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Abstract

Much fundraising is done by individuals within existing social groups. Exploiting a unique dataset, we demonstrate (i) a positive relationship between social group size and the number of donations; (ii) a negative relationship between group size and the size of individual donations; (iii) no clear relationship between group size and the total amount raised. Free riding with respect to the activity being funded cannot explain the relationship between group size and donation size, since the number of social group members is only a subset of total contributors. Instead, the findings are consistent with the notion that giving in social groups is motivated by "relational altruism".

JEL-Codes: D640, Z100, H310.

Keywords: online giving, fundraising, social groups, donations, charity, altruism.

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1 Introduction

Donations by individuals are an important source of income for charities – more than $200 billion is donated annually in the US and £10 billion in the UK – yet underlying individual motives for giving are not well understood. One possibility is that donors are motivated to give for altruistic reasons; that is, they care about the total amount of public good that is provided. Another is that donors give because they gain direct utility from the act of giving; that is, they experience a "warm glow" from giving (Andreoni, 1990). There is also interest in how donations may be determined in a "charity market" (List, 2011) where donors interact with other key players, including fundraisers and/or charities who are active in seeking donations through their own fundraising efforts. Yet another possibility is that donors are motivated by a personal relationship with a fundraiser. This may be important in practice given that charitable giving often takes place in social settings that are unrelated to the charitable activity, with the fundraising request coming not from a charity representative but from someone known to the donor. One example is individual-led fundraising, in which individuals engage in fundraising activities and ask their networks of friends, family and colleagues to make sponsorship donations to charity.[2] Table 1 summarizes survey evidence on donors' perceptions of the factors that were important determinants of how much they gave in response to an individual fundraiser, showing that the personal relationship between the donor and the fundraiser comes near the top – well above tax incentives, for example.

In this paper, we propose the idea that, in social group settings, there may be a "relational altruism" motivation for giving. By this we mean a motivation to give that comes from a donor's altruism towards a member of their social group who engages in individual fundraising activities and who experiences a warm glow from the amount of money that is raised from their fundraising effort. In practice, where fundraisers solicit donations from their existing social groups, the size of social groups – and therefore the size of the potential donor pool – is likely to vary. In our data, for example, where the number of Facebook friends is a plausible indicator of social group size, the 10th percentile of the distribution is 77 friends, while the median is 252 and the 90th percentile is 654 friends. Such variation may have implications for fundraising outcomes. We explore this conjecture theoretically and empirically by focusing on the relationship between the size of the fundraiser's social group and donation behaviour in the individual fundraising context.

[2] Individual-led fundraising is widespread in many countries, including the UK where 18% of donors report having sponsored family and friends for charity in the past year (source: Citizenship Survey, 2008-09, Department for Communities and Local Government, 2009).

At first sight, the idea that group size should affect the behaviour of individual donors might appear to be a straightforward implication of non-cooperative models of giving (as developed by, among others, Warr, 1983, and Bergstrom, Blume and Varian, 1986), in which individuals make private contributions towards a pure public good and that predict that, as the number of contributors to a public good increases, the size of contributions will fall. Indeed, this is the relationship we observe in our data – in larger social groups, we observe more donations, but each donor tends to give less. However, the crucial difference between this case and our setting is that the size of the social group we observe does not correspond to the total number of contributors to the public good provided by the charity. For the charities in our sample, the amount of money raised by any individual fundraiser typically makes an insignificant contribution towards the overall level of charitable provision. The most popular charity for which people fundraise is Cancer Research UK for whom the £100 million received in donations each year completely dwarves the amount raised by any individual fundraiser. In our analysis, we show that social group size is negatively correlated with contribution size across different fundraisers who are raising money *for the same charity*. Since these fundraisers face the same number of total contributors, we need a different explanation to explain the negative relationship between social group size and contributions in our data.

Our preferred explanation is that, if donors are motivated by relational altruism – i.e. if a donor cares about the fundraiser and the fundraiser cares about how much they raise – then the amount of money raised by the individual fundraiser becomes a "local" public good. In this case, as mentioned above, contributions fall with social group size, but the free-riding behavior that generates this outcome stems from altruism that the donor has towards the fundraiser who cares about how much they raise, as opposed to stemming from altruism on the part of the donor towards the charitable cause. There is circumstantial evidence that individual fundraisers *do* care about how much they raise – for example, the fact that the majority set aspirational fundraising targets that are notional (unrelated to specific funding needs) and non-binding (donations are passed to the charity even if the target is not met). It is therefore plausible that fundraising success is a local public good to the social group and thus a public good for which incentives will vary locally with social group size.

Our empirical analysis exploits a unique dataset of individual-led fundraising activity that links the donations made to individual fundraisers' online fundraising pages to an observable proxy for the size of the fundraisers' social group. This is a very rich dataset comprising all donations made to more than 35,000 individual fundraising pages; importantly, our data also contain

information about the number of Facebook friends of the fundraisers. While the number of Facebook friends cannot be taken to be the universe of the fundraiser's entire social group, we find evidence to support the idea that it is a meaningful proxy for social group size, and we show that the number of Facebook friends is positively correlated with the number of donations that the fundraiser elicits. Our key finding is that there is a negative correlation between the number of Facebook friends and the size of donations, across almost the entire distribution of friends. Our estimates also indicate that the magnitude is economically significant – moving from the 10th percentile of the distribution of Facebook friends (77 friends) to the 50th percentile (252 friends), predicted donation size declines by more than 10%; moving from the 10th percentile to the 90th percentile (654 friends), predicted donation size declines by nearly 20%.

This result is robust to including controls for demographic characteristics of the fundraiser that might plausibly be correlated with social group size and to including both charity- and event fixed effects – i.e. we find that donations are smaller for fundraisers participating in the same fundraising event, raising money for the same charity, but who have larger social groups. We also show that the negative correlation between the number of Facebook friends and donation size holds when we run separate regressions by the order of the donation on the page (i.e. for the first, second, third donation on each page and so on) and we also show that it holds for the size of the maximum donation to a page. We interpret these findings as indicating that a smaller mean donation size cannot simply be attributable to a negative marginal effect from the additional donations that are made in larger groups, but that larger group size tends to be associated more generally with smaller donations by all group members.

Our paper builds on the existing literature on the relationship between group size and private contributions to public goods, but adds to it along several important dimensions. Models of non-cooperative private provision of public goods that are based on collective consumption motives predict that individual donations are negatively related to the total number of contributors, i.e. there is free-riding, and that individual contributions approach zero as the number of contributors become very large.[3] This result has been tested in a laboratory setting (Isaac and Walker, 1988; Isaac, Walker and Williams, 1994) and in a real world setting (Zhang and Zhu, 2011). In our case, however, the groups we look at are primarily social in nature; their primary purpose for interaction is not charitable activity. Second, as mentioned above, the members of the social group are only a subset of the total number of potential contributors to the public good, implying

[3] This result is dampened if there are impurely altruistic motives for giving (Andreoni, 1990).

that any group size effect on public good provision will be a "local" one, specific to the amount of public good funded by a subset of contributors. Thus, the situation that we study is of how socially-determined divisions of the universe of private contributors to a public good, along lines that are not directly relevant to the nature of the public good, can determine donation outcomes. The model of relational altruism-based giving that we propose here is novel, and generates predictions that are supported by our evidence.

There is little theoretical literature focusing on donations in these social group contexts. Exceptions are Benabou and Tirole (2006) who consider the case where people make contributions out of concerns for reputation or status and Scharf (2014) who focuses on the effect of social interactions on giving decisions in a setting where social links are only relevant for information transmission and social learning. However, numerous empirical studies support the presence of social effects on giving. Among other things, donations have been found to be sensitive to: whether or not giving is publicly observable (Soetevent, 2005); social information and norms (Frey and Meier, 2004; Shang and Croson, 2008); social pressure (DellaVigna, List and Malmendier, 2012); and peer effects in solicitations and donations (Meer, 2011; Smith et al 2015). Many of these social effects are likely to interact with social group size, yet, to date, the sensitivity of donations to the size of social groups has not been explored. This paper extends this literature by presenting new evidence on the relationship between social group size and donations.

The plan of the rest of the paper is as follows. The next section discusses the individual fundraising context in more detail. Section 3 introduces the idea of relational altruism and discusses mechanisms through which social group size may affect donation size. Section 4 presents the main results on the relationships between social group size and donation outcomes, while Section 5 extends the analysis to explore alternative explanations for the observed relationships. Section 6 concludes with a discussion of the findings.

2 The individual fundraising context

Alongside traditional fundraising activities, which involve a direct approach from a charity to potential donors, the past decade has witnessed a huge growth in individual-led online fundraising. Since 2001, more than 1.3 million individual fundraisers have raised in excess of £1.5 billion in the UK through online fundraising via the leading website.

The way this type of fundraising activity works is as follows: individual fundraisers choose a charity for which to raise money and a fundraising event. This may be an activity they do together with other fundraisers, such as running a marathon, or something that they choose to do

independently, such as shaving their head. In practice, running events (particularly marathons) are the most common type of activity in our sample (39.5% pages), followed by walking (14.8%) and cycling (11.4%). Other specified sporting events include parachuting (2.3%), swimming (1.8%) and triathlon (1.6%). Non-sporting activities include memorials (3.9%) and appeals (0.5%). There are also a small number of anniversaries, including weddings and birthdays (0.3%) where individuals choose to let people make donations to a charity in lieu of receiving gifts. There is also a substantial category of "other" activities (24.0%).

Having decided on an activity and a charity, the fundraiser then sets up a personalized fundraising page on an online fundraising platform that hosts multiple pages by many fundraisers. The platform allows donors to make donations online and passes the money directly to the charity. Donors arrive at the page and choose whether and how much to give and whether to reveal the amount and their identity. In practice, 7% of donations in our sample are made anonymously. Donations are made at different points in time – typically over several weeks – and all are listed on the page, with the most recent first. Donors can see who has previously given and the amounts and have been shown to respond to this information in how much they choose to give (Smith et al., 2015).

