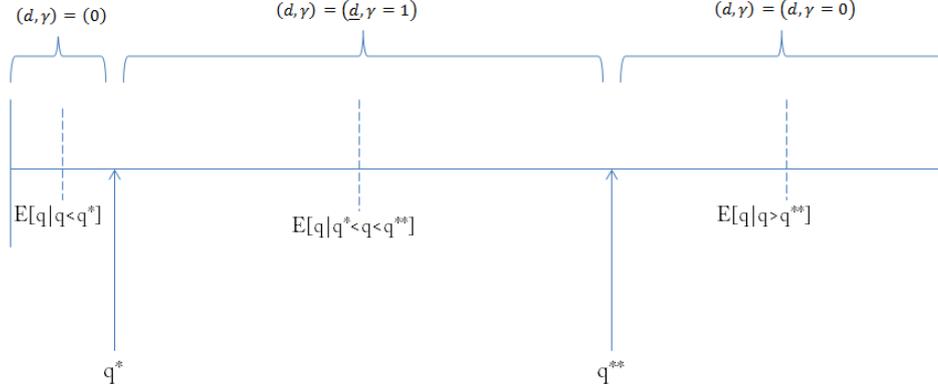
Figure 2: Equilibrium cutoff values of q

patibility constraints for each player. For R to donate $\overline{d}$ she will need to believe that q is sufficiently high:

$$E[q]\overline{d} - \overline{d} + \psi > max\{E[q]\underline{d} - \underline{d} + \psi, 0\} \tag{6}$$

This leads to two conditions:

$$E[q] > 1 \quad \text{if} \quad E[q] > \frac{\underline{d} - \psi}{\underline{d}} \tag{7}$$

$$E[q] > \frac{\overline{d} - \psi}{\overline{d}} \quad \text{if} \quad E[q] < \frac{\underline{d} - \psi}{\underline{d}} \tag{8}$$

However, the second clearly never holds since $\psi, \overline{d}, \underline{d}$ are all positive and $\overline{d} > \underline{d}$. Hence the condition for R to donate $\overline{d}$ is simply:

$$E[q|q \sim U(q^{**}, \overline{q})] = \frac{q^{**} + \overline{q}}{2} > 1 \tag{9}$$

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Equation 9 requires the expected quality of the charity to be greater than 1. Since R's own marginal private benefit from the public good is qd_R, this condition simply tells us that her expected private gain from the public good must be greater than the lost consumption from her donation (d_R). If this constraint is not satisfied, then R will not always donate $\overline{d}$. In this case there will be a mixed strategy, an example of this is illustrated in section 5.1.

For R to donate $\underline{d}$ she will need to believe:

$$E[q]\underline{d} - \underline{d} + \psi > max\{E[q]\overline{d} - \overline{d} + \psi, 0\} \tag{10}$$

This leads to two conditions:

$$E[q] < 1 \quad \text{if} \quad E[q] > \frac{\overline{d} - \psi}{\overline{d}} \tag{11}$$

$$E[q] > \frac{\underline{d} - \psi}{\underline{d}} \quad \text{if} \quad E[q] < \frac{\overline{d} - \psi}{\overline{d}} \tag{12}$$

These conditions simplify to:

$$\frac{\underline{d} - \psi}{\underline{d}} < E[q|q \sim U(q^*, q^{**})] = \frac{q^* + q^{**}}{2} < 1 \tag{13}$$

Equation 13 requires that the expected charity quality is within a certain range. If it falls below $\frac{\underline{d}-\psi}{\underline{d}}$ then the quality is so low that, the net cost to R, $\underline{d} - \underline{d}q$, will be more than the benefit of prestige ψ. If the expected quality goes above 1, then R's marginal private gain from the public good is greater than the cost of donating, and she will instead choose to donate more than $\underline{d}$.

Given R's strategies and beliefs, we need to show the range of values of $q^*, q^{**}, \underline{q}, \overline{q}$ for which S's signaling strategies are optimal.

