

THE IMPACT OF CHARITY EFFORT AND TRANSPARENCY ON  
THE PRICE ELASTICITY OF CHARITABLE GIVING

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THE IMPACT OF CHARITY EFFORT AND TRANSPARENCY ON  
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## DECLARATION OF ORIGINALITY

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## ABSTRACT

### The Impact of Charity Effort and Transparency on the Price Elasticity of Charitable Giving

Empirical studies suggest that donors are not very responsive to changes in tax/subsidy policies. We construct a framework in which donors imperfectly observe charity's effort to provide charitable goods/services. Effort is costly for charity. Donors' contributions and charity effort materialize as a charitable good. Government can manipulate "the price of giving" by offering tax deductions/subsidies. We show that when price of giving is high enough, charitable giving is more inelastic when charity effort can only be observed with noise. We also show that for lower prices of charitable giving, equilibrium levels of charity effort and aggregate contributions under imperfect information are lower than the corresponding perfect information levels. Conversely for higher prices, imperfect information levels are higher than the perfect information levels.

## ÖZET

### Hayır Kurumlarının Gayret ve Şeffaflığının Bağışların Fiyat Elastikiyetine Etkisi

Ampirik çalışmalar bağışçıların bağış miktarlarını vergi/teşvik politikalarına göre fazla deęiřtirmediklerini göstermektedir. Bu çalışmada bağışçıların, hayır kurumunun hizmet sunma yolundaki masraflı olduęu varsayılan gayretlerini kesin bir şekilde gözlemleyemedięi bir teorik çerçeve oluşturduk. Bu modelde bağışçıların katkıları ve hayır kurumunun gayretleri birleşerek hayır hizmetini oluşturmaktadır. Devlet, “bağış yapmanın bedeli”ni vergi kesintileri ve çeşitli teşviklerle belirleyebilmektedir. Bu modeli kullanarak, eęer bağış yapmanın bedeli yeterince yüksek ise, hayır kurumunun gayretinin net bir şekilde gözlemlenememesinin bağışların fiyat elastikiyetini düşürdüęünü gösterdik. Buna ek olarak, bağış yapmanın bedeli düşükken ve hayır kurumunun gayreti net bir şekilde gözlemlenemezken, hayır kurumunun gayretinin ve toplanan bağışların dengedeki miktarının gayretin net bir şekilde gözlemlendięi duruma göre daha az olduęunu tespit ettik. Aksine, bağış yapmanın bedeli yüksekken ilişki tersine dönmekte ve gayreti gözlemlenmenin kusurlu olduęu durumdaki gayret ve toplam bağış miktarı gözlemin kusursuz olduęu duruma göre daha yüksek olmaktadır.

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# CHAPTER 1

## INTRODUCTION

Gift giving, donations and bequests for charitable purposes have become a significant portion of economic activities in recent decades. List (2011) reports that since 1968, “growth in charitable gifts of money roughly doubled the growth of the Standard & Poor’s 500” (p. 157). Andreoni (2006) remarks that “philanthropy is one of the greatest puzzles for economics” (p. 1203). Analyzing the market for charitable funds has practical policy uses too. Government has always been a participant in the market for charitable giving using certain policy instruments including tax rebates, subsidies, donation matchings.<sup>1</sup> Several organizations in private sector also use different forms of matching mechanisms to induce their employees to contribute to charities.

This paper studies the market for charitable funds in which charities choose costly effort, donors contribute and government sets the price of giving through tax/subsidy policies. Main concern is to investigate the impact of observing charity effort with some noise on the price elasticity of charitable giving. There is a substantial literature of empirical studies on estimating this elasticity. Pelozo and Steel (2005) provide a survey of estimates, some of which are quite low.<sup>2</sup> Karlan and List (2006) found experimental evidence for “stickiness” of donations under changing prices of giving. We introduce a framework in which we demonstrate that when donors care about charity effort, the fact that they only observe it imperfectly may lead to a lower price elasticity. The model consists of large but finite number of identical donors and a single representative charity. Charity

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<sup>1</sup>In U.S. there is a complex scheme of tax deductability offered for itemized donations. In 2012 Canadian government announced that it would match the donations of Canadian citizens dollar-for-dollar to aid the humanitarian crisis in Sahel region of West Africa.

<sup>2</sup>One should also notice that empirical studies include many corporate donors who only respond to tax evasion incentives rather than being purposeful donors. Estimates would be even lower if only purposeful donors are considered.

chooses a costly effort level. Donors observe the effort of charity and contribute accordingly. The ultimate effectiveness of the provision of charitable good depends on both the sum of donations and the effort put by charity. The latter also determines how much donations charity can receive. In the benchmark case, donors can observe the effort perfectly. Then we introduce a noise and assume that donors can only imperfectly monitor charity's effort. We characterize equilibria under both cases and compare equilibrium levels of aggregate donation and effort. Then we investigate the elasticity implications of information asymmetry and show that this could lead to lower elasticity of giving for a certain range of prices.

Empirical studies and discussions about the economies of charitable organizations date back to early 70's.<sup>3</sup> The origin of theoretical studies on charitable giving can be traced back to the origins of public goods literature since charitable contributions are essentially public goods with positive spillovers.<sup>4</sup> The milestone in this literature is Bergstrom, Blume, and Varian (1986), framework of which we also employ in our benchmark analysis. That paper proves the existence of a unique Nash Equilibrium in public good contribution game and establishes the so-called neutrality property. An earlier paper, Warr (1982), argues in similar lines and shows that public contributions fully crowd out private contributions.<sup>5</sup>

Cornes and Sandler (1984) introduce a model with impure altruism to specifically address charitable giving. In such models, charitable contributions provide a private utility as well as utility derived from the resulting level of public good. Andreoni (1989,1990) develops models commonly referred as warm-glow giving. In these models, each donor values a dollar she contributes more than a

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<sup>3</sup>See Arrow (1972), Schwartz (1970), Taussig (1967).