Almost all donors belong to the fundraisers' existing social groups of friends, family and work colleagues and come to the fundraising page following a solicitation from the fundraiser. In a survey of more than 19,000 sponsors,[4] 84% of those that were asked for a donation had been asked by a family member (of whom 87% said that they always gave when asked); 96% had been asked by a friend (67% always gave); 89% had been asked by a colleague (48% always gave) and 70% had been asked by a charity representative (only 9% always gave). This indicates that most people who donate to a page will do so because they are asked by someone they know personally. Fundraisers can contact members of their social networks directly by email and/or via Facebook. The fundraising platform offers an option for fundraisers to share the page directly to Facebook; fundraisers can also post the web address for their fundraising page into their Facebook status. Sharing the fundraising page directly to Facebook allows the fundraising platform to capture information on the number of Facebook friends that the fundraiser has at the time of sharing. However, it is important to note that this is the only piece of information that is available from Facebook – there is no information on whether donors respond to the link, on the identity of Facebook friends or on whether donations are made by people who are Facebook friends of the

[4] See Payne, Scharf and Smith (2012).

fundraiser. However, even without this other information, the number of Facebook friends is of interest since it provides a measure of the size of the social group of the fundraiser and the potential number of contributors to the fundraising page. While there is considerable debate over the extent to which Facebook friends constitute a genuine social group, in this case, since fundraisers share their fundraising page with an explicit aim of soliciting donations, the number of Facebook friends is arguably a plausible measure of the number of potential contributors to the fundraising page.

In practice, the number of Facebook friends – and hence the number of potential contributors to a page – varies widely across individual fundraisers. Our sample for analysis comprises 35,571 fundraisers.[5] The mean number of Facebook friends in this sample is 332, but there is considerable variation as shown in Table 2. The 10th percentile is 77, while the 90th percentile is 654. Figure 1 compares the (mean) number of Facebook friends among fundraisers in our sample with the (mean) number of Facebook friends in the wider population.

For the youngest age group (aged 18 to 34), the number of Facebook friends in our sample (not shown) is broadly representative of the population. This implies that these individuals do not only link their fundraising page to a Facebook page when they have an above-average number of friends. Older fundraisers exhibit a comparatively higher degree of selection with respect to the number of their Facebook friends – this may be selection into fundraising or into linking to Facebook. As a robustness check, we look at whether the results hold for different age sub-groups, and we show that they do.

Table 2 provides summary information from the fundraising pages in our sample. We have all information that is publicly available on the page, including the name of the charity, the number of donations, the total amount raised, whether or not there is a fundraising target, and the value of the target. A typical page has nine donations and raises just over £130 in total. Most pages have a target, typically £300. We also have information on all the donations made online to the pages, including the date the donation was made, the amount given and the name of the donor where available (just over 7% of donations are made anonymously).

3 Relational altruism

In this section, we discuss whether the predictions of the standard model of non-cooperative private giving – in which individuals make private contributions to a collective good in an

[5] This is after some cleaning. We remove 3,817 pages where we cannot identify the charity registration number for England and Wales. We also drop 30 pages with zero friends and 364 with zero amounts donated.

uncoordinated fashion – can be used to interpret the observed relationship between group size and donation levels in our data; we then propose an alternative conceptual framework for thinking about donations to individuals' fundraising pages.

In the basic model of non-cooperative private contributions by privately motivated individuals (Warr, 1983; Bergstrom, Blume and Varian, 1984), each individual donation decision only accounts for the individual valuation of the contributor, neglecting the effect that donations have on other contributors; as a consequence, the level of donations is lower than the efficient level, and the more so the smaller is the individual valuation in relation to the total valuation of all contributors – i.e. the large is the number of contributors, N. Accordingly (as shown in Appendix A), the basic framework predicts that as N becomes large, the size of individual contributions goes to zero; that is, "free-riding" increases with group size. Moreover, if individual contributions are sufficiently elastic with respect to N, total contributions will also be decreasing in the number of contributors.

In our empirical analysis we find a negative correlation between the number of Facebook friends of fundraisers and the size of donations and little correlation between social group size and total contributions to the page. At first sight, it would seem that this finding fits the predictions of the basic model. Upon closer inspection, however, this conclusion is unwarranted. To see this, partition individuals in the economy so that $N = N_F + N_E$, where N_F is the number of Facebook friends of a fundraiser, and N_E is the number of other donors not belonging to the group of friends. In our data, we observe N_F but not N_E – and thus not N – and there is no reason to think that the total number of contributors to the public good should be correlated to the number of people that are Facebook friends of a particular fundraiser. Indeed, in our empirical analysis we include charity fixed effects and so estimate a negative relationship between donation amounts and N_F, conditioning on N. In this case, we need something other than the basic model to explain the correlations that we see in our data.

An alternative specification that could explain the negative correlation is one where fundraisers experience "warm glow" from the donations they raise, and where the members of the fundraisers' social group are altruistic towards the fundraiser, which makes fundraising success a "local" public good to the social group – and thus a public good for which incentives will vary locally with N_F. Formally, if $\overline{v}_F$ is average donation size within the social group and fundraising success within the social group is measured by $N_F\overline{v}_F$, we can model relational altruism in terms of an additional positive effect associated with $N_F\overline{v}_F$ (in addition to the standard collective

consumption effect) that is restricted to group members and that reflects the group members' concern for the warm glow experienced by their friend from fundraising success.

According to this specification, even though there is still no reason to assume that the total number of contributors to the given cause is related to the number of Facebook friends, the total number of contributors to $N_F\overline{v}_F$ *will* be related to the number of Facebook friends, and thus, through this channel, we can expect a negative correlation between $\overline{v}_F$ and N_F, and possibly, a negative correlation between $N_F\overline{v}_F$ and N_F.

The notion of relational altruism, as we have described above, is silent on an almost ubiquitous aspect of individual fundraising – the fundraiser engages in some kind of "arduous" activity; running a marathon, walking or swimming some distance. One way in which we can rationalize this feature being consistent with relational altruism is that it may be used by the fundraiser as a way of signalling their valuation when this valuation for the cause in question is private information. Engaging in a costly action may then serve, in a separating equilibrium, as an informative signal to their friends about the fundraisers' valuation; and doing so by undertaking an arduous activity (e.g. running a marathon), rather than by making a larger visible donation to the cause, may be more informative (i.e., would make it easier to support a separating equilibrium) if the fundraiser's friends cannot fully observe his/her fundraiser's income level – which would affect the "effective" cost to the fundraiser of a given observable donation but may not affect the cost of arduous activity.[6, 7]

In sum, although we can rule out standard free-riding behaviour, relational altruism from the donor to the fundraiser (where the donor cares directly about the fundraiser and/or how much the fundraiser raises) provides one plausible channel for donations being lower in larger social groups. In the rest of the paper, we explore this relationship empirically.

[6] In other words, the cost to the fundraiser of engaging in an arduous activity may be comparatively less affected by income than other visible costs may be. The comparative signaling strength of donations of money could be improved by making one's income more observable, but then this could prompt unhelpful interpersonal comparisons that might interfere with relational altruism.

[7] An alternative mechanism that could account for this is the fundraiser's reliance on relational warm glow in the presence of donation indivisibilities and loss aversion. If the fundraiser is loss averse, then incurring a cost would bring the fundraiser into the loss domain, implying higher marginal relational altruistic effects. It can be shown, that if there is a minimum level of donation, by incurring a cost of a certain size, the fundraiser can trigger giving by friends that would not otherwise give, and in this way, obtain a higher net payoff than by not incurring the cost.

4 Main findings on the relationship between social group size and donations

We are interested in modeling the relationship between social group size (proxied by the fundraiser's number of Facebook friends) and donation outcomes. We consider three outcomes. The first is the total number of donors, n_F, to the fundraising page. We expect the total number of donors to be positively related to social group size, N_F, but anticipate that there may some donors who are not Facebook friends and also Facebook friends who are not donors. Finding a positive relationship in our data provides some validation that the number of Facebook friends is a reasonable proxy for social group size. The second donation outcome – arguably the main outcome of interest in terms of our relational altruism hypothesis – is the amount of money given by each individual i: v_F^i being the contribution of donor i to fundraiser F's fundraising page. Finally, we are also interested in the total amount raised by the fundraiser, $V_F = \sum_F v_F^i$.

The relationships between the number of Facebook friends and these outcomes are shown graphically in Figure 2. Because the distribution of the number of Facebook friends is skewed to the right (the median number of friends is 252 and the maximum is 5,702), we plot percentiles of the distribution along the horizontal axis.

Panel (a) plots the mean of the number of donations per page for each percentile of the distribution. Note that the outcome is expressed in logs, corresponding to our regression results below. The figure shows that the number of donations is increasing in the number of friends across the distribution; we interpret this as indicating that the number of Facebook friends has some meaningful information about the size of the potential donor pool.

Panel (b) plots the average of the mean per-page (log) donation size by percentile.[8] This shows that average donation size is declining with group size across the distribution, but with evidence of non-linearity.

Bringing together the number of donations and donation size, panel (c) plots (in logs) the mean of the total amount raised per page by percentile. There is a non-monotonic relationship between the total amount raised and social group size. The negative effect of increasing social

[8] By using the mean (log) donation per page as the outcome, rather than observations on individual (log) donations, we give equal weights to each page. This does not entail any significant loss of statistical power – because donations are to a particular page, a specification that uses individual donations would need to allow for clustering of standard errors at the page level. When we investigate whether donations levels can be explained by the closeness of the relationship between donors and fundraisers, we use observations on individual (log) donations (with clustered standard errors), and the results are similar.

group size on donation size appears to dominate up to the median, while the positive effect of increasing social group size on the number of donations dominates in larger friendship groups.

In the rest of this section, we report on a series of regressions that test the robustness of these relationships to including controls for fundraiser characteristics and charity and event fixed effects.

We start by estimating the following regression specification:

$$y_F = \alpha + f(N_F) + u_F, \quad (1)$$

where F indexes fundraising page, y_F refers to the page outcome (log number of donations, mean log donation size and log total amount raised) and $f(N_F)$ is a quartic in the number of Facebook friends, allowing for non-linearity in the relationship.[9] Given the skewed distribution, we winsorize the distribution of the number of Facebook friends and replace the top 1% of the distribution with the value at the 99th percentile (= 1,461 friends).