For S to make a large private donation (i.e.$(\overline{d}, \gamma = 0)$) then:

$$2q\overline{d} - \overline{d} > max\{2q\underline{d} - \underline{d} + \psi, 0\} \tag{14}$$

This leads to two conditions:

$$q > \frac{\overline{d} - \underline{d} + \psi}{2(\overline{d} - \underline{d})} \quad \text{if} \quad q > \frac{\underline{d} - \psi}{2\underline{d}} \tag{15}$$

$$q > \frac{1}{2} \quad \text{if} \quad q < \frac{\underline{d} - \psi}{2\underline{d}} \tag{16}$$

However, the second clearly never holds since $\psi, \overline{d}, \underline{d}$ are all positive and $\overline{d} > \underline{d}$. Hence the condition for S to make a large private donation is simply:

$$q > \frac{\overline{d} - \underline{d} + \psi}{2(\overline{d} - \underline{d})} \tag{17}$$

Equation 17 states that q needs to be sufficiently large so that the sum of the increased donations to the public good, $2(\overline{d} - \underline{d})$, outweigh the increased private cost, $(\overline{d} - \underline{d})$, and forgone prestige (ψ).

For S to make a small public donation (i.e, $(\underline{d}, \gamma = 1)$) then

$$2q\underline{d} - \underline{d} + \psi > max\{2q\overline{d} - \overline{d}, 0\} \tag{18}$$

This leads to two conditions:

$$q > \frac{\underline{d} - \psi}{2\underline{d}} \quad \text{if} \quad q < \frac{1}{2} \tag{19}$$

$$q > \frac{\overline{d} - \underline{d} + \psi}{2(\overline{d} - \underline{d})} \quad \text{if} \quad q > \frac{1}{2} \tag{20}$$

These conditions simplify to:

$$\frac{\underline{d} - \psi}{2\underline{d}} < q < \frac{\overline{d} - \underline{d} + \psi}{2(\overline{d} - \underline{d})} \tag{21}$$

Equation 21 requires that the expected charity quality is within a certain range. If it falls below $\frac{\underline{d} - \psi}{2\underline{d}}$ the quality is so low the net cost to S, $\underline{d} - 2\underline{d}q$, would be more than the benefit of prestige ψ - even though the donation would induce an identical donation from R. If the quality goes above $\frac{\overline{d} - \underline{d} + \psi}{2(\overline{d} - \underline{d})}$, then a deviation to a large anonymous donation becomes worthwhile (see equation 17).

Hence, the cutoff values are $q^* = \frac{\underline{d} - \psi}{2\underline{d}}$ and $q^{**} = \frac{\overline{d} - \underline{d} - \psi}{2(\underline{d} - \overline{d})}$. The Bayesian Nash Equilibrium we have found is defined below by each player's strategy (equations 22 and 23), and R's beliefs contingent on S's action (equation 24). R's beliefs are common knowledge. The restrictions on the parameter range for which this is an equilibrium are given implicitly by equations 9 and 13.

$$(d_S, \gamma_S) = \begin{cases} 0, & \text{if } q < q^* \\ (\underline{d}, \gamma = 1), & \text{if } q^* < q < q^{**} \\ (\overline{d}, \gamma = 0), & \text{if } q > q^{**} \end{cases} \tag{22}$$

$$(d_R, \gamma_R) = \begin{cases} (\underline{d}, \gamma = 0), & \text{if } (d_S, \gamma_S) = (\underline{d}, \gamma = 0) \\ (\overline{d}, \gamma = 0), & \text{if } (d_S, \gamma_S) = (\overline{d}, \gamma = 1) \\ 0, & \text{otherwise} \end{cases} \tag{23}$$

$$\mu_R = \begin{cases} q \sim U(\underline{q}, q^*), & \text{if } (d_S, \gamma_S) = 0 \\ q \sim U(q^*, q^{**}), & \text{if } (d_S, \gamma_S) = (\underline{d}, \gamma = 0) \\ q \sim U(q^{**}, \overline{q}), & \text{if } (d_S, \gamma_S) = (\overline{d}, \gamma = 1) \\ 0 & \text{otherwise} \end{cases} \tag{24}$$

As is common among Bayesian Nash Equilibriums (BNE), the off equilibrium beliefs can take a number of other values (see Fudenberg and Tirole (1991)). This model is robust to a more general donation strategy, to differences in psychological factors or information endowments, and to the inclusion of more players (detailed descriptions can be found in the appendix).