<sup>4</sup>For an extensive review of this literature, see Andreoni (2006).

<sup>5</sup>In spite of the neutrality argument there were policy interventions to adjust the "price of charitable giving" in most economies. The prevalence of those policies spurred interest in estimating the price elasticity of charitable giving.

dollar another donor donates. So, another agent’s donation is an imperfect substitute and “donations will have some qualities of public goods, but also some properties of private goods” (Andreoni, 2006, p. 1221). Warm-glow motive implies a “stickiness” in charitable giving because contributions of other donors are imperfect substitutes of a donor’s own contribution. Thus, donors have less incentive to free ride. We follow an alternative approach. We show that strategic considerations in a contribution game between a charity and its donors could lead to lower donor responsiveness even in a typical public good game with standard assumptions on utility functions.

Fundraising activities are considered to be the main channel through which charities signal their commitment to their causes. Andreoni (2005) points to the huge sums charitable organizations spend to attract donations.<sup>6</sup> Andreoni and Payne (2003) provide evidence that public contributions induce charities to reduce fundraising activities and argue that this could be a reason for crowding-out phenomenon. In this study, we do not address the fundraising issue. Instead, charity’s effort in providing charitable services itself, albeit imperfectly, is a signal. This is not to say that fundraising is irrelevant. We argue that the donors consider the charity’s program performance as an indicator of charity effort even in the presence of intensive fundraising activities.

Krasteva and Yildirim (2012) construct a framework which accounts for the significance of information apart from the fundraising context. In their model, agents can seek information about charitable projects provided that they are willing to incur the cost. In this study, we keep agent homogeneous and assume that all agents identically suffer from information asymmetry. Heterogeneity in access to information could be a natural extension which we leave for future studies.

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<sup>6</sup>For theoretical studies, see Ackerman (1982), Andreoni (1998), Vesterlund (2003), Name-Correa and Yildirim (2012).

The rest of the paper is organized as follows: Chapter 2 constructs the benchmark model with no frictions and prove the existence of a unique full information equilibrium for all prices. Chapter 3 introduces the imperfection in observing the effort and prove that there is a unique equilibrium in that case as well. In that section, we also present the findings on elasticity and carry out comparative statics exercises on the severity of information asymmetry. Finally, Chapter 4 discusses the findings and concludes.

## CHAPTER 2

### BENCHMARK MODEL

The model consists of a single charity organization and finitely many donors who provide contributions. As it is commonly done in the literature, we treat charitable donations as contributions to a public good. Charitable goods/services are eventually provided by charity. Each donor obtains utility from charity's provision of public good so she has an incentive to contribute a positive sum as a charitable donation. Charity chooses an effort level which has an impact on the "effective amount of charitable good" that will eventually be provided. This "effort" might be interpreted as charity's investment to organizational efficiency and/or ability to convert donations to charitable services. Donors are willing to contribute to high-effort charities because their utility depends not only on their cumulative contribution but also on the effort charity chooses. Charity aims to maximize the contributions it receives while putting as little effort as possible, assuming that putting in extra effort brings disutility.

Without any interventions in the market for charitable giving, every dollar contributed by donor corresponds to a dollar available for charitable expenses. However, it is possible to manipulate the "price of giving" by using several policy instruments, including making contributions tax-deductible or introducing a matching mechanism. For instance, under a 1:2 matching policy by the government, a dollar donor contributes will yield 2 dollars of contribution to charity, which implies that price of donating \$1 is \$0.5. Let  $p$  denote the price of making a unit contribution to charity. Let's also define all goods other than charitable giving as a single composite good  $x$  and normalize its price to 1. Let  $m$  denote each donor's income.

Let  $a \in [0, 1)$  and  $s_i \in \mathbb{R}_+$  be charity's effort and a single donor's contribution respectively. A single donor's utility function is  $u_i(x, g(S, a))$  where

$u_x > 0, u_s > 0, u_a > 0, u_{xx} < 0, u_{ss} < 0, u_{aa} < 0$  and  $S = \sum_i^k s_i$  denotes the cumulative contribution of  $k$  donors. We assume  $s_i(a = 0) = 0$  for all  $i$ . The function  $g(S, a)$  is the “production technology” that maps the cumulative contribution and effort level to an “effective charity good”.  $g(S, a)$  satisfies  $g_S > 0$  and  $g_a > 0$ . We also assume that  $g_{Sa} = g_{aS} > 0$ . Furthermore,  $s_i(a) = s_i(0) \forall a < 0$  and  $s_i(a) = \lim_{a \rightarrow 1} s_i(a) \forall a > 1$ .

Charity’s utility function is  $v(S)$  where  $v_S > 0, v_{SS} < 0$ . Charity experiences a disutility from implementing a positive effort level. This is expressed by  $d(a)$  which satisfies  $d_a > 0, d_{aa} > 0$ . Since  $a \in [0, 1)$ , we also assume that  $\lim_{a \rightarrow 1} d'(a) = \infty$  holds. We define the “net utility” of charity as  $w(S, a) = v(S(a)) - d(a)$ .

The sequence of this game is as follows: Charity picks  $a \in [0, 1)$ . Then, given  $\{p, m\}$ , each donor observes  $a$  and chooses  $s_i^*$ . Finally, utilities realize under the total contribution  $S^*$

Given  $p$  and  $m$ , each donor solves the following problem:

$$\max_{x, s_i} u(x, g(s_i + \sum_{j \neq i} s_j, a))$$

subject to

$$x + ps_i = m$$

$$x, s_i \geq 0$$

Lemma 1. There exists a  $\{x^*, s_i^*\}$  such that

$\{x^*, s_i^*\} = \arg \max_{x, s_i} u(x, g(s_i + \sum_{j \neq i} s_j, a))$  and  $\{x^*, s_i^*\}$  is an interior optimum.