A second specification includes charity fixed effects, meaning that we identify the correlation between fundraising outcomes and the size of the fundraiser's social group among fundraisers raising money for the same charity. This controls for the total number of potential contributors to the charitable good and makes it clear that any relationship that we estimate cannot be explained by standard models of non-cooperative private giving, which focus on all potential contributors to a public (charitable) good.

In a third specification, we additionally include a vector of controls for the characteristics of the fundraiser (gender, age and household income[10]), the fundraising event type (anniversaries, appeals, memorials, cycling, parachuting, running, swimming, walking, triathlon, other), year and month. As well as including gender, age and income independently, a fourth specification allows the effects of both age and income to vary with gender. In Appendix C we report regression results within sub-groups that are defined by gender, age and event type.

As a final robustness check, we explore a fifth specification that additionally includes a set of indicators for fundraising events that have two or more fundraisers (i.e. a specific running race

[9] The Ramsey RESET test fails to reject the null of no omitted variables for the quartic specification in the case of all three outcome variables.

[10] Information on fundraiser age (banded; six categories: 18-35, 36-45, 46-55, 56-65, 66-75, 76+) and fundraiser household income (banded; 11 categories: < £10K, £10-15K, £15-20K, £20-25K, £25-30K, £30-40K, £40-50K, £40-50K, £50-60K, £60-75K, £75K) is matched at the six-digit postcode level from market research data.

or charity bike ride), thus identifying any relationship between fundraising outcomes and the fundraiser's social group size among fundraisers *doing the same event for the same charity*.

Estimated coefficients from these five regression specifications for all three outcomes are reported in Appendix B, Table B.1. When the dependent variable is the number of donations or donation size, the estimated coefficients for the terms of the quartic component, $f(N_F)$, are statistically significant at the 5% level in all regressions. When the dependent variable is the total amount raised, however, the coefficients become insignificant once the control variables are added, indicating a weaker relationship between the total amount raised and the number of Facebook friends.

For ease of interpretation – since the relationships between donation outcomes and social group size are non-linear – Table 3 reports predicted values, based on the estimated coefficients, for different percentiles of the distribution of the number of Facebook friends (10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th}), as well as differences in the predicted outcomes between the 10^{th} and 50^{th} percentiles and between the 10^{th} and 90^{th} percentiles. We also report the number of Facebook friends at which the predicted outcome is maximized (when the dependent variable is the number of donations) or minimized (when the dependent variable is amount of donation).

Predicted values for when the dependent variable is the number of donations are shown in panel (a). Column (I) confirms the positive correlation over most of the distribution, corresponding to Figure 2. This correlation is robust to including charity fixed effects, and controls for fundraiser characteristics and event fixed effects, as shown in columns (II)–(V). The correlation remains positive over most of the relevant range: in all cases the number of friends corresponding to the maximum number of donations to a page lies above the 97^{th} percentile of the distribution of the number of friends. Further regression results, shown in Appendix C, confirm that this positive holds for sub-groups defined in terms of fundraiser gender, fundraiser age and event type. However, although coefficient estimates are robust and statistically significant, it is worth noting that the absolute magnitude of the estimated relationship is small. Focusing on Column (I), the results imply that moving from the 10^{th} to the 50^{th} percentile in the distribution of the number of Facebook friends (from 77 to 252 friends) yields just over half an extra donation. This may reflect the fact that an individual's Facebook network is typically larger than their real world social network – closer friends, family and colleagues who may be more likely to respond to a solicitation for donations.

Panel (b) of Table 3 reports predictions from coefficient estimates for the relationship between the number of Facebook friends and donation size. We find that the average size of donations to a page is negatively correlated with the fundraiser's social group size over most of the distribution. As with the number of donations, the sign of this relationship is robust to including additional controls, as shown by the different regression specifications (and within different sub-samples as shown in Appendix C). The number of friends associated with the smallest predicted donation size lies above the 98th percentile of the distribution for all specifications.[11] Our estimates indicate that moving from the 10th to the 50th percentile in the distribution of the number of Facebook friends is associated with a 15% reduction in average donation size (11% when including a full set of controls). This represents a sizeable effect.

Panel (c) of Table 3 shows results for the relationship between social group size and the total amount raised per page – bringing together the effects of group size on both the number of donations and average donation size. In this case, the relationship is less clear, and the results are more sensitive to the addition of controls. Broadly, the negative correlation between group size and donation size tends to dominate the positive correlation between group size and number of donors over the first half of the distribution of the number of friends, resulting in total donations decreasing in group size (this is the case in all but the final specification). However, this relationship is reversed beyond the 50th percentile, after which total donations tend to increase as group size increases. In most of the specifications, we find that people with only a few Facebook friends (who receive a small number of larger donations) are able to raise as much as people with a large number of Facebook friends (who receive more, but smaller, donations).

[11] Although we find a negative relationship over most of the distribution, the relationship weakens as the number of Facebook friends becomes larger and becomes non-monotonic for those few individuals who have a very large number of friends. This can be reconciled with a model of relational altruism by considering the curvature properties of the comparative statics effects predicted by the theoretical model. If preferences are strictly convex, the predicted effect of a marginal increase in group size on the size of individual contributions is negative, but decreasing in absolute terms as group size increases; i.e. the first total derivative of the per-capita contribution with respect to group size is negative, but the second total derivative is positive, implying that the negative marginal effect of groups size on donation size is increasingly negligible as groups size increases. If variation in group size were also related to some unobservable characteristic (e.g., personal charisma) that also happens to be positively related to donation size, independently of the relational altruism mechanism we propose, then, as groups becomes progressively larger, the positive effect would eventually come to dominate the negative effect predicted by relational altruism. We return to a discussion of potential omitted characteristics in Section 5.4.

5 Further analysis

The observed negative association between donation size and social group size is consistent with a relational altruism motive for giving in this type of social setting. Of course, there are other possible explanations for the relationship. In this section, we report a number of further analyses that attempt to rule out competing explanations.

5.1 Within-page variation

The results in Table 3, panel (b) capture the relationship between the fundraiser's social group size and the *average* size of donations to the fundraiser's page. In larger social groups, average donation size tends to be smaller, but we also know that there tend to be more donations. A plausible explanation is that the smaller *average* donation size in larger groups is driven by marginal donors who may give less, e.g. because they have a less close relationship with the fundraiser. By contrast, the relational altruism interpretation would suggest that a larger group size should be associated with smaller donations from *all* donors to a page.

In fact, the evidence strongly supports this: we show in this section that all donations to a fundraising page tend to be smaller in larger social groups.

First, panel (a) of Figure 3 shows different moments of the within-page distribution of (ln) donation amounts, specifically the means of the 10^{th}, 75^{th}, 50^{th}, 75^{th} and 90^{th} percentiles of the (ln) donation distributions, by percentiles of the distribution of the number of Facebook friends. This figure indicates that the negative relationship holds generally for all donations to a page, and not just the mean. Results for a regression specification that includes charity fixed effects and controls for fundraiser characteristics, reported in column (I) of panel (a) in Table 4, confirm the negative relationship for the maximum donation to each page. As before, we report estimated coefficients in the Appendix (Table B.2.) and focus on predicted values for ease of interpretation. Our results show that the size of even the largest donation to each fundraising page is generally smaller in larger social groups. The number of friends associated with the smallest maximum donation size within pages (328 friends), is lower than is the case for the smallest mean donation size but is still above the 60^{th} percentile of the distribution.

Second, panel (b) of Figure 3 plots mean (ln) donation size by order of donations to a page, separately for the top half of the distribution of the number of Facebook friends (fundraisers with larger social groups) and for the bottom half. Mean (ln) donation size is consistently smaller for those with larger social groups across each donation on the page – from the first donation to the

50th. This negative relationship is confirmed, for the first five donations to each page, by regressions, reported in columns (II)–(VI) of Table 4, panel (a). The results confirm that the first, second, third, fourth and fifth donations to each page are all smaller in larger social groups, controlling for charity fixed effects and fundraiser characteristics. In all five cases, the number of friends associated with the smallest donation size lies above the 99th percentile.

Taken together, we find this to be strong evidence that all donations to a page (and not just marginal donations) are smaller in larger social groups, consistently with relational altruism.

5.2 Closer ties in smaller groups

Another possible explanation for the observed negative relationship between donation size and group size is that social ties might be weaker in larger groups (e.g. because fundraisers spend less time investing in their personal relationship with each person). This explanation still points to personal ties playing a role in shaping donation behaviour in social groups, but rationalizes the negative relationship between group size and donation size by invoking a different mechanism. To shed light on this, we exploit the fact that donors provide signals on the fundraising platform that might plausibly capture the closeness of the donor-fundraiser relationship – namely writing a personal message and choosing a particular donor icon.

Donors have the option to write a personal message along with their donation and most do so (only 16% of donations have no personal message). We use the length of the personal message as a proxy measure of the closeness of the relationship between the donor and the fundraiser, based on the fact that donors in larger social groups are both less likely to leave a message and write shorter messages and also that larger donations are associated with longer messages. These relationships are shown in Appendix D. The second way that donors can signal their closeness to the fundraiser is through the "donor icon" that they choose to accompany their donation on the individual's fundraising page. There are twenty different icons (including a cupcake, flower, windmill, heart and smiley) that may plausibly reflect different relationships between the donor and fundraiser and are also associated with significant differences in donation size.

We re-estimate the relationship between group size and donation size and include these proxy measures of closeness between donor and fundraiser as additional controls. The results are reported in Table 4, panel (b). Since this model is estimated on individual-donation-level data, rather than page-level data as before, we first estimate the relationship without these additional controls (column I), and then add controls for icon type (as a set of binary indicators) and the

length of the message, up to 100 words (as a set of binary indicators). The results show that including these additional controls slightly reduces the magnitude of the observed relationship between group size and amounts donated, but it remains negative and significant. Our interpretation of this is that larger social groups are associated with smaller donations even conditioning on proxies for the proximity of the relationship between the fundraiser and donor. This provides some suggestive evidence that the negative association between social group size and donation size cannot just be explained by there being weaker social ties in larger groups.