4.2 Numerical Example

We use the following parameters as illustrative example:

$\underline{d} = 2, \overline{d} = 10, q \sim U[0, \frac{4}{3}], \psi = \frac{3}{2}$

Using the strategies and beliefs proposed in section 4.1, it is easy to verify there is a equilibrium with cut off values: $q^* = \frac{1}{8}$ and $q^{**} = \frac{19}{24}$.

If $q < \frac{1}{8}$ the quality is so low that even if two small donations are made, the net cost to an individual, $2 - 4q$, will be more than the benefit of prestige ($\frac{3}{2}$). For this range of q, S's payoff is decreasing in d_S, so clearly donating nothing is optimal. Since $q^* = \frac{1}{8}$, $E[q|d_i = 0] = \frac{1}{16}$, and so it is also optimal

for R to donate nothing.

If $\frac{1}{8} \leq q < \frac{19}{24}$ then S chooses $(d_S, \gamma_S) = (\underline{d}, 0)$. The net cost to S, $2 - 4q$, will now be less than the benefit of prestige $\frac{3}{2}$. So a donation is worthwhile. However, for this range of q, S's payoff is still decreasing in d_S. The quality is still too low for a deviation to a large anonymous donation to be worthwhile - even if it convinces R to donate $\overline{d}$. $E[q|(\underline{d}, 0)] = \frac{11}{24}$, which means R's expected cost to donating, $\frac{4}{24}$, is less than the value of prestige ψ and hence R also donates $\underline{d}$.

If $q > \frac{19}{24}$ then S chooses $(d_S, \gamma_S) = (\overline{d}, 1)$. In this case quality is sufficiently high that inducing R into a larger donation will provide a sufficient increase in S's payoff to outweigh the net gain from a smaller public donation. Here $E[q|(\overline{d}, 1)] = \frac{51}{48}$. Since the expected quality is greater than 1, R's expected payoff is increasing in donation size and she will also donate $\overline{d}$ (but her donation will be public).

There is no incentive for either player to deviate, hence this in an equilibrium. Since $q \sim U[0, \frac{4}{3}]$, the probabilities that each of these outcomes occur are:

$$P(q < q^*) = \frac{3}{32}, P(q^* < q < q^{**}) = \frac{1}{2}, P(q^{**} < q) = \frac{13}{32} \qquad (25)$$

Hence the expected payoff for S and R are $\frac{2011}{384}$ and $\frac{2245}{384}$ respectively. The total surplus is $\frac{4056}{384}$. The expected amount raised for the charity is $\frac{3888}{384}$.

5 Welfare Comparison

For comparison we consider a similar scenario, using the same parameters in section 4.2, but without the choice of anonymity. We show that the equilibrium characterized in 4.1 may not exist when there is no choice over anonymity. It is privately optimal for R to donate if $E[q] > 1$. However if the most costly signal that S can send will still not convince R that $E[q] > 1$, then there will be scope for improved outcomes. Hence we suggest that anonymity may help correct the market failure present in public goods games.

5.1 Equilibrium when Anonymity Cannot be Chosen

If the option of making a private donation is not available, anonymity cannot be used as a signal. We propose an equilibrium where donation amount alone signals quality. The most costly signal that can be sent in this case is through a donation of $\overline{d}$, but for the parameter range given this signal is not costly enough to convince R that $E[q] > 1$. Thus R will never respond by always donating $\overline{d}$, instead she will play a mixed strategy (characterized below). Other than this a similar equilibrium ensues with S's cut-off values given by: $q^* = \frac{1}{8}$ and $q^{**} = \frac{2}{3}$

As before, the quality threshold for which no donation is made is the same: $q^* = \frac{1}{8}$. This is because the decision is identical: in both instances S will receive prestige when she donates $\underline{d}$.

However, when anonymity is not possible, S will continue to receive prestige when making a donation of $\overline{d}$ and therefore the quality of the charity does not need to be as high in order for this donation to be worthwhile. Hence S

will send the signal for lower values of q that if anonymity could have been chosen. R responds with the mixed strategy: donate $\underline{d}$ with probability p and $\overline{d}$ with probability $(1-p)$.