*Proof.*  $u(x, g(s_i + \sum_{j \neq i} s_j, a))$  is concave in both variables by assumption while budget constraint is quasi-concave (linear). We have

$\mathcal{L}(x, s, \lambda) = u(x, g(s_i + \sum_{j \neq i} s_j, a)) - \lambda(x + ps_i - m)$ . Lagrangian is concave so an

interior optimum exists. □

Let  $w(S, a) = v(S(a)) - d(a)$  be the net utility of charity. Then, charity solves the following problem:

$$a^* = \arg \max_a w(S(a))$$

Lemma 2. For a given  $s$ , there exists finite  $a^*$  such that  $a^* > 0$  and  $a^* = \arg \max_a w(S(a))$

*Proof.* Note that  $v(S(a))$  is concave in  $a$ . Also,  $d(a)$  is convex. Therefore,  $w(S, a)$  is concave in  $a$  and there exists  $a^* > 0$  such that  $a^* = \arg \max_a w(S(a))$  □

Proposition 1. For all  $p \in \mathbb{R}_{++}$ , there exists an SPNE such that C plays  $a^*$  and each D plays  $s_i^*(a) = \max\{S(a) - S_{-i}^*, 0\}$

*Proof.* See Appendix A for the proof of Proposition 1. □

The SPNE of Proposition 1 defines an equilibrium under the assumption that the effort level charity chooses ( $a^*$ ) is perfectly observable to donor. It is difficult to justify this assumption when we consider the costs associated with gathering such information. In the following section, we introduce an imperfection in observing the effort level and investigate its impact on the equilibrium.

## CHAPTER 3

### MODEL WITH IMPERFECT INFORMATION

Suppose, instead of being able to observe  $a$ , each donor can only observe  $\theta_i \sim U(a - N, a + N)$ . That is to say, the donors can only imperfectly observe the effort choice of charity. Thus, we have an intermediary stage between 1 and 2 in which Nature picks  $\theta_i$  which donor  $i$  observes.

Note that, because donors cannot monitor the effort of charity perfectly, there is a possibility (and incentive) for charity to deviate from full information equilibrium. So, the imperfect information equilibrium  $\{\hat{s}_i, \hat{a}\}$  could be different from the corresponding pair in full information case. Suppose charity picks  $\hat{a} = a^* - \epsilon$  where  $\epsilon > 0$ . Figure 1 illustrates the situation:

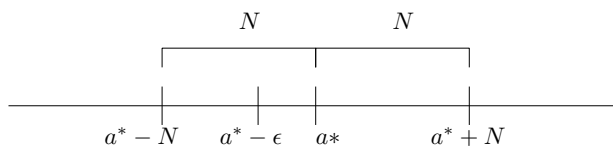


Figure 1: An example of charity's choice under uncertainty

**Proposition 2.** For all  $p \in \mathbb{R}_{++}$ , there exists a Perfect Bayesian Equilibrium such that charity plays  $\hat{a}$  and each donor contributes according to the assessment  $\{S(\hat{a}), \mu_i\}$

*Proof.* See Appendix B for the proof of Proposition 2 □

The existence of solution for charity's problem is established by Proposition 2. Suppose, for a given price  $p$ , equilibrium level of charity efficiency is  $a^*$ . Proposition 2 implies that the imperfect information equilibrium level of effort  $\hat{a}$  could be different from  $a^*$ . In the rest of this paper, the focus of analysis is the ways the imperfect information equilibrium differs from the benchmark (full information) case. Therefore, we define  $\hat{a} = a^* - \epsilon$ ,  $\epsilon \in \mathbb{R}$  and redefine charity's problem as follows:

$$\max_{\epsilon} \frac{|\epsilon|}{2N} v(S(\check{a})) + \frac{2N - |\epsilon|}{2N} v(S(a^*)) - d(a^* - \epsilon)$$

where

$$\check{a} = \begin{cases} \underline{x} & \text{if } \epsilon < 0 \\ \bar{x} & \text{otherwise} \end{cases}$$

Proposition 3.  $\epsilon$  increases as  $p$  decreases.

*Proof.* See Appendix C for the proof of Proposition 3 □

Proposition 3 shows that  $\epsilon$  is increasing all over the domain of  $a^*$ 's. By definition, we have  $a^* \in [0, 1)$ . Let's examine the values  $\epsilon$  attains on the boundaries.

Lemma 3.  $\epsilon^* < 0$  for  $p \rightarrow \infty$

*Proof.* First, note that  $p \rightarrow \infty$  implies  $S^* \rightarrow 0$  and hence,  $a^* = 0$ . Also, it is impossible for donor to observe any  $a < 0$  (as ruled out at the very beginning) so  $\theta \geq 0$  holds. Since  $\hat{a} = a^* - \epsilon$ , we have  $\epsilon^* \leq 0$  for sure. Let's see if we can refine this further.

For  $\epsilon^* \leq 0$ , F.O.C of charity's problem is as follows:

$$\frac{1}{2N} (v(S(a^*)) - v(S(\bar{a}))) - d_{\epsilon}(a^* - \epsilon)$$

Plug  $a^* = 0$  in the optimality condition (which is the first-order condition of charity organization's problem):

$$-\frac{1}{2N} v(S(\bar{a})) = d_{\epsilon}(-\epsilon)$$

Since  $v(S(\bar{a})) > 0$ ,  $d_{\epsilon}(-\epsilon) < 0$  must hold. This is possible only if  $\epsilon^* < 0$ . Hence,

$\epsilon^* < 0$  for  $p \rightarrow 0$ . □

Lemma 4.  $\epsilon^* > 0$  for  $p \rightarrow 0$

*Proof.* Analogous to the argument in previous lemma, we can say that  $a^* \rightarrow 1$ . It is also impossible to have  $a > 1$  (which was also ruled out in model construction) so  $\theta \leq 1$  will hold. Since  $\hat{a} = a^* - \epsilon$ , we will have  $\epsilon^* \geq 0$  for sure. Let's see if it is possible to refine this further.

