A Signaling Game of Charitable Giving

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Abstract

This paper studies a two-stage signaling game of charitable donations with two players: a charity manager and a wealthy donor. A representative charity manager, who is perfectly informed, collects a donation from a representative donor, who has imperfect information about the manager's types. The manager uses the donation to produce some public good, and in the process decides whether to create waste in order to obtain a personal gain. We solve for separating and pooling sequential equilibria of the game. One of the nd-ings is that there exists no fully separating equilibrium in which the donor can discern all possible manager types. In addition, we present a characterization of all possible quasi-separating and pooling equilibria. One nding suggests that the amount of the initial donation may help the donor to induce the manager to reveal his true type. Since there are multiple equilibria in this signaling game, the Intuitive Criterion of Cho and Kreps (1987) is used as a re nement. We nd that one of the equilibria does not pass the Intuitive Criterion.

Key words: Altruism, Public Goods, Signaling, Moral hazard
JEL: H41, D82

I am grateful to Dimitrios Diamantaras for his support and guidance. I thank Michael Leeds and Hakan Yilmazkuday and students in a graduate seminar at Temple University for their helpful comments. However, all errors are my own.

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Current version October 20, 2009

1. Introduction

This paper contributes to the existing literature regarding the economics of philanthropy. There is a myriad of reasons as to why this topic has been of great interest to economists. First, the amount of individual donations for eleemosynary causes has been steadily increased in the past few decades in the United States. Americans donated $307 billion to charitable causes in 2007, which was more than 65 percent greater than a decade earlier.[1] In addition, the current financial crisis that started in 2007 has increased our need for philanthropy, which has played a vital role in search for optimal solutions to our social problems. This paper aims to develop a theoretical framework that will help us better understand how donors and charity managers interact in the philanthropic sector.

The primary objective of many economists has been to explain the seemingly altruistic behavior of self-interested individuals in the philanthropic sector. Researchers agree that individuals give away their wealth for various reasons. Perhaps individuals act unselfishly for selfish reasons. Therefore, numerous social scientists have constructed models which model charity as a privately provided public good. In other words, if the total amount of the public good provided enters the giver's utility function directly, then people have an incentive to make vonluntary contributions for charitable purposes.

Other economists have argued that donors could be purely egoistic, and as such, are motivated to give because of the 'warm-glow' feeling they receive from giving.[2] In other words, rather than allowing the amount of public good provided to enter directly into the giver's utility function, Andreoni (1989) assumes that the giver's utility directly depends on the giver's own donation. This idea has also been tested and supported empirically. Glazer and Konrad (1996) theoretically show that, to a large degree, people donate money because of their desire to demonstrate wealth.

Duncan (2004) develops a new model of altruism called 'impact philanthropy'. He argues that impact philanthropists make monetary contributions because of their desire to 'make a difference'. In other words, anything that one philanthropist does to increase the supply of the good reduces the impact of other philanthropists' contributions, and therefore, increases the philanthropist's own utility but reduces the utility of other philanthropists.

[1] The New York Times, June 23, 2008.

[2] See Andreoni (1989) for the original 'warm-glow' theory of giving.

Benabou and Tirole (2006) investigate a broader set of motives that shape people's social conduct. They argue that providing rewards and punishments to foster prosocial behavior sometimes may have perverse effects. Ariely et al. (2009) experimentally test a mechanism by which extrinsic incentives, or material reward such as thank-you gifts and tax breaks, can have detrimental effects on prosocial behavior. Their results strongly support Benabou and Tirole (2006) hypothesis that image motivation is important for prosocial behavior, and that private monetary incentives partially crowd out image motivation. In other words, monetary incentives are more effective in facilitating private, rather than public, prosocial activity.

Although economists have done extensive research in the area of philanthropy, the vast majority of the literature looks only at one side of the market; either the demand side of the market, which is represented by the charitable organizations, or the supply side of the market, which is represented by the wealthy individuals capable of making donations. On the supply side of the market, both empirical and theoretical studies examine the types of behavior that will allow a charitable organization to collect more donations. On the demand side of the market, most theoretical and empirical studies preoccupy themselves with explaining what motivates people to give away their wealth.