5.3 Target setting

The majority of pages have a fundraising target–typically £300 (see Table 2). The targets are not binding (unlike the case of crowd-funding, for example) and donations are passed to the charity irrespective of whether or not the target is reached. The targets are also not typically linked to the funding of specific projects; instead the money raised usually provides the charity with general-purpose funds. In this setting, one role of the targets may be to signal how much money the fundraiser wants to raise.

It may be expected that targets affect the relationship between group size and donation size. One possibility is that donors mechanically adjust their donations by dividing the target amount by the expected number of contributors and that this explains all of the observed relationship between group size and donation amounts. To show that this is not the case, Table 4, panel (c), reports results from a regression of donation size on group size separately for pages with and without a target, showing a very similar relationship across the two. This might seem surprising – if the presence of a target acts as a signal to donors that fundraisers care about how much they raise, it should elicit a stronger response among donors who care about the fundraiser. However, the choice of setting a target and the value of the target are both endogenous outcomes and they may both be affected by group size. Target-setting is more likely in larger social groups, which can be seen as resulting from a rational response by fundraisers who anticipate more free-riding, while the target amount is positively correlated with group size. Nevertheless, these results indicate that target-setting and responses to targets cannot explain the relationships that we observe in the data, and that there is a relationship between group size and donation size that is independent of fundraising targets.

5.4 Other omitted variables

To what extent can we treat group size as exogenous and so interpret our findings as causal relationships? The advantage of using the number of Facebook friends at the start of the

fundraising campaign is that it will not be affected by individual fundraising activity. The only exception would be if individuals proactively added to their Facebook friendship networks prior to beginning fundraising. We cannot rule this out. More plausibly, the number of Facebook friends may be correlated with other characteristics of the fundraiser and/or their donors that also affect donations to the page (for example, young people typically have more friends and may also have younger friends who give less). We have shown that our results are robust to controlling for key fundraiser characteristics which proxy for donor characteristics under the assumption of network homophily. Of course, it is possible that there are other unobserved characteristics of the fundraiser or the members of their social group that we cannot control for and that may be correlated with both the number of Facebook friends (social group size) and how much is donated. The literature suggests a number of potential factors that may affect social group size, including popularity (Conti et al., 2013) and brain size (Kanai et al., 2012). Of these candidate factors, popularity would be likely to result in a positive relationship between group size and donation size and, as discussed earlier, may be a possible explanation for the observed positive relationship among the very largest groups.

6 Discussion

This paper has provided novel and robust evidence on the relationship between social group size and private contributions to public goods in a real world setting. We have a strong finding that contributions are smaller in larger social groups, even when we control for characteristics such as age and income that are likely to affect both social group size and contribution size. We can rule out that this is attributable to free riding on (total) public good provision. Instead we argue that the negative correlation is consistent with a relational altruism motivation for giving where donors are altruistic towards fundraisers and fundraisers, in turn, care about the total amount of money they raise.

We do not rule out that other explanations might also be relevant in this context. For example, a number of studies have suggested that donations may be motivated by a desire to signal generosity or wealth (Glazer and Konrad, 1996; Harbaugh, 1998). This is relevant to online fundraising where most donations are public and are visible to other (subsequent) donors as well as to the fundraiser. In this case, however, it seems likely that there would be a positive relationship between social group size and donation size since there would be a higher return to signalling to a larger group, i.e. there would be a race to the top. However, the evidence we have presented clearly suggests that, in the case of individual fundraising, donations are motivated not (just) by the desire

to contribute to the public good, but also by the personal relationship between fundraiser and donor. This indicates that research on the social dimensions of giving should take account of pre-existing structures of social relationships that will affect giving behaviour.

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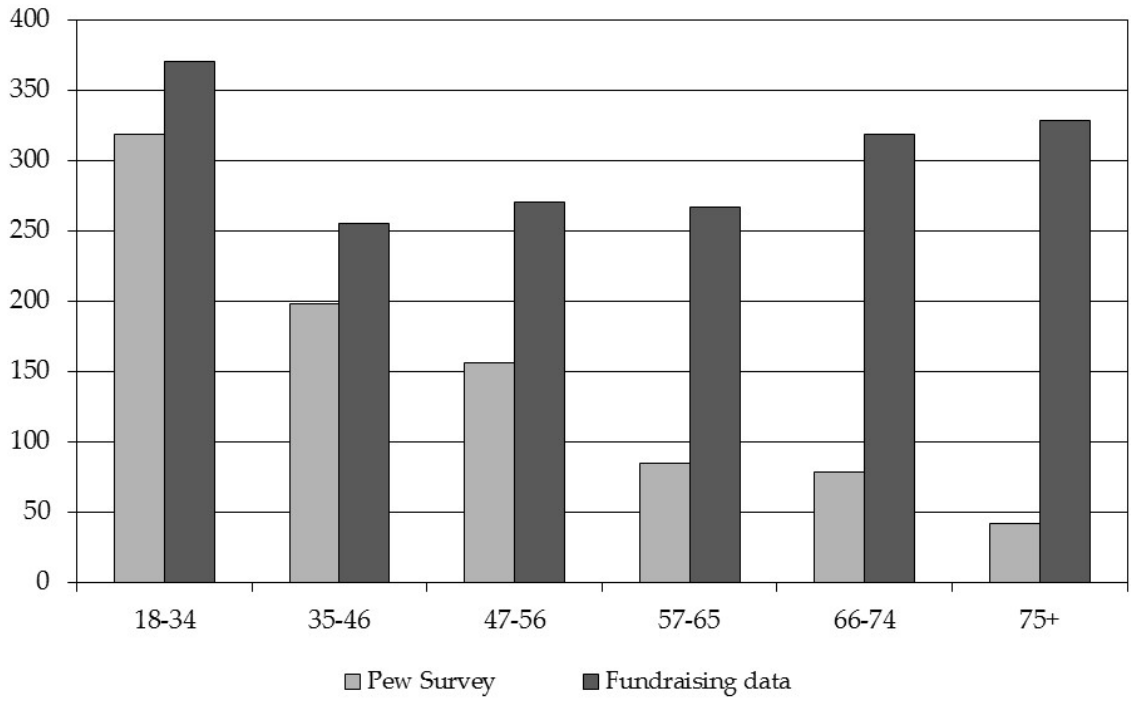
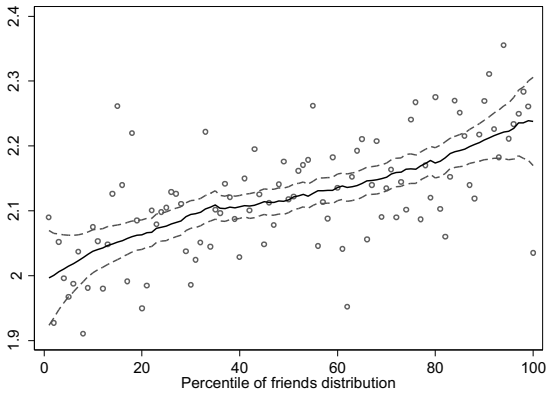
Figure 1: Mean number of Facebook friends (by age)



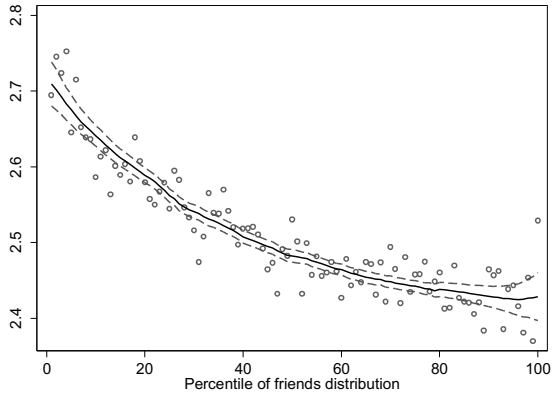
Notes to figure: This figure compares the mean number of Facebook friends, by age, within our fundraising data with nationally representative data from the Pew Survey results. These data are taken from the Pew Internet Project (2006) and are for the US, for which disaggregated numbers by age are available. However, aggregate national averages are similar for the UK and US.

Figure 2: Relationship between social group size and donations

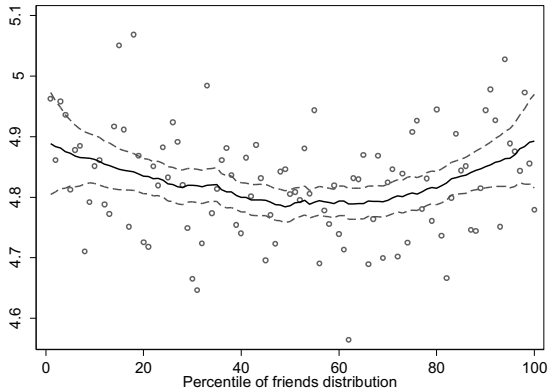
a. ln (number of donations per page)



b. Per page mean ln (donation size)



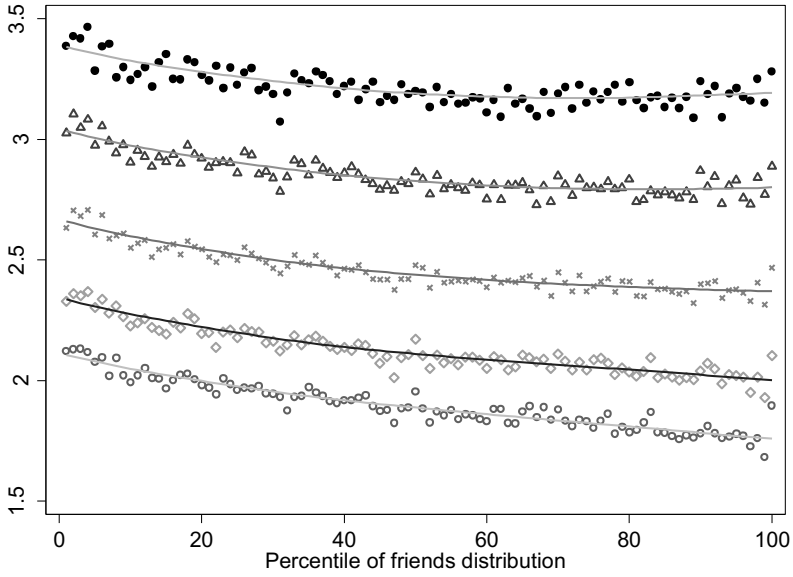
c. ln (total amount raised per page)