The optimality condition is as follows:

$$\frac{1}{2N}(v(S(\underline{a})) - v(S(a^*))) - d_\epsilon(-\epsilon) = 0$$

Let  $a^* \rightarrow 1$  and use  $d_\epsilon(a^* - \epsilon) = -d_{a^*}(a^* - \epsilon)$ :

$$\frac{1}{2N}(v(S(\underline{a})) - \lim_{a^* \rightarrow 1} v(S(a^*))) + \lim_{a^* \rightarrow 1} d_a(a^* - \epsilon) = 0$$

Now suppose  $\epsilon = 0$ . Then  $\lim_{a \rightarrow 1} d_a(a^*) = \infty$  but  $\lim_{a \rightarrow 1} \frac{1}{2N}v(S(a^*))$  is a finite quantity. Therefore,  $\epsilon \neq 0$ . Hence,  $\epsilon^* > 0$  for  $p \rightarrow 0$  □

Proposition 4. There exists a  $\tilde{p} \in \mathbb{R}_{++}$  such that for  $p < \tilde{p}$ ,  $\hat{a} < a^*$ ; for  $p = \tilde{p}$ ,  $\hat{a} = a^*$ ; for  $p > \tilde{p}$ ,  $\hat{a} > a^*$

*Proof.* See Appendix D for the proof of Proposition 4 □

Proposition 4 shows that when price of giving is below the threshold level, charity effort is lower than the corresponding benchmark level. Conversely, when price is higher than the threshold, charity effort is higher than the corresponding full information level. When price is low (i.e. when government offers huge subsidies), equilibrium level of contributions and charity effort are high. Due to the the noise in information about the effort, charity faces the following trade-off: Charity could choose a slightly lower effort level to reduce disutility, but then it is exposed to the risk of sending an off-the-equilibrium path (low effort) signal which leads to lower contributions. When price is low and hence, current effort level is

high, the incentive to save from the cost of effort dominates. Exactly the opposite occurs when price is high. Contributions and effort level are low. So, the risk of bad signal dominates the cost of effort. Thus, we have threshold where the trade-off balances out and we observe  $a^* = \hat{a}$ .

The existence of threshold has interesting welfare implications. Proposition 4 shows that there exists a level of policy variable at which the information asymmetry does not matter at all. If there are external welfare costs associated with information asymmetry, these can be alleviated through choosing an appropriate level for policy variable  $p$ . Obviously, there are efficiency costs associated with such interventions. Welfare analysis of this sort requires an explicit formulation of a planner's problem, a task which we leave for future studies.

### 3.1 Price elasticity of charitable giving

We have established that there exists a unique equilibrium for every price  $p$ . We also discussed some properties of imperfect information equilibria. Government can alter the price of giving  $p$  through tax/subsidy policies. The impact of these policies depend on the elasticity of charitable giving. Let's define elasticity of giving as  $\mu = \frac{\partial S}{\partial p} \frac{p}{S} = \frac{\partial S}{\partial a} \frac{\partial a}{\partial p} \frac{p}{S}$ . For perfect information case we have:

$$\mu^f = \frac{\partial S(a^*)}{\partial a^*} \frac{\partial a^*}{\partial p} \frac{p}{S(a^*)}$$

Under imperfect information and in aggregate terms, the expression becomes:

$$\mu^i = \frac{\partial S(\hat{a})}{\partial \hat{a}} \frac{\partial \hat{a}}{\partial p} \frac{p}{S(\hat{a})}$$

Proposition 5.  $|\mu^i| < |\mu^f|$  for  $p > \tilde{p}$

*Proof.* See Appendix E for the proof of Proposition 5 □

Proposition 5 shows that for higher price levels, imperfect information leads to lower elasticity. Note that we cannot easily comment on the case  $p < \tilde{p}$  because  $\left| \frac{\partial S(\hat{a})}{\partial \hat{a}} \right| > \left| \frac{\partial S^*}{\partial a^*} \right|$  whereas  $\left| \frac{\partial \hat{a}}{\partial p} \right| < \left| \frac{\partial a^*}{\partial p} \right|$  and  $S(\hat{a}) < S(a^*)$ . Still for lower prices, we would expect charitable giving to be price-inelastic even under perfect information. If  $|\mu^i|$  and  $|\mu^f|$  do not diverge extremely, we would expect charitable giving to be price-inelastic under imperfect information for lower prices as well.

### 3.2 Degree of imperfection

The findings up to this point show that even a slight imperfection in the availability of information changes the nature of equilibrium. Lemma 5 explores the magnitude of deviation from benchmark equilibrium as information becomes more noisy.

Lemma 5.  $|\epsilon|$  increases as  $N$  increases for all  $p \in \mathbb{R}_{++}$

*Proof.* Let's first investigate  $\epsilon \geq 0$ . Charity's optimality condition can be rewritten as follows:

$$2d_a(a^* - \epsilon) = \frac{v(S(a^*)) - v(S(\underline{a}))}{N}$$

Suppose  $N$  increases. Then for this equality to hold,  $d_a(a^* - \epsilon)$  must increase, which is possible only if  $\epsilon$  increases. Hence,  $|\epsilon|$  increases as  $N$  increases for  $\epsilon \geq 0$ .