Very few studies examine the two sides of the market and analyze the interaction between the donors and the charitable organizations. One goal of this paper is to fill this gap. Specifically, using the tools of game theory, I build a two-sided model of charitable giving in which both the wealthy donor and the charitable organization are modeled as strategic players.

Aside from addressing the issue of interaction between the donors and the charities to which they donate, this paper also examines some moral hazard issues that arise in such environments. *The Wall Street Journal*, December 10, 2007 issue argues that the past few years have brought a string of reports of flagrant charity and foundation abuses, from officials who waste money on dubious fundraising ploys to lavish executive perks. In addition, we do not have a system in place, similar to what we have for government and corporations, that would make charities sufficiently accountable and transparent.

Evaluating a charity's success and efficiency has been a difficult, if not impossible, task. Therefore, it has been fairly simple for charity managers to mismanage the donations they collect. At the same time, it has been a difficult task for wealthy individuals to assess and recognize which charities would use their donations most efficiently. The existing literature does not address these questions as much as they deserve.

The rest of the paper is structured as follows. The next section provides a brief review of the existing literature that motivates the present reserach. Section 3 contains a detailed description of the model and the solution concept we use to obtain pure strategy equilibria. The complete speci cation of all sequential equilibria of the signaling game is presented in section 4. We discuss the e ciency implications of the results in section 5. We conclude our analysis with section 6.

2. Literature Review

The existing literature regarding charitable giving typically assumes perfect information. However, several papers look at fundraising when information is imperfect. Vesterlund (2003) studies the role of the fundraiser in the contribution game and concludes that fundraisers may choose to announce previous contributions because this helps them signal the quality of the public good that they provide. Therefore, as in the present paper, Vesterlund (2003) assumes that the contributors have imperfect information about the quality of the charity and concludes that di erent announcement strategies will allow charities to maximize contributions. Contrary to my assumption, Vesterlund (2003) also assumes that the fundraisers' single objective is to maximize the sum of the contributions.

Andreoni (2006), similarly to Vesterlund (2003), argues that it is reasonable to assume that the quality of a potential charitable project is unknown. Andreoni (2006) builds a model of \leadership giving" in which wealthiest donors provide a signal to all other givers that the charity is of high quality. My model is di erent from these models since it allows for the possib ility of corrupt fundraisers. This is a reasonable assumption since informational asymmetries mean that charitable activities are subject to moral hazard and adverse selection problems.

A few papers have looked at the problems that the di culty of monitoring charitable work pose to donors who fear misuse of their funds. Duncan (2004) argues that, because the donors and organizations disagree on how to meet their proposed goals, there is a con ict between charitable organizations and impact philanthropists. In addition, both Duncan (1999) and Leeds et al. (2007) show that charitable contributions of time and money are perfectly substitutable in equilibrium. One explanation for this might be that donors volunteer labor in order to reduce informational asymmetries.

Rose-Ackerman (1996) explains that nonprofit managers have little incentive to manage their organizations efficiently because no one has a claim to the residual earnings. Managerial shirking may be a problem in nonprofit sector because no market in ownership shares exists to discipline corrupt managers. Lastly, organizations may continue to exist when they are performing no valuable functions.

The idea that managers of nonprofit institutions derive personal satisfaction from allocating resources of their firm to other than productivity increasing expenses is not novel. Migue et al. (1974) argue that the budgets of nonprofit managers is too large but output is not necessarily so from the standpoint of Pareto efficiency, which results from the managers' enjoying rents in the form of utility generating non-productive expenses. In their model, the manager's objective is budget or output maximization, which is similar to the good manager type's objective in our model.

Calmette and Kilkenny (2001) analyze the problems of moral hazard and adverse selection in terms of international charity. They model how and why international charity encourages recipient governments to shirk, and why the payment of informational rents cannot be avoided.

We adapt the analytical framework of Besley and Smart (2007) to examine some of the problems that informational asymmetries pose. Besley and Smart (2007) build a political agency model with both moral hazard and adverse selection to examine the optimality of inefficient taxation, limits on the size of government, increasing transparency and yardstick competition. However, we are not interested in the political process described by Besley and Smart (2007), where benevolent politicians are elected to the office when they act in the interest of the voter. We are interested in the process that guides the donor to select a charity and make a monetary contribution.