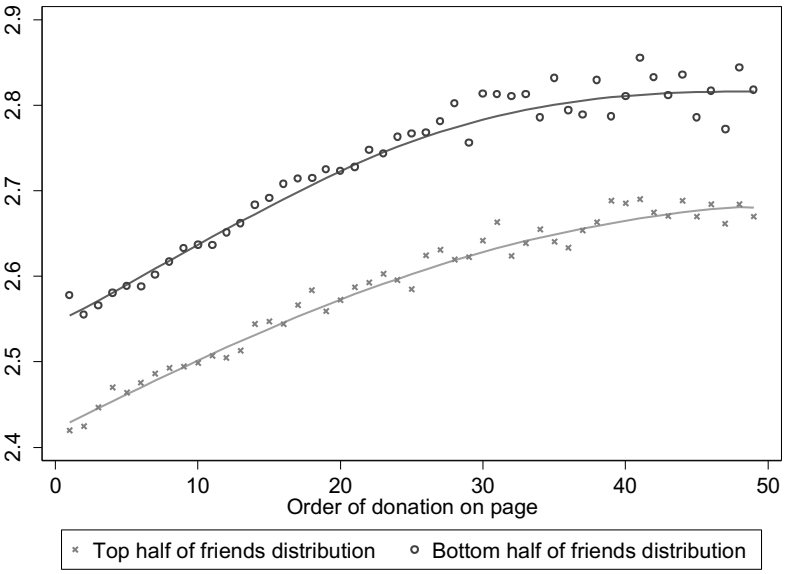
Notes to figure: Information on 531,315 donations to 35,571 fundraising pages. Panel (a), (b) and (c) plot the means of the ln (number of donations per page), the per-page mean ln (donation size) and ln (total amount raised per page), by the percentile of the distribution of the number of Facebook friends (shown by the scatter points), together with smoothed running lines and 95% confidence intervals.

Figure 3: Within-page variation in donations, by group size

a. 10th, 25th 50th, 75th, 90th percentile of within-page distribution



b. Mean of ln(donation size), by order on page



Notes to figure: Information on 531,315 donations to 35,571 fundraising pages. Panel (a) plots means of moments of the within-page distribution of ln(donation size), by the percentile of Facebook friends (shown by the scatter points), together with smoothed running lines (Stata command "lowess", bandwidth = 0.4). Panel (b) plots the mean of ln(donation size), by order of donations on the page, from first (oldest) donation to 50th (most recent) donation, for the bottom half of the friends distribution (= fewer friends) and the top half of the friends distribution (= more friends). Means shown by scatter plots, together with smoothed running lines (Stata command "lowess", bandwidth = 0.4).

Table 1. Which factors are important in deciding how much to give?

	Very important	Somewhat important	Not very important	Not at all important	Not applicable
A sense that money will be used efficiently/ effectively	56.1%	35.0%	6.9%	1.6%	0.6%
The charity's cause or mission	45.1%	44.1%	8.4%	1.9%	0.6%
My income and what I can afford	45.3%	42.3%	9.0%	2.5%	0.8%
A personal connection to the fundraiser	41.5%	43.4%	10.6%	3.5%	1.1%
The fundraiser's reason for fundraising	38.0%	48.0%	10.1%	3.0%	1.0%
The reputation of the charity	32.7%	47.5%	15.3%	3.4%	1.0%
Tax relief (i.e. Gift Aid)	21.7%	34.8%	23.5%	14.3%	5.8%
Type of fundraising event	14.4%	45.8%	29.8%	8.6%	1.5%
The name of the charity	14.1%	39.4%	32.5%	12.1%	1.9%
The total amount the fundraiser is seeking to raise	3.3%	28.0%	38.9%	24.9%	5.1%
How much other people have given to the fundraiser	2.7%	21.6%	39.0%	33.1%	3.7%
An individual amount suggested by the fundraiser	1.4%	15.9%	39.6%	29.9%	13.2%

Note to table: These responses are from a survey of users of an online giving platform carried out in 2012. The relevant sample for this question consisted of 17,989 people who had previously sponsored a fundraiser. For further information see Payne, Scharf and Smith (2012).

Table 2. Sample summary statistics

	Mean	St. dev.	Min.	1st pctile	10th pctile	Med.	90th pctile	99th pctile	Max.
Number of donations per page	15.0	22.0	1	1	2	9	34	91	1501
Total raised online per page	£330.9	£793.8	£2	£5	£20	£133	£751	£3,033	£39,816
Donation size	£22.1	£58.8	£1	£2	£5	£10	£50	£165	£9,000
Proportion of pages with target	0.703								
Target amounts	£207,226	£167m	£0.1	£50	£100	£300	£1,600	£8,000	£2bn
Number of Facebook friends	332.5	322.4	1	24	77	252	654	1,461	5,702
Number of pages	35,571								
Number of donations	531,315								

Table 3. Main regression results

a. Dependent variable = ln (number of donations per page)

	(I)	(II)	(III)	(IV)	(V)
Predicted values at percentiles of no. of friends distribution:					
at 10th percentile	2.044 (0.011)	2.055 (0.012)	2.028 (0.012)	2.028 (0.012)	2.074 (0.012)
at 25th percentile	2.080 (0.008)	2.087 (0.008)	2.068 (0.008)	2.068 (0.008)	2.131 (0.008)
at 50th percentile	2.122 (0.009)	2.123 (0.009)	2.121 (0.009)	2.121 (0.009)	2.209 (0.009)
at 75th percentile	2.160 (0.010)	2.154 (0.010)	2.175 (0.010)	2.174 (0.010)	2.298 (0.010)
at 90th percentile	2.207 (0.015)	2.194 (0.015)	2.231 (0.015)	2.231 (0.015)	2.394 (0.015)
Difference:					
10th – 50th percentile	0.078 (0.014)	0.068 (0.014)	0.093 (0.015)	0.093 (0.015)	0.134 (0.015)
10th – 90th percentile	0.163 (0.018)	0.138 (0.019)	0.204 (0.019)	0.202 (0.019)	0.318 (0.020)
No. friends corresponding to maximum [95% CI]	1,100 [983 – 1,169]	1,094 [940 – 1,175]	1,045 [874 – 1,130]	1,043 [913 – 1,130]	1,226 [1,086 – 1,460]
Charity fixed effects	×	✓	✓	✓	✓
Controls	×	×	✓	✓	✓
Gender interacted controls	×	×	×	✓	✓
Event fixed effects	×	×	×	×	✓
N	35,571	35,571	34,868	34,868	17,479

b. Dependent variable = per page mean ln (donation size)

	(I)	(II)	(III)	(IV)	(V)
Predicted values at percentiles of no. of friends distribution:					
at 10th percentile	2.633 (0.006)	2.636 (0.006)	2.605 (0.006)	2.606 (0.006)	2.603 (0.006)
at 25th percentile	2.561 (0.004)	2.567 (0.004)	2.551 (0.004)	2.552 (0.004)	2.551 (0.004)
at 50th percentile	2.482 (0.004)	2.489 (0.004)	2.489 (0.004)	2.490 (0.004)	2.489 (0.004)
at 75th percentile	2.439 (0.005)	2.437 (0.005)	2.449 (0.005)	2.449 (0.005)	2.449 (0.005)
at 90th percentile	2.438 (0.007)	2.419 (0.007)	2.434 (0.007)	2.432 (0.007)	2.436 (0.007)
Difference:					
10th – 50th percentile	-0.151 (0.007)	-0.148 (0.007)	-0.116 (0.007)	-0.116 (0.007)	-0.114 (0.007)
10th – 90th percentile	-0.195 (0.009)	-0.217 (0.009)	-0.171 (0.009)	-0.173 (0.009)	-0.167 (0.009)
No. friends corresponding to minimum [95% CI]	1,189 [1,077 – 1,277]	1,159 [1,074 – 1,237]	1,178 [1,099 – 1,291]	1,178 [1,097 – 1,230]	1,290 [1,157 – 1,461]
Charity fixed effects	×	✓	✓	✓	✓
Controls	×	×	✓	✓	✓
Gender interacted controls	×	×	×	✓	✓
Event fixed effects	×	×	×	×	✓
N	35,571	35,571	34,868	34,868	17,479

c. Dependent variable = ln (total amount raised per page)

	(I)	(II)	(III)	(IV)	(V)
Predicted values at percentiles of no. of friends distribution:					
at 10th percentile	4.860 (0.015)	4.881 (0.014)	4.818 (0.014)	4.819 (0.014)	4.871 (0.014)
at 25th percentile	4.826 (0.010)	4.844 (0.010)	4.807 (0.010)	4.808 (0.010)	4.878 (0.010)
at 50th percentile	4.793 (0.011)	4.803 (0.011)	4.800 (0.011)	4.802 (0.011)	4.898 (0.011)
at 75th percentile	4.796 (0.012)	4.786 (0.012)	4.786 (0.012)	4.820 (0.012)	4.950 (0.012)
at 90th percentile	4.856 (0.019)	4.814 (0.019)	4.815 (0.019)	4.854 (0.018)	5.042 (0.018)
Difference:					
10th – 50th percentile	-0.066 (0.018)	-0.078 (0.018)	-0.017 (0.018)	-0.016 (0.018)	0.026 (0.017)
10th – 90th percentile	-0.003 (0.023)	-0.066 (0.023)	0.050 (0.024)	0.046 (0.024)	0.170 (0.023)
Charity fixed effects	×	✓	✓	✓	✓
Controls	×	×	✓	✓	✓
Gender interacted controls	×	×	×	✓	✓
Event fixed effects	×	×	×	×	✓
N	35,571	35,571	34,868	34,868	17,479

Notes to table:
Standard errors in parentheses.
Predictions are from regressing the outcome variable on a quartic in the number of Facebook friends (regression coefficients are shown in Appendix B, Table B.1.). The distribution of Facebook friends has been winsorized at the upper limit of the 99th percentile (= 1,461 friends). Predicted outcomes are evaluated at mean values of all other variables. Where specified, controls are male fundraiser (0/1), fundraiser age (18-35, 36-45, 46-55, 56-65, 66-75, 76+), fundraiser household income (<£10K, £10-15K, £15-20K, £20-25K, £25-30K, £30-40K, £40-50K, £40-50K, £50-60K, £60-75K, £75K), event type (anniversaries, appeals, memorials, cycling, parachuting, running, swimming, walking, triathlon, other), year and month.
Gender interacted controls allow effects of (banded) age and income to vary with fundraiser gender. Event fixed effects are for events with two or more fundraisers.
The #friends corresponding to the max/min is evaluated using the predicted outcomes. Confidence intervals are estimated using bootstrapped sampling with 1,000 replications. We report the 2.5th and 97.5th percentiles of the distribution.