For  $\epsilon < 0$ , optimality condition can be expressed as such:

$$-2d_a(a^* - \epsilon) = \frac{v(S(\bar{a})) - v(S(a^*))}{N}$$

Suppose  $N$  increases. Then for this equality to hold,  $d_a(a^* - \epsilon)$  must increase, which is possible only if  $\epsilon$  decreases. Thus,  $|\epsilon|$  increases as  $N$  increases for  $\epsilon < 0$  as well. □

## CHAPTER 4

### CONCLUSION

This paper studies the market for charitable funds under the observation that charity effort can be observed imperfectly. We construct a framework in which charity chooses a costly effort level and donors contribute after observing the effort with noise. Government directly sets the price of giving. We characterize the equilibria under both perfect and imperfect information. Depending on the price of giving, information asymmetry could cause the equilibrium effort/donations to be higher or lower. We also show that under information asymmetry, price elasticity of charitable giving is strictly lower for a certain range of prices. We shortly discuss the welfare implications of the equilibrium.

This study contributes to our understanding of the market for charitable funds. Our findings indicate that when price of giving is low, imperfect information equilibrium level of effort and contributions are lower higher than corresponding full information levels. Vice versa occurs when price of giving is high. In both cases, imperfection in observing the charity effort, which can be attributed to limited transparency of the charity, biases the equilibrium outcome away from the benchmark (full information) level.

There are a few natural extensions that could yield further insights. We kept donors homogeneous throughout the analysis. However in practice, charities have a few big donors along with many small ones. One can conceive a variant in which a certain fraction of donors are big and others are small contributors. Depending on this parameter, it could be possible to have different sorts of equilibria with interesting properties. This extended model can be used to analyze the motives of rich and poor donors. For our purposes, full information equilibrium ensuing from the game defined in chapter 2 is a good benchmark. However, this is not necessarily the first best solution. It is possible to enhance the model with a

planner's problem and perform extensive welfare analyses of equilibria. Such a model can also be used to determine welfare-maximizing level of price of charitable giving and could have direct policy implications.

## APPENDIX A

### PROOF OF PROPOSITION 1

Let  $S_C$  and  $S_D$  be strategy sets of charity and an individual donor respectively.

Then we have:

$$S_D = \{s_i(a) | s_i(a) : [0, 1) \rightarrow \mathbb{R}_+\}$$

$$S_C = [0, 1)$$

Payoffs are defined by utility functions  $u(x, g(S))$  and  $w(S, a)$ .

Charity is the first-mover, so let's investigate charity's problem first. For a fixed  $S$ , Charity solves the following problem:

$$\max_a v(S(a)) - d(a)$$

First-order conditions yield:

$$v_a(S(a)) = d_a(a)$$

For  $a = 0$ , we have  $v_a(S(a)) > d_a(a)$ . When  $a \rightarrow 1$ , we have  $\lim_{a \rightarrow 1} d_a(a) = +\infty$  so  $v_a(S(a)) < d_a(a)$ . Since both functions are continuous in  $a$ , by Intermediate Value Theorem we can conclude that there exists an effort level  $a^*$  which satisfies the optimality condition.

Donor's problem resembles the public good provision problem defined in Bergstrom et al. (1986). So the treatment will follow a similar methodology. Let's rewrite the problem as follows:

$$\max_{x,S} u(x, g(S, a))$$

subject to

$$x + pS = m + S_{-i}^*$$

$$S \geq S_{-i}^*$$

$S_{-i}^*$  denotes the equilibrium contributions of donors other than donor  $i$ . Ignoring the inequality constraint for the time being, first-order conditions of donor's problem are as follows:

$$\begin{aligned} x : \frac{\partial u_i(x, g(S, a))}{\partial x} - \lambda &= 0 \\ S : \frac{\partial u_i(x, g(S, a))}{\partial g} \frac{\partial g(S, a)}{\partial S} - \lambda p &= 0 \end{aligned}$$

Using these equations we can obtain the following:

$$S : \frac{\partial u_i(x, g(S, a))}{\partial g} \frac{\partial g(S, a)}{\partial S} = \frac{\partial u_i(x, g(S, a))}{\partial x} p$$

Note that both sides of the equality are functions of  $S$  and  $a$ . If we solve for  $S$  and replace  $x = m + S_{-i}^* - pS$  to get rid of  $x$  terms, we can obtain  $S^*(a)$  which is the utility-maximizing response of donor to a given  $a$ . Taking the inequality constraint into consideration, it is possible to express the best response of donor as:

$$S^*(a) = \max\{S(a), S_{-i}^*\}$$

Subtracting  $S_{-i}^*$  from both sides, we obtain:

$$s_i^*(a) = \max\{S(a) - S_{-i}^*, 0\}$$

For a given effort level  $a$ , the function  $S^*(a)$  defines the aggregate best response. Note that, holding all parameters (price, income etc.) fixed, this function expresses the demand for charitable giving as a function of charity effort.

It is also possible to draw some insights about the properties of  $s_i^*(a)$ , which will also apply to  $S^*(a)$ . We can make the following observation:

$$\begin{aligned}\frac{\partial s_i}{\partial a} &= \frac{\partial s_i^*}{\partial g} \frac{\partial g}{\partial a} \\ &= \frac{\partial g / \partial a}{\partial g / \partial s_i^*}\end{aligned}$$

Since  $\partial g / \partial a > 0$  and  $\partial g / \partial s_i^*$ , we have  $\partial s_i / \partial a$  meaning that contributions are increasing in effort level  $a$ . Let's investigate the second derivative:

$$\frac{\partial}{\partial a} \left( \frac{\partial g / \partial a}{\partial g / \partial s_i^*} \right) = \frac{\frac{\partial^2 g}{\partial a^2} \frac{\partial g}{\partial s_i} - \frac{\partial g}{\partial a} \frac{\partial g}{\partial s_i^* \partial a}}{\left( \frac{\partial g}{\partial s_i} \right)^2}$$

From model assumptions, we have  $\frac{\partial^2 g}{\partial a^2} < 0$ ,  $\frac{\partial g}{\partial s_i} > 0$ ,  $\frac{\partial g}{\partial s_i \partial a} > 0$ ,  $\frac{\partial g}{\partial a} > 0$ .