Consequently, this study uses a similar analytical approach to the one that Besley and Smart (2007) use in their paper. We set up a two-stage sequential game with a representative donor and a representative charity manager. In the first period, the manager decides how much public good to produce, and, based on the amount of the public good produced, the donor decides how much to contribute to the charity. Since the game is of incomplete information with different manager types, the manager will have to signal to the donor what type of the charity he represents, and therefore, induce the donor to give as large of a donation as possible. The following section presents this model in detail.

3. Model

There are two players in a two-period game: a single representative charity manager m, and a single representative donor d. Both players are interested in the production of a public good G_t, $t \in \{1,2\}$ (for example, a new public library, humanitarian aid to hurricane victims, medical treatments, vaccines, etc.). The donor makes a monetary contribution v_t, $t \in \{1,2\}$, toward the production of the public good. Monetary contribution v_t is exogenous in the first period; it is some fixed amount F.[3] In the second period, the donor decides how much to contribute to the charity. Hence, the second period donation is endogenous. The donor's wealth endowment for charitable purposes is ω.[4] Therefore, the donor's budget constraint is $\omega \geq v_1 + v_2$, with $v_1 = F$.

The charity collects and uses the donation to produce the public good. The unit cost of producing the public good is $c \in \{c^L; c^H\}$. We assume that it is more costly to produce high levels of the public good than it is to produce low levels of the public good, hence $c^L < c^H$.[5] The unit cost of production is common knowledge. Nature at the beginning of the game determines the charity's cost type. However, the donor does not directly observe these costs. The donor only knows the probability of the charity's costs, $Pr(c = c^H) = p$. In part, the uncertainty about the unit cost of production will allow the charity to mismanage the donation. Mismanagement on the part of the charity will lead to some waste w_t, $t \in \{1,2\}$. Assume that the waste cannot be larger than the total contributions collected by the charity, $w_t \leq v_t$, $t \in \{1,2\}$. Therefore, the charity's budget constraint is $v_t = cG_t + w_t$, $c \in \{c^L; c^H\}$, $t \in \{1,2\}$. Therefore, v_t is the total amount of donations collected in period t, which must equal total charity's expenditure in the same period.

The donor knows that there is a possibility that the charity will mismanage his donation. In other words, the charity could claim that it incurred high costs, when in reality it had low costs but wasted the rest of the money.

[3] We make this assumption for simplicity reasons. Our results are robust. We arrive at the same conclusion when we relax this assumption.

[4] Notice that this is only a portion of the donor's total wealth designated for charitable causes.

[5] It might seem more natural to assume economies of scale, and therefore, $c^L > c^H$. However, changing this assumption would not affect our results in any meaningful way.

Therefore, there are two different types of managers of the charity: good and bad. The types $m \in \{good; bad\}$ are also determined by Nature at the beginning of the game. The donor does not directly observe the type of the charity to which he is contributing. However, he does observe some signal of the charity's type. This signal allows the donor to form some prior belief about the likelihood that the charity is good. Let the types of the first-period charity be independent draws from an identical distribution with $Pr(m = good) = \;$. In other words, is the donor's prior belief that the charity's type is good.

After the donor observes the amount of the public good produced in the first period, G_1, he forms some posterior beliefs about the type of the manager he is facing. Let the donor's posterior beliefs be specified in Table 1 such that $(G_1) + (G_1) + (G_1) + (G_1) = 1$. We do not require the same posterior probabilities for different amounts of the public good produced in the first period. For example, (G_1) may be greater, less or equal to G_1'. We also assume that it is costly for the donor to obtain information about the amount of the public good that the charity produces, which will be reflected in the donor's payoff. We let $c_d(v)$ describe this cost. Vesterlund (2003) makes a similar assumption. In her model, the quality of the charity is revealed after the donor conducts some sort of costly inspection. Similarly, in our model, it will be costly for the donor to obtain information about the quality or the amount of the public good produced. However, in our model, even after the donor obtains this information, he remains uncertain of the charity's true type. Alternatively, this could be a cost to the donor of donating his money to this specific charity instead of giving it to another charity that might have used the donation more efficiently.