Table 4: Alternative specifications

(a) Within-page variation of individual donations

Dependent variable = ln (donation size)

	Maximum Donation	By order of donation on page				
		First	Second	Third	Fourth	Fifth
Predicted values at percentiles of no. of friends distribution:						
at 10th percentile	3.557 (0.011)	2.615 (0.009)	2.586 (0.009)	2.593 (0.010)	2.596 (0.010)	2.614 (0.010)
at 25th percentile	3.519 (0.008)	2.550 (0.006)	2.528 (0.007)	2.542 (0.007)	2.561 (0.007)	2.563 (0.007)
at 50th percentile	3.485 (0.008)	2.475 (0.007)	2.462 (0.007)	2.483 (0.007)	2.512 (0.007)	2.505 (0.008)
at 75th percentile	3.486 (0.009)	2.427 (0.007)	2.421 (0.008)	2.443 (0.008)	2.464 (0.008)	2.465 (0.009)
at 90th percentile	3.521 (0.014)	2.406 (0.012)	2.411 (0.012)	2.426 (0.012)	2.434 (0.013)	2.442 (0.014)
Difference:						
10th – 50th percentile	-0.072 (0.014)	-0.140 (0.011)	-0.124 (0.012)	-0.110 (0.012)	-0.084 (0.013)	-0.110 (0.013)
10th – 90th percentile	-0.035 (0.018)	-0.209 (0.015)	-0.175 (0.016)	-0.166 (0.016)	-0.162 (0.017)	-0.172 (0.018)
No. friends corresponding to minimum [95% CI]	328 [285 – 1,461]	1,177 [1,064 – 1,267]	1,237 [984 – 1,460]	1,177 [881 – 1,418]	1,049 [674 – 1,461]	1,194 [1,068 – 1,368]
Charity fixed effects	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
N	34,868	34,868	29,979	27,548	25,350	23,452

(b) Including proxies for personal relationship

Dependent variable = per page mean ln (donation size)

	(I)	(II)	(III)	(IV)
Predicted values at percentiles of no. of friends distribution:				
at 10th percentile	2.673 (0.005)	2.658 (0.005)	2.669 (0.005)	2.654 (0.005)
at 25th percentile	2.633 (0.004)	2.621 (0.004)	2.630 (0.004)	2.619 (0.003)
at 50th percentile	2.584 (0.004)	2.576 (0.004)	2.584 (0.004)	2.557 (0.004)
at 75th percentile	2.548 (0.005)	2.543 (0.005)	2.550 (0.005)	2.545 (0.005)
at 90th percentile	2.526 (0.009)	2.528 (0.008)	2.530 (0.008)	2.531 (0.008)
Difference:				
10th – 50th percentile	-0.088 (0.008)	-0.081 (0.007)	-0.085 (0.007)	-0.078 (0.007)
10th – 90th percentile	-0.146 (0.012)	-0.130 (0.011)	-0.139 (0.012)	-0.124 (0.010)
No. friends corresponding to minimum [95% CI]	1,313 [1,246 – 1,444]	1,322 [1,242 – 1,460]	1,311 [1,250 – 1,450]	1,334 [1,243 – 1,460]
Charity fixed effects	✓	✓	✓	✓
Controls	✓	✓	✓	✓
Donor icons (indicators	×	✓	×	✓
Message length (indicators)	×	×	✓	✓
N	519,260	519,260	519,260	519,260

(c) Pages with and without target

Dependent variable = per page mean ln (donation size)

	Target	No target
Predicted values at percentiles of no. of friends distribution:		
at 10th percentile	2.612 (0.007)	2.588 (0.011)
at 25th percentile	2.562 (0.005)	2.526 (0.008)
at 50th percentile	2.504 (0.005)	2.455 (0.008)
at 75th percentile	2.466 (0.006)	2.408 (0.009)
at 90th percentile	2.442 (0.009)	2.406 (0.014)
Difference:		
10th – 50th percentile	-0.108 (0.008)	-0.133 (0.014)
10th – 90th percentile	-0.169 (0.012)	-0.181 (0.018)
No. friends corresponding to minimum [95% CI]	1,153 [1,059 – 1,322]	1,362 [475 – 1,461]
Charity fixed effects	✓	✓
Controls	✓	✓
N	25,015	10,556

Notes to table: See notes to Table 3. In panel (a) different sample sizes refer to the fact that the second donation on the page is only defined for pages with two or more donations, the third donation on the page for pages with three or more donations and so on. For the results in panel (b), controls additionally include indicators for donor gender (Male, Female, Missing). Message length refers to the length (in words) of the personal message left by the donor on the fundraising page. Donor icon refers to the particular icon chosen by the donor on the fundraising page. Message length and donor icon are proxies for the personal relationship between the donor and fundraiser. As shown in Appendix D, length of donor message is correlated with both donation size (positively) and group size (negatively).

Online Appendices

Appendix A. Contributions and group size

Case 1. Group = all potential contributors to a charitable good

Suppose that all individuals each have an exogenously given income y, and that they each consume a private good and a pure public good in amounts respectively equal to x and G, with G being funded with individual private contributions, v. Preferences are identical across individuals and are represented by an increasing, strictly concave utility function, $U(x, G)$. As is standard in this literature, assume that both the private good and the public good are strictly normal goods, that the public good and private good are measured in the same units, and that the marginal rate of transformation between the public good and the private good in production is unity. The individually optimal contribution by donor $i \in \{1, \dots, N\}$ maximizes $U\left(y - v^i,\ v^i + \sum_{j \neq i} v^i\right)$, where $\sum_{j \neq i} v^i$ represents donations by other individuals. This yields the interior first-order condition $-U_x\left(y - v^i,\ v^i + \sum_{j \neq i} v^i\right) + U_G\left(y - v^i,\ v^i + \sum_{j \neq i} v^i\right) = 0$; which, in a symmetric equilibrium with $v^i = v^*$ for all $i \in \{1, \dots, N\}$ and $G^* \equiv Nv^*$, can be re-written as

$$-U_x(y - v^*,\ Nv^*) + U_G(y - v^*,\ Nv^*) = 0. \tag{2}$$

Note that the level of provision in this equilibrium is inefficient – the optimal provision level is characterised by the Samuelson condition, $N\,MRS_{Gx} = 1$, while (1) gives $MRS_{Gx} = 1$; since MRS_{Gx} is decreasing in x/G, this implies under-provision.

Totally differentiating (2) with respect to v^* and N, we obtain

$$\frac{dv^*}{dN} = \frac{\left(U_{xG}(y - v^*,\ Nv^*) - U_{GG}(y - v^*,\ Nv^*)\right)\ v^*}{U_{xx}(y - v^*,\ Nv^*) - U_{Gx}(y - v^*,\ Nv^*) - N\left(U_{xG}(y - v^*,\ Nv^*) - U_{GG}(y - v^*,\ Nv^*)\right)}. \tag{3}$$

The denominator of the ratio on the right-hand side of the above is negative by concavity, and the numerator is positive, making dv^*/dN negative. This basic framework thus predicts that as N becomes large, individual contributions, $v^*(N) = G^*(N)/N$, go to zero; that is, there is free-riding. The effect of an increase in N on the total volume of contributions is

$$\frac{dG^*}{dN} = v^* + N\frac{dG^*}{dN} \qquad \frac{dG^*}{dN} = v^* + N\frac{dG^*}{dN}. \tag{4}$$

This is negative if contributions are sufficiently elastic with respect to N, i.e. if dv^*/dN is sufficiently large in absolute value.

Case 2. Group = all potential contributors to a fundraising page

Let fundraising success within the social group be measured by $\sum_i^{N_F} v_F^i \equiv V_F$; total donations are $G = V_F + G_{-F}$ (with G_{-F} representing donations by individuals outside the group). We can write the relational-altruism augmented objective of individual Facebook friends as $U(x, G, V_F)$, with $U(.)$ again strictly concave in its arguments. The first-order condition for an optimal choice of donation, in conjunction with the symmetric equilibrium condition $v_F^i = v_F^*$, gives

$$\begin{aligned} -U_x(y - v_F^*,\ G_{-F} + N_F v_F^*,\ N_F v_F^*) + U_G(y - v_F^*,\ G_{-F} + N_F v_F^*,\ N_F v_F^*) \\ + U_{V_F}(y - v_F^*,\ G_{-F} + N_F v_F^*,\ N_F v_F^*) = 0. \end{aligned} \tag{5}$$

Here the level of V_F depends only on N_F and not on N, whereas provision of G depends on both N_F and N. In this specification, even though there is still no reason to expect that the total number of contributors to G should be related to the number of Facebook friends, the total number of contributors to V_F will be related to the number of Facebook friends, and thus, through this channel, we can expect a negative correlation between v_F and N_F, and, possibly, a negative correlation between V_F and N_F.[12]

[12] This can be derived by total differentiation of (5) with respect to v_F^* and N_F, as we did earlier for the basic model.