Using these we can show that  $\frac{\partial}{\partial a} \left( \frac{\partial g / \partial a}{\partial g / \partial s_i^*} \right) < 0$ , implying that  $s_i$  is concave in  $a$ . It follows that  $S(a)$  is also concave in  $a$ . The concavity of contribution function will be essential for the findings in latter propositions.

Since we obtained  $S^*(a)$ , it is possible to plug this in charity's optimality condition and obtain  $a^*$ .

$$\frac{\partial v}{\partial S} = \frac{d(a)}{S_a^*(a)}$$

Effort level  $a$  which satisfies the equation above is  $a^*$ , i.e. the best response for particular  $S^*(a)$

We also assume that for  $\{a^*, S^*(a^*)\}$ ,  $v(s^*(a^*)) - d(a^*) \geq 0$  holds (Otherwise, charity is always better off with  $a^* = 0$ ). Then, the pair  $\{s_i^*(a), a^*\}$

constitutes a Subgame-Perfect Nash Equilibrium (SPNE), with the aggregate outcome of the game being  $\{S^*, a^*\}$ .

## APPENDIX B

### PROOF OF PROPOSITION 2

The strategy sets for the imperfect information case are as follows:

$$S_D = \{s_i(\theta) | s_i(\theta) : [0, 1) \rightarrow \mathbb{R}_+\}$$

$$S_C = [0, 1)$$

Let's fix  $a = \hat{a}$  to be the equilibrium strategy for charity. Each donor  $i$  observes  $\theta_i \in [\hat{a} - N, \hat{a} + N]$ . Then we have the following:

$$f(\theta | a = \hat{a}) = \begin{cases} \frac{1}{2N} & \text{for } \theta \in [\hat{a} - N, \hat{a} + N] \\ 0 & \text{otherwise} \end{cases}$$

For  $a = \hat{a}$ , we have the following:

$$Pr(a = \hat{a} | \theta = \theta_i) = \frac{f_\theta(\theta_i | a = \hat{a}) Pr(a = \hat{a})}{f_{\theta_i}(\theta_i)}$$

Note that  $Pr(a = \hat{a}) = 1$  and

$f_\theta(\theta_i) = f_\theta(\theta_i | a = \hat{a}) Pr(a = \hat{a}) + f_{\theta_i}(\theta_i | a \neq \hat{a}) Pr(a \neq \hat{a})$ . From these, we obtain

$f_\theta(\theta_i) = f_\theta(\theta_i | a = \hat{a}) Pr(a = \hat{a})$ . This implies  $Pr(a = \hat{a} | \theta = \theta_i) = 1$ .

Let  $\mu_i(\theta_i)$  be the belief function of donor  $i$ . Then we have the following:

$$\mu_i(a = \hat{a} | \theta_i) = 1 \text{ for } \theta_i \in [\hat{a} - N, \hat{a} + N]$$

Under this belief, each donor solves the following problem:

$$\max_{x,S} u(x, g(S, \hat{a}))$$

subject to

$$x + pS = m + S_{-i}^*$$

$$S \geq S_{-i}^*$$

Best response of donor is  $S(\hat{a}) = \hat{S}$ . On the equilibrium path, the belief given above is consistent. If  $\theta \notin [\hat{a} - N, \hat{a} + N]$ , the game is off the equilibrium path.

Let's construct beliefs in such cases as follows:

$$\mu_i(a = \underline{a} | \theta_i) = 1 \text{ for } \theta_i < a - N$$

$$\mu_i(a = \bar{a} | \theta_i) = 1 \text{ for } \theta_i > a + N \text{ where } \bar{a} > a$$

Under this belief and strategies, equilibrium path payoff of charity is:

$$w(S, a) = v(S(a)) - d(a)$$

We need to check whether  $a$  is sequentially rational. There are two possible deviations: charity can either deviate to  $a - \delta_\ell$  (reducing the effort) or to  $a + \delta_h$  (increasing the effort). For the first case, the expected payoff is the following:

$$Ew(S, a - \delta_\ell) = \frac{\delta_\ell}{2N} v(S(\underline{a})) + \frac{2N - \delta_\ell}{2N} v(S(a)) - d(a - \delta_\ell)$$

Similarly for  $a + \delta_h$ , we have:

$$Ew(S, a + \delta_h) = \frac{\delta_h}{2N} v(S(\bar{a})) + \frac{2N - \delta_h}{2N} v(S(a)) - d(a + \delta_h)$$

For  $a$  to be sequentially rational,  $\delta_\ell^* = \operatorname{argmax}_{\delta_\ell} Ew(S, a - \delta_\ell) = 0$  and  $\delta_h^* = \operatorname{argmax}_{\delta_h} Ew(S, a + \delta_h) = 0$  must hold. Let's evaluate the F.O.C for the first case.

$$\begin{aligned}\frac{\partial Ew}{\partial \delta_\ell} &= \frac{1}{2N}v(S(\underline{a})) - \frac{1}{2N}v(S(a)) - d_{\delta_\ell}(a - \delta_\ell) = 0 \\ &= -\frac{1}{2N}(v(S(a)) - v(S(\underline{a}))) + d_a(a - \delta_\ell) = 0 \\ d_a(a - \delta_\ell) &= \frac{1}{2N}(v(S(a)) - v(S(\underline{a})))\end{aligned}$$

Note that for  $a \rightarrow 1$ ,  $d_a(a) \rightarrow \infty$ . Therefore, above a certain  $a$ , deviation is profitable. But there exists  $a$ 's lower than that threshold for which deviation is not profitable under the specified beliefs.