3.1. Timing and Strategies

The game has two periods. In the first period Nature selects charity's types. The charity manager observes the cost of production of the public good, c. Upon this observation, he chooses the amount of the public good to

$Pr(g; c^L \mid G_1) = (G_1)$
$Pr(g; c^H \mid G_1) = (G_1)$
$Pr(b; c^L \mid G_1) = (G_1)$
$Pr(b; c^H \mid G_1) = (G_1)$

Table 1: Donor's posterior beliefs

produce, G_1, which in turn determines the amount of waste, w_1, as implied by the budget constraint. With the asymmetric information, the charity manager will also be choosing whether or not to be truthful. The charity manager has an incentive to lie, since this could bring him personal gains.

After observing G_1 and knowing from the start the total expenditure F in the first period, the donor then decides whether or not to contribute to this charity again in the second period. The second period is the same as first, except that since the game ends at the end of the second period, the donor is no longer a strategic player. The charity manager is the only strategic player choosing G_2. To summarize:

1. Nature determines the state of the world, i.e. manager's types.
2. Player m decides how much public good G_1 to produce, which in turn determines how much waste w_1 to produce as implied by the budget constraint.
3. Player d observes how much public good G_1 was produced, and knows total charity's expenditure $v_1 = F$ in the first period. Based on this information, player d decides how much to contribute to the charity.
4. If payer d decides not to contribute at the end of the first period, the game ends. If player d decides to contribute, player m again chooses how much public good G_2 to produce, which in turn determines how much waste w_2 is produced as implied by the budget constraint.

The extensive form[6] of the described game is presented in Figure 1. We point out that donor's contribution v_2 is modeled as a continuous variable. However, for simplicity reasons, the tree presents it as a binary choice variable, which also happen to be the actions of the donor in an equilibrium. Detailed description of the payoff at terminal nodes is presented in the following section in Table 2.

When interpreting the game, we can think of the charity as the representative charity randomly selected from the set of all charities, of whom a fraction p has high costs and a fraction are good. Also, think of the donor as the representative donor randomly selected from the set of all donors. Next we specify players' payoff functions.

[6] We thank Martin J. Osborne for providing the LaTeX style for formatting strategic games, available at http://www.economics.utoronto.ca/osborne/latex/index.html .

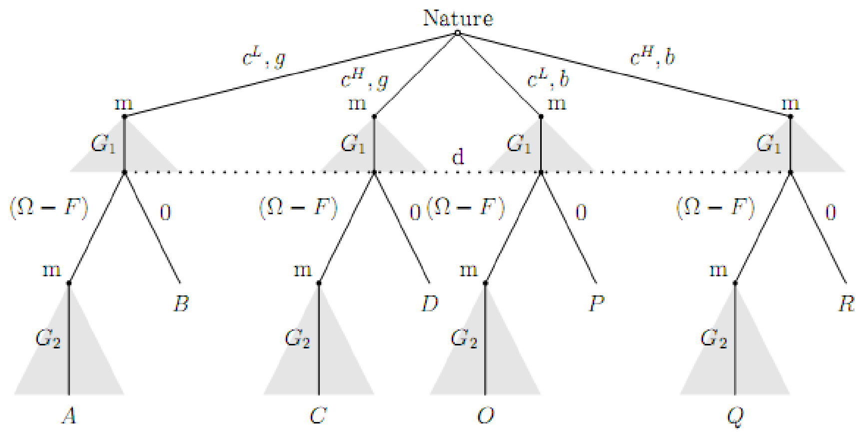

Figure 1: Game tree for the game

3.2. Payo s

The donor's expected payo depends on the total amount of the public good produced, his own donation, and on the cost of information acquisition in the rst period. Therefore, the donor's utility will be derived from the total amount of the public good produced in the rst period, G_1, and the total starting contribution $v_1 = F$, which is exogenously given, and as such, can be left out of the donor's payo function. In the second period, the donor will again derive utility from the total amount of the public good produced, G_2, and the total contribution v_2 in the second period[7]. The donor's payo is also negatively a ected by the total contribution v_2: There are several ways we can interpret this cost. It can represent the monetary reduction in the donor's wealth. Alternatively, it can represent an indirect cost imposed on the donor as a result of ine cient management of the donor's funds (the donor could have given his money to another more e cient charity). Lastly, it is reasonable to assume that contributors spend substantial resources to investigate the quality of the implemented project. This term encompasses the cost of investigation. Therefore, the donor's expected payo function (discount factors omitted) is speci ed as follows:

[7]This could be interpreted as the warm-glow component, originally introduced by Andreoni (1989).

$$u_d(G_t; v_t) = G_1 + G_2 + (\quad 1)v_2 \tag{1}$$

where > 0 is a parameter that re ects donor's valuation of donation or public good production spending.