Since this is an equilibrium strategy, R will be indifferent between these donation amounts which means $E[q|\overline{d}] = 1$, and so $q^{**} = \frac{2}{3}$. S will be indifferent between donating $\underline{d}$ and $\overline{d}$ at $q = \frac{2}{3}$, when $p = \frac{1}{2}$:

$$q\overline{d}(1+p) + q\underline{d}(1-p) - \overline{d} + \psi = 2q\underline{d} - \underline{d} + \psi \tag{26}$$

Finally, we verify that if $\frac{1}{8} \leq q < \frac{2}{3}$ then R chooses $\underline{d}$. In this case $E[q|\underline{d}] = \frac{19}{48}$. Since, for R, the expected cost to donating, $\frac{4}{24}$, is less than ψ, R also donates $\underline{d}$. Since $q \sim U[0, \frac{4}{3}]$, the probabilities that each of these outcomes occur are:

$$P(q < q^*) = \frac{3}{32}, P(q^* < q < q^{**})) = \frac{13}{32}, P(q^{**} < q) = \frac{1}{2} \tag{27}$$

Hence the expected payoff for S and R are $\frac{1609}{384}$ and $\frac{2377}{384}$ respectively. The total surplus is $\frac{3986}{384}$. The expected amount raised for the charity is $\frac{3696}{384}$

5.2 Complete Information equilibrium

With complete information both S and R will know the quality of the charity. Since an individual's donation will only consider the private return, the externalities from the public good cause market failure.

A small donation will only be made if charity quality is sufficiently large so that the cost of donating $\underline{d}(1-q)$ is less than the prestige received ψ, but

sufficiently small so that a larger donation is not more privately beneficial ($q < 1$). Hence small donations will be made if $\frac{1}{4} < q < 1$ and large donations will be made if $q > 1$. The expected amount raised for the charity is $\frac{2784}{384}$. Each player will receive a symmetric payoff of $\frac{1776}{384}$:

$$P(0 < q < \frac{1}{4})[0] + P(\frac{1}{4} < q < 1)[\frac{5}{8}(4) - 2 + \frac{3}{2}] + P(1 < q < \frac{4}{3})[\frac{7}{6}(20) - 10 + \frac{3}{2}] \tag{28}$$

5.3 Social Optimum

Here we consider the payoffs if quality is known to both players and individuals consider the public good element of the charity: so that investments are made at the socially optimal level.

In this case the net cost of donating is $\underline{d}(1 - 2q)$ and so the threshold for which an individual makes a small donation will fall: $q < \frac{d - \psi}{\underline{d}} = \frac{1}{8}$. If $q > \frac{1}{2}$, the (social) benefit starts increasing in d_i, and hence this is the cutoff quality for a large donation.

The expected amount raised for the charity is $\frac{5232}{384}$. Each player will receive a symmetric payoff of $\frac{2441}{384}$:

$$P(0 < q < \frac{1}{8})[0] + P(\frac{1}{8} < q < \frac{1}{2})[\frac{5}{16}(4) - 2 + \frac{3}{2}] + P(\frac{1}{2} < q < \frac{4}{3})[\frac{11}{12}(20) - 10 + \frac{3}{2}] \tag{29}$$

5.4 Welfare Comparison

We have shown that there are both efficiency improvements and equity changes from endogenous anonymity. Compared to situations where dona-

tions cannot be made anonymously (5.1), endogenous anonymity requires a larger quality threshold (q^{**}) before large donations are made. This means that $E[q|q > q^{**}]$ will be larger; in our example $E[q|q > q^{**}] > 1$. However without the choice of anonymity, no such credible signal can be sent.

In this case $E[q|q > q^{**}] = 1$, and so S does not receive a large private benefit from investing. Moreover, R now plays a mixed strategy which reduces her expected donation amount. S's payoff is smaller ($\frac{1609}{384}$ compared to $\frac{2011}{384}$) because she has to donate over a large range of q, with little benefit.

In contrast, R benefits from the large donations made by S whilst only sometimes reciprocating with a large donation. When endogenous anonymity is available R makes the same donations as S creating a more equal split (with the difference, $\frac{134}{384}$, coming from the additional prestige R is able to receive when making a large donation).