Similarly, for deviation to  $a + \delta_h$ :

$$\begin{aligned}\frac{\partial Ew}{\partial \delta_h} &= \frac{1}{2N}(v(S(\bar{a})) - v(S(a))) - d_{\delta_h}(a + \delta_h) = 0 \\ d_a(a + \delta_h) &= \frac{1}{2N}(v(S(\bar{a})) - v(S(a)))\end{aligned}$$

For  $a \rightarrow 0$ ,  $d_a(a) \rightarrow 0$ . Therefore, below a certain  $a$ , deviation is profitable.

Sequentially rational charity strategy  $\hat{a}$  must satisfy  $\delta_\ell^* = \delta_h^* = \delta^* = 0$  because no deviation should be profitable. Then the following must hold:

$$\begin{aligned}\frac{1}{2N}(v(S(\bar{a})) - v(S(\hat{a}))) &= d_a(\hat{a}) \\ \frac{1}{2N}(v(S(\hat{a})) - v(S(\underline{a}))) &= d_a(\hat{a})\end{aligned}$$

Since we can choose  $\underline{a}$  and  $\bar{a}$  freely (i.e. off the equilibrium path beliefs can be set arbitrarily), there exists  $\{\underline{a}, \bar{a}\}$  such that  $\hat{a}$  satisfies conditions above. Such  $\hat{a}$  is sequentially rational under donor assessment  $\{S(a), \mu_i(a)\}$ . Therefore,  $\{\hat{a}, S(\hat{a}), \mu_i\}$  constitutes a Perfect Bayesian Equilibrium.

## APPENDIX C

### PROOF OF PROPOSITION 3

We already know that  $\frac{\partial a^*}{\partial p} < 0$ . So, if we can show that  $\frac{\partial \epsilon}{\partial a^*} > 0$ , then it follows from chain rule that  $\frac{\partial \epsilon}{\partial p} < 0$ .

There are two possible cases: Either  $\epsilon < 0$  or  $\epsilon \geq 0$

Case 1: For  $\epsilon < 0$ , charity solves the following problem:

$$\max_{\epsilon} \frac{-\epsilon}{2N} v(S(\bar{a})) + \frac{2N + \epsilon}{2N} v(S(a^*)) - d(a^* - \epsilon)$$

First-order conditions yield:

$$\frac{1}{2N} (v(S(a^*)) - v(S(\bar{a}))) - d_{\epsilon}(a^* - \epsilon) = 0$$

Note that  $d_{\epsilon}(a^* - \epsilon) = -d_a(a^* - \epsilon)$ . Let

$\psi(a^*, \epsilon) = \frac{1}{2N} (v(S(a^*)) - v(S(\bar{a}))) - d_{\epsilon}(a^* - \epsilon)$ . Using Implicit Function Theorem, we can write the following:

$$\frac{\partial \epsilon}{\partial a^*} = - \frac{\partial \psi / \partial a^*}{\partial \psi / \partial \epsilon}$$

Evaluating the expressions we have

$$\frac{\partial \epsilon}{\partial a^*} = - \frac{\frac{1}{2N} [v_a(S(a^*)) - v_a(S(\bar{a}))] + d_{aa}(a^* - \epsilon)}{-d_{aa}(a^* - \epsilon)}$$

We have  $d_{aa}(a^* - \epsilon) > 0$  and the expression in the numerator is strictly positive because  $v_a(S(a^*)) - v_a(S(\bar{a})) > 0$ . Thus,  $\frac{\partial \epsilon}{\partial a^*} > 0$  for  $\epsilon < 0$ .

Case 2: For  $\epsilon \geq 0$ , charity solves the following problem:

$$\max_{\epsilon} \frac{\epsilon}{2N} v(S(\underline{a})) + \frac{2N - \epsilon}{2N} v(S(a^*)) - d(a^* - \epsilon)$$

First-order conditions yield:

$$\frac{1}{2N}(v(S(\underline{a})) - v(S(a^*))) - d_\epsilon(a^* - \epsilon) = 0$$

Note that  $d_\epsilon(a^* - \epsilon) = -d_a(a^* - \epsilon)$ . Let

$\psi(a^*, \epsilon) = \frac{1}{2N}(v(S(\underline{a})) - v(S(a^*))) + d_a(a^* - \epsilon)$ . Using Implicit Function Theorem, we can write the following:

$$\frac{\partial \epsilon}{\partial a^*} = -\frac{\frac{1}{2N}[v_a(S(\underline{a})) - v_a(S(a^*))] + d_{aa}(a^* - \epsilon)}{-d_{aa}(a^* - \epsilon)}$$

We have  $d_{aa}(a^* - \epsilon) > 0$  and the expression in the numerator is strictly positive because  $v_a(S(\underline{a})) - v_a(S(a^*)) > 0$ . Thus,  $\frac{\partial \epsilon}{\partial a^*} > 0$  for  $\epsilon \geq 0$

Therefore,  $\frac{\partial \epsilon}{\partial p} < 0$  as claimed.

## APPENDIX D

### PROOF OF PROPOSITION 4

We already showed  $\epsilon^*(a^* = 0) < 0$  and  $\lim_{a^* \rightarrow 1} \epsilon^*(a^*) > 0$ . We also have  $\frac{\partial \epsilon}{\partial a^*} > 0$ .