Appendix B. Estimated coefficients

Table B.1. Main regression results (coefficients corresponding to Table 3)

	(I)	(II)	(III)	(IV)	(V)
ln (number of donations per page)					
Friends/1000	0.983*	0.873*	0.999*	1.015*	1.287*
	(0.280)	*(0.287)*	*(0.283)*	*(0.283)*	*(0.294)*
(Friends/1000)^2	-2.286+	-2.087+	-1.960+	-2.016+	-2.101+
	(0.908)	*(0.930)*	*(0.912)*	*(0.912)*	*(0.957)*
(Friends/1000)^3	2.725*	2.505+	2.234+	2.296+	2.209+
	(1.057)	*(1.084)*	*(1.060)*	*(1.060)*	*(1.123)*
(Friends/1000)^4	-1.098*	-1.012+	-0.925+	-0.948+	-0.827+
	(0.389)	*(0.400)*	*(0.390)*	*(0.390)*	*(0.418)*
per page mean ln (donation size)					
Friends/1000	-1.904*	-1.778*	-1.426*	-1.405*	-1.369*
	(0.139)	*(0.140)*	*(0.140)*	*(0.140)*	*(0.129)*
(Friends/1000)^2	4.094*	3.673*	3.015*	2.931*	2.777*
	(0.450)	*(0.455)*	*(0.452)*	*(0.452)*	*(0.420)*
(Friends/1000)^3	-3.722*	-3.373*	-2.834*	-2.735*	-2.463*
	(0.524)	*(0.531)*	*(0.525)*	*(0.525)*	*(0.492)*
(Friends/1000)^4	1.183*	1.101*	0.936*	0.900*	0.757*
	(0.193)	*(0.196)*	*(0.193)*	*(0.193)*	*(0.183)*
ln (total amount raised per page)					
Friends/1000	-0.890+	-0.891+	-0.377	-0.331	0.011
	(0.358)	*(0.359)*	*(0.352)*	*(0.351)*	*(0.345)*
(Friends/1000)^2	1.788	1.577	0.976	0.809	0.415
	(1.161)	*(1.166)*	*(1.134)*	*(1.133)*	*(1.124)*
(Friends/1000)^3	-0.878	-0.808	-0.484	-0.295	0.119
	(1.351)	*(1.359)*	*(1.318)*	*(1.317)*	*(1.319)*
(Friends/1000)^4	0.008	0.051	-0.046	-0.114	-0.228
	(0.498)	*(0.501)*	*(0.485)*	*(0.485)*	*(0.490)*
Charity fixed effects	×	✓	✓	✓	✓
Controls	×	×	✓	✓	✓
Gender interactions	×	×	×	✓	✓
Event fixed effects	×	×	×	×	✓
N	35,571	35,571	34,868	34,868	17,479

Notes to table: The distribution of Facebook friends has been winsorized at the 99th percentile (=1461 friends). Controls are male fundraiser (0/1), fundraiser age (18-35, 36-45, 46-55, 56-65, 66-75, 76+), fundraiser household income (<£10K, £10-15K, £15-20K, £20-25K, £25-30K, £30-40K, £40-50K, £40-50K, £50-60K, £60-75K, £75K), event type (anniversaries, appeals, memorials, cycling, parachuting, running, swimming, walking, triathlon, other), year and month. Gender interactions allow effects of (banded) age and income to vary with fundraiser gender. Event fixed effects are for events with 2+ fundraisers. Standard errors in parentheses: $^+$ $p<0.05$ * $p<0.01$.

Table B.2. Alternative specifications (coefficients corresponding to Table 4)

(a) Within-page variation of individual donations

Dependent variable = ln (donation size)

	Maximum	By order of donation on page				
	Donation	First	Second	Third	Fourth	Fifth
Friends/1000	-1.119*	-1.738*	-1.543*	-1.362*	-0.771*	-1.388*
	(0.264)	(0.224)	(0.232)	(0.238)	(0.251)	(0.263)
(Friends/1000)^2	2.766*	3.725*	3.228*	2.853*	1.042	2.986*
	(0.852)	(0.721)	(0.746)	(0.766)	(0.809)	(0.844)
(Friends/1000)^3	-2.476+	-3.572*	-2.926*	-2.682*	-0.693	-2.930*
	(0.990)	(0.838)	(0.867)	(0.890)	(0.940)	(0.980)
(Friends/1000)^4	0.739+	1.198*	0.923*	0.888*	0.189	0.999*
	(0.365)	(0.309)	(0.320)	(0.328)	(0.347)	(0.361)
Charity fixed effects	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
N	34,868	34,868	29,979	27,548	25,350	23,452

(b) Including proxies for personal relationship

Dependent variable = per page mean ln (donation size)

	(I)	(II)	(III)	(IV)
Friends/1000	-1.025*	-0.883+	-0.986*	-0.840*
	(0.357)	*(0.367)*	*(0.335)*	*(0.354)*
(Friends/1000)^2	1.564	1.240	1.544	1.211
	(1.061)	*(1.073)*	*(0.991)*	*(1.031)*
(Friends/1000)^3	-1.197	-0.837	-1.211	-0.845
	(1.169)	(1.170)	(1.093)	(1.121)
(Friends/1000)^4	0.354	0.224	0.364	0.231
	(0.416)	*(0.413)*	*(0.390)*	*(0.395)*
Charity fixed effects	✓	✓	✓	✓
Controls	✓	✓	✓	✓
Donor icons (indicators	×	✓	×	✓
Message length (indicators)	×	×	✓	✓
N	519,260	519,260	519,260	519,260

(c) Pages with and without target

Dependent variable = per page mean ln (donation size)

	Target	No target
Friends/1000	-1.681*	-2.010*
	(0.168)	*(0.272)*
(Friends/1000)^2	3.465*	4.121*
	(0.540)	*(0.904)*
(Friends/1000)^3	-3.290*	-3.437*
	(0.625)	(1.074)
(Friends/1000)^4	1.118*	0.985+
	(0.229)	(0.401)
Charity fixed effects	✓	✓
Controls	✓	✓
N	25,015	10,556

Notes to table: Controls as in Table B.1, plus indicators for donor gender (Male, Female, Missing). Message length refers to the length (in words) of the personal message left by the donor on the fundraising page. Donor icon refers to the particular icon chosen by the donor on the fundraising page. Message length and donor icon are proxies for the personal relationship between the donor and fundraiser. Standard errors in parentheses: + $p<0.05$ * $p<0.01$. In panel (b) standard errors are clustered by fundraising page.

Appendix C. Regressions within sub-groups

By fundraiser gender

	ln (no. donations/page)		mean ln (don. size)/page	
	Male	Female	Male	Female
Estimated coefficients:				
Friends/1000	1.559*	0.561	-2.008*	-1.473*
	(0.418)	*(0.415)*	*(0.205)*	*(0.201)*
(Friends/1000)^2	-4.393*	-0.863	4.348*	2.784*
	(1.372)	*(1.340)*	*(0.672)*	*(0.649)*
(Friends/1000)^3	5.190*	0.868	-3.989*	-2.551*
	(1.618)	*(1.551)*	*(0.793)*	*(0.751)*
(Friends/1000)^4	-2.026*	-0.354	1.250*	0.870*
	(0.603)	*(0.569)*	*(0.295)*	*(0.275)*
Predicted values at percentiles of no. of friends distribution:				
at 10th percentile	2.173 (0.017)	1.943 (0.016)	2.681 (0.008)	2.584 (0.008)
at 25th percentile	2.199 (0.012)	1.989 (0.011)	2.619 (0.006)	2.514 (0.006)
at 50th percentile	2.236 (0.013)	2.031 (0.012)	2.541 (0.006)	2.435 (0.006)
at 75th percentile	2.277 (0.015)	2.045 (0.013)	2.481 (0.007)	2.388 (0.006)
at 90th percentile	2.316 (0.022)	2.060 (0.021)	2.445 (0.011)	2.381 (0.010)
Difference:				
10th – 50th percentile	0.063 (0.022)	0.087 (0.020)	-0.140 (0.011)	-0.149 (0.010)
10th – 90th percentile	0.143 (0.028)	0.116 (0.026)	-0.236 (0.014)	-0.203 (0.013)
No. friends corresponding to maximum/minimum [95% CI]	1,028 [656 – 1,461]	1,086 [899 – 1,168]	1,082 [814 – 1,183]	1,279 [1,188 – 1,461]
Charity fixed effects	✓	✓	✓	✓
N	18,083	16,785	18,083	16,785

Note to table: Standard errors in parentheses: $^+$ $p<0.05$ * $p<0.01$.