Part of the inefficiency of 5.1 comes from the mixed strategy being played by R: she will sometimes fail to make a large donation when q is large, but will sometimes make a large donation when q is smaller. However even if the parameters were changed and $E[q|q > q^{**}] < 1$ with endogenous anonymity, and therefore q^{**} was the same as (5.1), the increased signaling cost would result in a different mix. There would be a larger probability of R making a higher donation, and hence larger expected donations would occur under endogenous anonymity.

With the parameters we have used, the separating that occurs with endogenous anonymity increases the total amount given to charity ($\frac{3888}{384}$ compared to $\frac{3696}{384}$) because the increased donations by R ($\frac{480}{384}$) outweigh the reduced donations from S ($\frac{288}{384}$). There are also distribution changes, with a

larger sum going to the very highest quality charities and a smaller sum going to mid-quality charities. The low-quality charities continue to receive either little or nothing.

Comparing to the complete information situation (5.2), both incomplete information situations provide Pareto improvements. Since the private return from the public good is lower than the social return, complete information results in under investment. With incomplete information this is reduced for two reasons: Firstly, R's attempt to encourage S that the private return is high enough to invest increases S's investment. Secondly, part of the signal (albeit privately costly) is itself an investment, which has a public benefit. Unlike an increased donation, signaling anonymity inflicts no direct externality and hence R's payoff is smaller in 5.1 than with endogenous anonymity.

6 Conclusion

Using a large dataset from the natural environment of VMG fundraising pages, we have investigated the characteristics of anonymous donations and subsequently their effect on other donors. We find that, contrary to our expectations from the literature, large anonymous donations are fairly common. Empirically, our main result is the finding that large anonymous donations induce larger donations from subsequent donors than do public donations of the same size.

Given this result, we have produced a signaling model whereby anonymity is used as a costly signal of a charity's quality by an informed donor, which produces results consistent with our empirical findings. This is the main

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contribution of the work set out in this paper.

By comparing our model to one in which anonymity cannot be chosen, we show that a choice of anonymity leads to efficiency improvements and changes to which charities receive donations. When anonymity is used to signal charity quality, a larger sum will go to the highest quality charities and the amount given to mid-quality charities will be reduced.

We believe that, conditional on the signal being sent, we have a lower estimate of its effect, because the revealed donations are not a perfect counterfactual. Those donors who do not conceal their identity are necessarily those for whom revelation is optimal, and so may differ to anonymous donors in important characteristics.

The largest difficulty with our empirical result is that we have so little information about anonymous donors. If we were able to gain more detailed information about them, and so track their donations across different communities, we may be able to develop a better counterfactual.

7 Appendix

7.1 Virgin Money Giving Pages

7.2 Robustness of the Model

This appendix extends the simple two player model presented in section 4. In the primary model, two agents interact and make a choice from one of three donation amounts, and whether to donate anonymously. One agent is informed, and the other not, and both agents extract some utility from both the provision of the public good and from having others know that they have contributed to it. Here, we relax many of these assumptions, and demonstrate that the principle conclusions of our model continue to hold (although they become weaker under many such relaxations). In section 7.2.1a, we expand the set of donations, while in section 7.2.2b we allow the characteristics of donor and their information sets to vary, such that the second player, R, may have some information about the charity's quality. In section 7.2.3c we allow for ψ to vary between players, and in section 7.2.4d we introduce multiple players to the game.

7.2.1   7.2a Generalizing the Donation Strategy

In our model, costs and benefits to donations were both linear. This assumption will lead to corner solutions, where if donations occurred they would either be the minimum possible, or the maximum. If, however, donors have diminishing returns to consumption, or the benefit from donating is concave in d_i, then they may choose to donate amounts that are between the minimum and maximum, i.e. $\notin \{\underline{d}, \overline{d}\}$. It is possible to generalize the way in which donations can be given either by allowing a choice over a finite discrete number of donations, or by allowing a choice over a continuum of donations.

A discrete choice model is plausible since a large portion of donations observed in our data are of round amounts. If players have a possible choice over N discrete donations; $d_i \in \{0, d_0, d_1, d_2...d_N\}$ we propose that there can be a separating equilibrium, in which different signals are sent according to $|N| - 1$ threshold values for q.