The payo s of the good manager types are speci ed di erently from the payo s of the bad manager types. We assume that the bad manager type cares only about the personal gain w: Therefore, the bad manager's expected payo is de ned as follows:

$$u^b_m(w_t) = w_1 + w_2 \tag{2}$$

On the other hand, the good manager type derives utility from the total production of the public good, and therefore, he obtains the largest payo when the maximum amount of the public good is produced. Hence, the good manager type's expected payo is de ned as follows:

$$u^g_m(G_t) = G_1 + G_2 \tag{3}$$

The complete speci cation of payo s at terminal nodes in Figure 1 is presented in Table 2. We abuse notation in Table 2 since we do not specify

A	$(G_1 + G_2^g; G_1 + G_2^g + (\quad 1)v_2)$
B	$(G_1; G_1)$
C	$(G_1 + G_2^{0g}; G_1 + G_2^{0g} + (\quad 1)v_2)$
D	$(G_1; G_1)$
O	$(w_1 + \quad F; G_1 + G_2^b + (\quad 1)v_2)$
P	$(w_1; G_1)$
Q	$(w_1 + \quad F; G_1 + G_2^{0b} + (\quad 1)v_2)$
R	$(w_1; G_1)$

Table 2: Revised payo s

how unit costs a ect the production of the public good in the second period. Namely, due to di erent unit costs of production, the payo s at terminal node A must not be the same as the payo s at terminal node C, since $G_2^g \neq G_2^{0g}$. Similarly, the payo s at terminal node O must not be the same as the payo at terminal node Q, since $G_2^b \neq G_2^{0b}$.

The managers' preferences satisfy the single-crossing property. The single-crossing property requires that the indi erence curves of the two manager types intersect at most once, such that the two manager types display different marginal rates of substitution when faced with the same G.

Let denote the described game that consists of two players, m and d, each player's set of actions G and v, and each player's payoff as specified in equations 1, 2 and 3. In the next section, we derive the sequential equilibria of the game .

3.3. Signaling Game Pure Strategy Sequential Equilibrium

We employ sequential equilibrium as the equilibrium solution concept of because we want to insist upon rational behavior on the part of the donor at its information set, and further, that the manager takes this into account. The solution of is the collection of strategies and beliefs that have the properties as specified by a sequential equilibrium.

A pure strategy $^{g}_{m} = (G^{g}_{c}; w^{g})$ for the good charity manager is a specification of how much public good G^{g}_{c} to produce in each period given the charity's true cost c, which in turn imply the amount of the waste w^{g} produced. Similarly, a pure strategy for the bad charity manager is a specification of the amount of the public good and waste, $^{b}_{m} = (G^{b}_{c}; w^{b})$; to be produced in each period given the charity's true cost c.

The donor is choosing how much to contribute to the incumbent charity at the end of the first period. Thus, a pure strategy for the donor is a choice of $_{d} = v_2$ where v_2 2 $[0; \quad F]$. Once the public good is produced in the first period, the donor formulates some beliefs about the manager types. Based on his beliefs (G_1); (G_1); (G_1); (G_1), the donor decides how much to contribute at the end of the first period.

Abusing notation, we call the pair $(; \; ; \; ; \; ; \quad)$ an assessment. In general, an assessment is a sequential equilibrium if and only if it is sequentially rational and consistent. An assessment is sequentially rational if each player is playing the strategy that maximizes his expected payoff given the strategy played by his opponent. An assessment is consistent if there is a sequence $(^{k}; \; ^{k}; \; ^{k}; \; ^{k}; \; ^{k})$ of assessments such that $(^{k}; \; ^{k}; \; ^{k}; \; ^{k}; \; ^{k})$! $(; \; ; \; ; \; ; \quad)$; each ^{k} is completely mixed; each $^{k}; \; ^{k}; \; ^{k}; \; ^{k}$ is derived from ^{k} using Bayes' rule.