By fundraiser age

	18-35	36-45	46-55	56-65	66-75
ln (no. donations/page)					
Estimated coefficients:					
Friends/1000	2.253*	1.348*	1.629+	0.277	-4.479
	(0.508)	*(0.570)*	*(0.769)*	*(1.369)*	*(2.422)*
(Friends/1000)^2	-5.001*	-3.837	-6.720+	1.313	16.03
	(1.522)	*(1.962)*	*(2.637)*	*(4.837)*	*(8.262)*
(Friends/1000)^3	5.091*	4.335	8.827*	-2.881	-18.66
	(1.693)	*(2.377)*	*(3.164)*	*(5.847)*	*(9.971)*
(Friends/1000)^4	-1.818*	-1.583	-3.399*	1.337	6.591
	(0.608)	*(0.897)*	*(1.182)*	*(2.190)*	*(3.813)*
Predicted values at percentiles of no. of friends distribution:					
at 10th percentile	1.998 (0.016)	2.078 (0.021)	2.080 (0.032)	2.026 (0.059)	2.110 (0.104)
at 25th percentile	2.074 (0.012)	2.112 (0.015)	2.112 (0.023)	2.040 (0.042)	1.971 (0.070)
at 50th percentile	2.145 (0.012)	2.150 (0.016)	2.134 (0.026)	2.092 (0.047)	1.934 (0.077)
at 75th percentile	2.189 (0.015)	2.167 (0.018)	2.072 (0.029)	2.176 (0.053)	2.096 (0.085)
at 90th percentile	2.230 (0.021)	2.160 (0.030)	2.044 (0.046)	2.202 (0.087)	2.233 (0.141)
Difference:					
10th – 50th percentile	0.148 (0.020)	0.072 (0.026)	0.054 (0.042)	0.066 (0.081)	-0.176 (0.141)
10th – 90th percentile	0.233 (0.027)	0.082 (0.037)	-0.036 (0.055)	0.176 (0.104)	0.123 (0.179)
No. friends corresponding to maximum [95% CI]	1,118 [446 – 1,461]	1,179 [1,055 – 1,231]	1,216 [294 – 1,461]	1,117 [407 – 1,303]	1,118 [1,090 – 1,325]
Charity fixed effects	✓	✓	✓	✓	✓
mean ln (don. size)/page					
Estimated coefficients:					
Friends/1000	-1.298*	-0.944*	-2.197*	-1.391	-3.906*
	(0.285)	(0.312)	(0.423)	(0.759)	(1.408)
(Friends/1000)^2	2.777*	1.185	5.337*	1.195	11.63+
	(0.853)	(1.075)	(1.449)	(2.682)	(4.803)
(Friends/1000)^3	-2.500*	-0.444	-5.691*	-0.104	-12.47+
	(0.949)	(1.303)	(1.739)	(3.242)	(5.796)
(Friends/1000)^4	0.772+	0.004	2.106*	-0.095	4.178
	(0.341)	(0.492)	(0.650)	(1.214)	(2.216)
Predicted values at percentiles of no. of friends distribution:					
at 10th percentile	2.532 (0.008)	2.639 (0.010)	2.714 (0.015)	2.749 (0.029)	2.664 (0.054)
at 25th percentile	2.484 (0.006)	2.601 (0.007)	2.649 (0.011)	2.716 (0.020)	2.522 (0.036)
at 50th percentile	2.437 (0.006)	2.543 (0.007)	2.550 (0.012)	2.616 (0.023)	2.433 (0.039)
at 75th percentile	2.409 (0.007)	2.484 (0.008)	2.482 (0.014)	2.460 (0.026)	2.479 (0.044)
at 90th percentile	2.398 (0.010)	2.443 (0.014)	2.447 (0.022)	2.371 (0.042)	2.530 (0.073)
Difference:					
10th – 50th percentile	-0.095 (0.010)	-0.096 (0.026)	-0.163 (0.020)	-0.133 (0.039)	-0.231 (0.073)
10th – 90th percentile	-0.133 (0.013)	-0.196 (0.037)	-0.267 (0.026)	-0.379 (0.051)	-0.135 (0.092)
No. friends corresponding to minimum [95% CI]	1,310 [458 – 1,461]	1,447 [575 – 1,461]	1,104 [386 – 1,461]	655 [768 – 1,461]	1,118 [1,041 – 1,165]
Charity fixed effects	✓	✓	✓	✓	✓
N	16,371	10,530	5,052	1,621	659

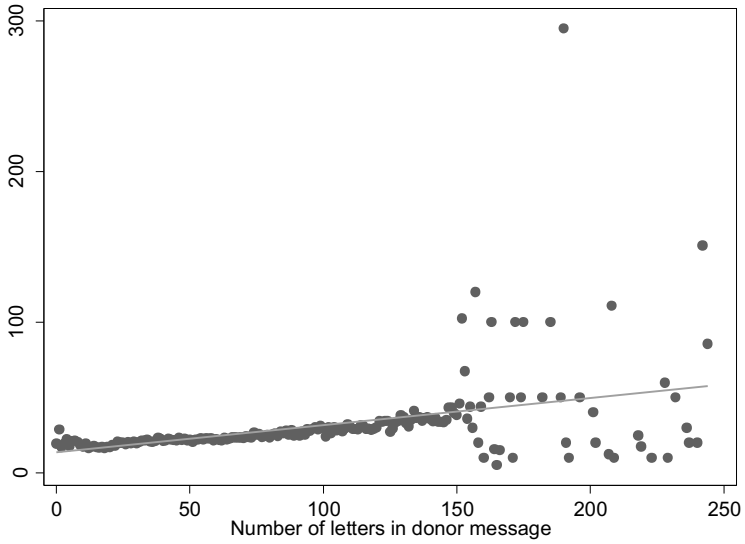
By event type

	Anniversary	Cycling	Parachuting	Running	Swimming	Walking	Triathlon	Other
ln (no. donations/page)								
Estimated coefficients:								
Friends/1000	0.367	0.302	-1.519	1.284*	1.323	1.548+	-0.162	-0.254
	(1.549)	(0.845)	(2.493)	(0.493)	(2.240)	(0.701)	(3.443)	(0.622)
(Friends/1000)^2	-2.262	0.490	2.674	-3.244+	-1.848	-3.595	1.924	0.583
	(4.934)	(2.971)	(7.438)	(1.592)	(7.700)	(2.392)	(12.22)	(1.946)
(Friends/1000)^3	4.247	-0.482	-1.158	3.547	-0.865	3.465	-3.945	0.0899
	(5.639)	(3.675)	(8.264)	(1.860)	(9.527)	(2.883)	(15.71)	(2.204)
(Friends/1000)^4	-2.044	-0.0480	-0.0569	-1.246	1.334	-1.102	1.738	-0.320
	(2.045)	(1.420)	(2.982)	(0.690)	(3.733)	(1.084)	(6.437)	(0.795)
Predictions:								
at 10th percentile	2.215 (0.064)	1.986 (0.033)	2.074 (0.089)	2.155 (0.019)	1.951 (0.084)	1.694 (0.027)	2.534 (0.112)	2.153 (0.025)
at 25th percentile	2.217 (0.043)	2.004 (0.023)	2.009 (0.064)	2.198 (0.013)	1.998 (0.058)	1.743 (0.019)	2.540 (0.079)	2.145 (0.018)
at 50th percentile	2.206 (0.047)	2.043 (0.025)	1.956 (0.064)	2.240 (0.014)	2.065 (0.062)	1.803 (0.021)	2.558 (0.087)	2.146 (0.019)
at 75th percentile	2.210 (0.053)	2.107 (0.027)	1.978 (0.079)	2.261 (0.016)	2.086 (0.068)	1.840 (0.022)	2.573 (0.092)	2.178 (0.022)
at 90th percentile	2.306 (0.082)	2.193 (0.044)	2.079 (0.108)	2.282 (0.024)	2.010 (0.108)	1.844 (0.036)	2.481 (0.159)	2.245 (0.033)
Difference:								
10th – 50th percentile	-0.009 (0.084)	0.058 (0.042)	-0.117 (0.118)	0.084 (0.023)	0.114 (0.108)	0.110 (0.034)	0.024 (0.151)	-0.007 (0.032)
10th – 90th percentile	0.091 (0.104)	0.207 (0.055)	0.005 (0.146)	0.127 (0.030)	0.058 (0.139)	0.150 (0.046)	-0.053 (0.199)	0.092 (0.041)
No. friends corresponding to maximum [95% CI]	1,087 [1 – 1,233]	835 [573 – 1,461]	1,051 [1 – 1,461]	1,269 [1,117 – 1,461]	1,461 [250 – 1,461]	1331 [500 – 1,461]	367 [1 – 1,461]	950 [1 – 1,116]
Charity fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
mean ln (don. size)/page								
Estimated coefficients:								
Friends/1000	-2.067+	-0.263	-2.658+	-1.787*	-0.368	-1.917*	1.346	-2.506*
	(0.949)	(0.456)	(1.338)	(0.254)	(1.060)	(0.416)	(1.817)	(0.378)
(Friends/1000)^2	3.421	-0.990	6.524	3.930*	0.160	4.074*	-7.841	5.840*
	(3.023)	(1.601)	(3.991)	(0.820)	(3.643)	(1.418)	(6.449)	(1.182)
(Friends/1000)^3	-1.938	1.960	-6.860	-3.599*	-0.112	-3.499+	12.34	-5.870*
	(3.454)	(1.981)	(4.434)	(0.957)	(4.507)	(1.709)	(8.287)	(1.339)
(Friends/1000)^4	0.281	-0.910	2.429	1.140*	0.141	1.034	-5.428	2.040*
	(1.253)	(0.766)	(1.600)	(0.355)	(1.766)	(0.643)	(3.397)	(0.483)
Predictions:								
at 10th percentile	2.842 (0.034)	2.660 (0.016)	2.608 (0.042)	2.622 (0.008)	2.530 (0.035)	2.555 (0.014)	2.742 (0.049)	2.657 (0.013)
at 25th percentile	2.721 (0.023)	2.637 (0.011)	2.506 (0.030)	2.560 (0.006)	2.511 (0.024)	2.488 (0.010)	2.742 (0.035)	2.558 (0.010)
at 50th percentile	2.593 (0.025)	2.589 (0.012)	2.427 (0.030)	2.493 (0.006)	2.469 (0.026)	2.400 (0.011)	2.701 (0.038)	2.467 (0.010)
at 75th percentile	2.525 (0.028)	2.523 (0.013)	2.411 (0.037)	2.456 (0.007)	2.411 (0.028)	2.337 (0.011)	2.617 (0.041)	2.420 (0.012)
at 90th percentile	2.551 (0.044)	2.458 (0.021)	2.367 (0.050)	2.448 (0.011)	2.368 (0.045)	2.323 (0.019)	2.668 (0.070)	2.381 (0.017)
Difference:								
10th – 50th percentile	-0.249 (0.045)	-0.070 (0.020)	-0.181 (0.054)	-0.130 (0.011)	-0.061 (0.045)	-0.154 (0.018)	-0.041 (0.067)	-0.190 (0.017)
10th – 90th percentile	-0.291 (0.056)	-0.202 (0.027)	-0.241 (0.068)	-0.175 (0.013)	-0.161 (0.058)	-0.231 (0.024)	-0.073 (0.088)	-0.275 (0.022)
No. friends corresponding to minimum [95% CI]	1,461 [424 – 1,461]	1,461 [761 – 1,461]	1,182 [829 – 1,461]	1,239 [1144 – 1,438]	668 [440 – 1,461]	1,316 [512 – 1,461]	1,461 [221 – 1,461]	1,120 [1,012 – 1,189]
Charity fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
N	1,881	3,710	818	13,145	622	5,410	444	8,838

Note to table: Standard errors in parentheses: $^+$ $p<0.05$ * $p<0.01$.

Appendix D. Proxies for personal relationship

Positive relationship between length of personal message (in words) and donation size



Negative relationship between length of personal message (in words) and group size