7.2.2 7.2b Information Endowments and Player Characteristics

Our model assumes that S has perfect knowledge about the quality of the charity. Our model also requires that the sender obtains utility from the receiver's donation. These assumptions (that S has more information than R, and is motivated by the general level of charitable good provision) are consistent with past work in this area; Potters et al. (2005) assume that one agent has knowledge of the charity's quality, while Vesterlund (2003), shows that if charity quality is uncertain, some individuals will engage in costly information search. That S receives utility from R's donation is a standard public good setup. Here we find it useful to think in terms of more and less motivated agents.

Then they have a greater incentive to signal charity quality than do other players, as their return on others' donations is higher. Intuitively, we can also turn to the framework of Vesterlund (2003), and assume that the cost of information gathering is may be lower for more motivated agents, as they are likely to be more closely linked to the charity than are less motivated agents.

We can relax this assumption, so that each player gets a signal about the quality of the charity, with similar results. However, it is clear that signals are

only as valuable as the information they can transmit, which is diminished in a case where both players have information. Hence, the less that can be learnt from S, the smaller the power of her signal. This results in a smaller range of values for which a separating equilibrium will occur.

Intuitively, we assume that individuals who care about the charity have a lower cost to gathering information about it and so will be more likely to do so. While it is possible for R (as well as S) be concerned with how much the other player donates (as in our model), the only assumption required on her is that her utility is increasing in q.

7.2.3   7.2c Differences in Psychological Factors

We have so far assumed that the net effect of the psychological factors, ψ, is constant. We can relax this assumption in one of two ways - either by allowing ψ to vary within individual, so that the same person could experience different, non-zero, values of ψ depending the action he takes, or between individuals, such that different people are more or less motivated by psychological factors.

The assumption that ψ is a positive constant suggests that prestige is the dominant psychological factor. When donations are very small, however (i.e. less than the mean) the dominant psychological effect may be (lack of) conformity. We might expect, for this level of donation, ψ to be negative. Hence it is possible that ψ is an increasing function of d_i. When the cost of the signal is negative, i.e. for small d, we might still observe anonymity. In this case, anonymity would not need always to be a response to charity quality. As a signal is only as effective as its cost, the signaling value of anonymity

may be weaker for low values of d_i, but may be stronger for higher values, depending on the form of the relationship between d_i and ψ.

For example, consider ψ as any monotonically increasing function of d_i, such that:

$$\psi(\underline{d}) < 0 \text{ and } \psi(\overline{d}) > 0$$

ψ is determined by both the sizes of relevant psychological factors and social norms. There is a donation size x, where these effects will exactly cancel each other out. For example, it could be that x is the current mean donation of the group.

In this case, donations less than x will have a negative net psychological cost (e.g, driven by a lack of conformity), whilst larger donations will have a positive psychological benefits (e.g, driven by aforementioned prestige).

Since there is now no psychological benefit (moreover, there is a loss) to making a minimum donation, R will no longer make minimum donations[6]. Hence, the separating equilibrium we are looking for will simply have one "cut off" value of q. R will either make a large public donation, or choose not to donate at all. The receiver's beliefs will take the following form:

$$\mu_R \begin{cases} \mu_{R0} = q \sim U(\underline{q}, q^*), & \text{if } (d_S, \gamma_S) = 0 \\ \mu_{R1} = q \sim U(q^*, \overline{q}), & \text{if } (d_S, \gamma_S) = (\overline{d}, \gamma = 1) \\ \mu_{R2} = q = 0 & \text{otherwise} \end{cases} \qquad (30)$$

and the strategies played in equilibrium are given by:

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[6]If there is a range for which ψ increases very rapidly, and a non-large donation gives a high psychological payoff, then there is an equilibrium where a medium donation is used primarily for psychological gain.

$$(d_S, \gamma_S) = \begin{cases} 0, & \text{if } q < q^* \\ (\overline{d}, \gamma = 1), & \text{if } q > q^* \end{cases} \tag{31}$$

$$(d_R, \gamma_R) = \begin{cases} 0, & \text{if } (d_S, \gamma_S) = 0 \\ (\overline{d}, \gamma = 0), & \text{if } (d_S, \gamma_S) = (\overline{d}, \gamma = 1) \\ 0, & \text{otherwise} \end{cases} \tag{32}$$

Where $q^* = \frac{1}{2}$

We note that there are still a multitude of equilibria after relaxing this assumption. In any separating equilibrium, other signals may be sent by S, but they will all be less costly and hence would only imply a smaller q*.