So, using Mean Value Theorem, we can deduce that

$\exists a^* \in [0, 1]$  s.t.  $\epsilon^*(a^*) = 0$ . This implies  $\hat{a} = a^*$  for that particular  $a^*$ . We know from Proposition 1 that there is a unique  $a^* \in [0, 1]$  corresponding to each  $p \in \mathbb{R}_{++}$ . Call this corresponding price  $\tilde{p}$  and the existence of  $\tilde{p}$  for which  $\hat{a} = a^*$  is established.

From Proposition 3, we have  $\frac{\partial \epsilon}{\partial p} < 0$ . It follows immediately that for  $p > \tilde{p}$ ,  $\epsilon < 0$  and for  $p < \tilde{p}$ ,  $\epsilon > 0$ . Since  $\hat{a} = a^* - \epsilon$ , we can conclude that for  $p > \tilde{p}$ ,  $\hat{a} > a^*$  and for  $p < \tilde{p}$ ,  $\hat{a} < a^*$ .

## APPENDIX E

### PROOF OF PROPOSITION 5

For  $p > \tilde{p}$ , we have  $\hat{a} > a^*$  (see Proposition 4). Then we have  $\left| \frac{\partial S(\hat{a})}{\partial \hat{a}} \right| < \left| \frac{\partial S(a^*)}{\partial a^*} \right|$  because  $S(a)$  is strictly concave in  $a$ .

We also have  $\left| \frac{\partial \hat{a}}{\partial p} \right| < \left| \frac{\partial a^*}{\partial p} \right|$  for all  $p$ . To see this, suppose  $p_1, p_2 \in (\tilde{p}, \infty)$  and  $p_1 < p_2$ . Let  $\Delta^* = a^*(p_1) - a^*(p_2)$ . For imperfect information case, we have  $\hat{\Delta} = \hat{a}(p_1) - \hat{a}(p_2)$ . Note that  $\hat{a}(p_1) = a^*(p_1) - \epsilon_1$  and  $\hat{a}(p_2) = a^*(p_2) - \epsilon_2$ . From Proposition 3, we have  $\epsilon_1, \epsilon_2 < 0$  and  $|\epsilon_1| < |\epsilon_2|$ . It follows that:

$$\begin{aligned} \hat{\Delta} &= (a^*(p_1) - \epsilon_1) - (a^*(p_2) - \epsilon_2) \\ &= a^*(p_1) - a^*(p_2) - (\epsilon_1 - \epsilon_2) \end{aligned}$$

Since  $\epsilon_1 - \epsilon_2 > 0$ , we have  $\hat{\Delta} < \Delta^*$ . Following a similar argument, it is possible to show that this also holds for  $p < \tilde{p}$ . Therefore, change in  $a$  due to change in  $p$  is less when there is information asymmetry.

For  $p > \tilde{p}$ , we also have  $S(\hat{a}) > S(a^*)$  because  $\hat{a} > a^*$  and  $S(a)$  is increasing in  $a$ . Therefore, we can conclude that  $|\mu^i| < |\mu^f|$  for  $p > \tilde{p}$ .

## REFERENCES

- Andreoni, J. (1989). Giving with impure altruism: Applications to charity and Ricardian equivalence. *Journal of Public Economics*, 97(6), 1447-58.
- Andreoni, J. (1990). Impure altruism and donations to public goods: A theory of warm-glow giving. *Economic Journal*. 100(401), 464-77.
- Andreoni, J. (1998). Toward a theory of charitable fund-raising. *The Journal of Political Economy*, 106(6), 1186-1213.
- Andreoni, J. (2006). Philanthropy. In S. Kolm & J. M. Ythier (Eds.), *Handbook of Giving, Reciprocity and Altruism* (pp. 1201-69). Amsterdam: North Holland.
- Andreoni, J., & Bergstrom, T. C. (1996). Do government subsidies increase the private supply of public goods? *Public Choice*, 88(3-4), 295-308.
- Andreoni, J., & Payne, A. A. (2003). Do government grants to private charities crowd out giving or fund-raising? *American Economic Review*, 93(3), 792-812.
- Arrow, K. J. (1972). Gifts and exchanges. *Philosophy and Public Affairs*, 1(4), 343-362.
- Bergstrom, T. C. , Blume, L., & Varian, H. (1986). On the private provision of public goods. *Journal of Public Economics*, 29(1), 25-49.
- Karlan, D., & List, J. A. (2007). Does price matter in charitable giving? Evidence from a large-scale natural field experiment. *American Economic Review*, 97(5), 1774-93.
- Krasteva, S., Yildirim, H. (2013). (Un)Informed charitable giving. *Journal of Public Economics*, 106, 14-26.
- Name-Correa, A. J., Yildirim, H. (2013). A theory of charitable fund-raising with costly solicitations. *American Economic Review*, 103(2), 1091-1107.
- List, J. A. (2011). The market for charitable giving. *Journal of Economic Perspectives*, 25(2), 157-80.
- Pelozo, J., & Steel, P. (2005). The price elasticities of charitable contributions: A meta-analysis. *Journal of Public Policy & Marketing*, 24(2), 260-72.
- Rose-Ackerman, S. (1982). Charitable giving and 'excessive' fundraising. *Quarterly Journal of Economics*, 97(2), 193-212.

- Sandler, T., & Posnett, J. (1991). The private provision of public goods: A perspective on neutrality. *Public Finance Quarterly*, 19(1), 22-42.
- Schwartz, R. (1970). Personal philanthropic contributions. *Journal of Political Economy*, 78(1), 1264-91.
- Steinberg, R. (1986). Charitable giving as a mixed public/private good: Implications for tax policy. *Public Finance Quarterly*, 14(4), 415-31.
- Vesterlund, L. (2003). The informational value of sequential fundraising. *Journal of Public Economics*, 87, 627-57.
- Warr, P. G. (1982). Pareto optimal redistribution and private charity. *Journal of Public Economics*, 19(1), 131-138.