We now consider relaxing the assumption that psychological effects are constant between individuals, i.e. that $\psi_i \neq \psi_j$. If we introduce variation (i.e, individuals each have a private ψ, drawn from a common, known, distribution), signalling power would be reduced. Those who benefited from low cost signals (i.e, who had low draws of ψ) would have lower thresholds for private donations (and a receiver's belief would be higher than the true q). Those who had high cost signals (i.e, who had high draws of ψ) would have higher thresholds for private donations (and receivers' beliefs would be lower than the true q). Of course, on average, the receiver's belief would be cor-

rect. A simple model with 'types' of players who vary in their psychological characteristics can be found in section 7.3.

7.2.4 7.2d Multiple players

As there are only two players in our model, it is clear that R will have perfect knowledge about S's actions independently of her choice of γ. In this game, we interpret a public donation as a 'plaque' which is seen by members of the public. Hence we suggest that the effect of R's contribution on S's prestige is negligible relative to the (large) exogenous population.

There is an obvious way in which we can generalize the game to N players. Player 1 sends a signal which is received by all future players. Each player i after that, acts as both a receiver (of previous players' signals) and a sender (in as much as their donation is informative about those donations which went before, which were informed). Each donor will learn from the previous signals she has received and use this to decide what action to take. This type of information flow would possess similar properties to the herding model of Banerjee (1992). Since the number of future donors that can be influenced, and perhaps the expectation that the donor is informed, are decreasing in the lateness of a donation, we would expect earlier players to donate larger amounts and more frequently donate anonymously.

7.3 Extensions to Model - A World with Types

Individuals may differ in both their (psychological) persona[7] and how much they value a given charity[8]. In this extension we model this heterogeneity, by allowing both ψ and q to be individual specific. These parameters are privately known to the individual, and the distribution of each is common knowledge. Altering either of these parameters has a similar effect - confusion is added about why an individual is donating.

First consider ψ; On the one hand, individuals with a low draw of ψ find it less costly to forego prestige, and thus weaken the signalling value of anonymity. On the other hand, individuals with a large draw of ψ strengthen its value. Thus the values of q^* and q^{**} will depend on the individual's ψ_i . Larger values of ψ_i will result in a lower q^* and a larger q^{**}. Thus individuals with higher ψ_i will be more likely to donate small amounts publicly and less likely to make large anonymous donations. Since ψ_i is privately known, R can only condition his strategy on $E[q|(d_S, \gamma_S)]$ and not $E[q|(d_S, \gamma_S), q_i]$. Hence a larger variance of ψ decreases efficiency.

Second if q is individual specific; e.g, $q_i = q + \epsilon_i$, individuals who have low q_i will find it less worthwhile both to donate and to encourage others to donate. This results in higher values of both q^* and q^{**} for lower values of an individual's q_i . As before, a larger variance of q decreases efficiency. If the two characteristics (q and ψ) are jointly distributed we can tell a story containing three types; "Heroes" are motivated primarily by the former, whereas

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[7]For example, some people may be conditional or unconditional co-operators (Fischbacher et al. (2001).

[8]For example, if an individual has personal experience with a disease, she may perceive the value of the charity higher.

"Villains" are motivated purely by the latter. In addition we suggest the majority of individuals are "Citizens", who are motivated by a combination of the two factors. Furthermore, we suggest that Heroes possess perfect knowledge of the charity quality whereas the other types do not[9].

As donating is costly, for a given utility function there is a minimum quality of charity at which it is optimal for both Heroes and Citizens to donate. While the Heroes are able to make this choice with the advantage of information, Citizens may decide not to donate ex-ante even when, ex-post, the quality of the charity is high.

As Villains' utility is independent of the charity's quality, they will always donate when the value of the prestige is greater than the cost of donating. Hence simply observing a donation is not sufficient to infer anything about the quality of the charity. However, if Heroes are able to donate anonymously, they are able to send a signal about the quality of the charity. This is because a Villain will never donate anonymously, as she will not be willing to forgo prestige. If a Citizen observes an anonymous donation, they know that it must have been made by a Hero, and hence that the charity must be of high quality. The result of this is that on observing an anonymous donation, a Citizen will choose to donate.

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[9]In this analogy, we note that we do not require the distribution of types to be known.

Table 4 - Probit model: whether donation is anonymous

	(1)	(2)	(3)	(4)	(5)
Log amount	0.032***	-0.600***	-0.596***	-0.053***	-0.073***
	(0.005)	(0.024)	(0.024)	(0.007)	(0.007)
Place in order (10)	-0.010***	-0.010***	-0.005*	-0.005*	-0.005*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Log amount squared		0.096***	0.095***		
		(0.003)	(0.003)		
First Donation			0.223***	0.230***	0.230***
			(0.024)	(0.024)	(0.024)
Large Donation				0.370***	-1.114***
				(0.021)	(0.139)
Large · Log amount					0.315***
					(0.029)
Constant	-1.247***	-0.282***	-0.304***	-1.043***	-0.986***
	(0.018)	(0.039)	(0.039)	(0.022)	(0.022)

standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 4: Probit model: whether donation is anonymous

7.4 Further Empirical Specifications

7.4.1 First Stage Empirics

Tables 4 and 5 report probit and logit models of the results contained within Table 2. These results are consistent with those displayed in the main body of this paper.

7.4.2 Second Stage Empirics

This section contains robustness checks for our most important empirical finding - that donations made immediately after a large anonymous donation are significantly larger than are those made after a large public donation. Table 6, below, contains robustness checks for this finding. Regressions 1, 2 and 3 in this table replicate the regressions found in Table 3. Following Smith

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Table 5 - Logit model: whether donation is anonymous

	(1)	(2)	(3)	(4)	(5)
Log Amount	0.065***	-1.066***	-1.059***	-0.102***	-0.144***
	(0.010)	(0.041)	(0.041)	(0.014)	(0.014)
Place in order (10)	-0.019***	-0.019***	-0.010*	-0.009*	-0.009*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Logged Amount Squared		0.169***	0.168***		
		(0.006)	(0.006)		
First Donation			0.407***	0.419***	0.419***
			(0.044)	(0.044)	(0.044)
Large Donation				0.686***	-1.968***
				(0.039)	(0.240)
Large · Log amount					0.567***
					(0.050)
Constant	-2.140***	-0.398***	-0.440***	-1.739***	-1.620***
	(0.035)	(0.069)	(0.070)	(0.042)	(0.043)

standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 5: Logit model: whether donation is anonymous

et al. (2012), we perform the same kind of difference in difference analysis as in our second stage regressions, but focus only on the first large donation to a given page. Given Smith et al. (2012) observe that large donations will tend to follow large donations, we consider that a large anonymous donation may simply be the result of following a large donation of one kind or the other, possibly outside of the bandwidths covered by our analyses. Comparing donations made before and after the first *large* donation within a given page, we see results that are similar or larger in the magnitude of effect size to those reported in Table 3. Although these results are not significant, the stability of the point estimate of the effect suggests that the large reduction of statistical power may be at least partially responsible.

Other columns show results from different specifications, varying the bandwidths of interest and including more controls. These results are broadly

Table 6 - Difference in difference with first large anonymous donations

	(1)	(2)	(3)	(4)	(5)
Ln(amount)	0.149**	0.077	0.014	0.013	
	(0.048)	(0.044)	(0.042)	(0.045)	
Anonymous	0.023	0.024	0.024	0.119*	
	(0.060)	(0.054)	(0.051)	(0.057)	
Place(10)	0.197	0.275**	0.208*		
	(0.115)	(0.096)	(0.085)		
Distance to Target	0.000*	0.000**	0.000**	0.000	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L.First Large Anonymous					0.158***
					(0.036)
L.First Large					0.207***
					(0.023)
L.First Donation					0.018
					(0.018)

standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 6: Difference in difference with first large anonymous donations

in line with those found in Table 3, and with the implications of our model.

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