We can make some predictions about what may happen in an equilibrium:

- the *bad* manager type could impersonate the *good* manager type in order to get a contribution in the second period, which yields the pooling equilibrium;

the *bad* manager type plays truthfully and creates a maximum amount of waste in the first period, which yields the separating equilibirum.

Therefore, we examine separating and pooling equilibria of . As it turns out, in any separating equilibrium, the donor is able to only distinguishing a good manager from a bad one; he is not able to make any inferences about the manager's true costs. We call these equilibria quasi-separating and -pooling equilibria to emphasize that the donor is not able to fully separate between all possible manager types. The complete specification of all possible sequential equilibrium strategies and beliefs consistent with these equilibrium strategies is presented in the next section.[8] The current section describes general requirements on the model parameters needed to support an equilibrium.

To solve for an equilibrium of , we start by applying backward induction. Therefore, we start by determining the optimal actions for moves at the final decision nodes in the tree. Since there are no further strategic interactions between the players at that point, the determination of optimal behavior involves a simple single-player decision problem. In the second period, the *bad* manager type will produce the maximum amount of waste, $w_2 = F$; since the game ends in this period. However, if the manager is the *good* type then he produces some amount of public good, G_2 that maximizes his payoff, and therefore, he produces no waste, $w_2 = 0$: From the budget constraint, it follows that $G_2^{good} = \frac{v_2}{c}$ and $G_2^{bad} = \frac{(v_2 + F)}{c}$ given the true costs $c \in \{c^L; c^H\}$: The resulting payoffs are given in Table 2.

Given these payoffs, the donor's optimal play at the end of the first period will depend on the posterior beliefs the donor will form based on his observation of G_1. Let G_1 be the manager's equilibrium amount of the public good produced in the first period. According to the manager's budget constraint and his objective of utility maximization, the *good* manager type will choose to produce $G_1^g = \frac{F}{c} > 0$ for $c \in \{c^L; c^H\}$. However, the *bad* manager type's optimal choice regarding the amount of the public good to produce will depend on the relative magnitude of the initial contribution. We explain this in detail in the following section.

Generally, the donor will make a contribution at the end of the first period if the expected payoff of contributing is at least as large as the expected payoff

[8] See Appendix A for complete derivation.

of not contributing. In other words, the donor examines the following:

$$(\quad (G_1) + \quad (G_1))(G_1 + G_2^g + (\quad 1)v_2) + (\quad (G_1) + \quad (G_1))(G_1 + (\quad 1)v_2) \quad G_1 \tag{4}$$

Rearranging this equation and canceling some terms we get $\frac{}{c^L} + \frac{}{c^H} \quad (1 \quad):$ Given the donor's payo in equation 1 and his budget constraint, if the donor decides to contribute, the amount of his contribution will be a corner solution, $v_2 = \quad F.$

What about the donor's o -the-equilibrium-path beliefs? In other words, let us specify the donor's beliefs when he observes some G_1^{0} such that $G_1^{0} \neq G_1$: Let the donor believe with certainty that the manager is the bad type if he observes any amount of the public good other than the equilibrium amount. In other words, $Pr(g|G_1^{0}) = 0$; or $Pr(b|G_1^{0}) = 1$: Therefore, in order for the donor to be willing to give a donation, the following has to be true.

$$(0)(G_1^{0} + G_2^g + (\quad 1)v_2) + (1)(G_1^{0} + (\quad 1)v_2) \quad G_1^{0} \tag{5}$$

This inequality requires that $(\quad 1)v_2 \quad 0$. By assumption, $\quad 2 (0;1)$; and therefore, this condition will be satis ed if and only if $v_2 = 0$: The donor does not make a contribution at the end of the rst period whenever he observes G_1^{0}:

Let us now formally state the good manager's equilibrium strategies in the rst and second periods of .[9]

Lemma 1 (Good manager's equilibrium strategies) In any sequential equilibrium of , the good manager type produces $G_1 = \frac{F}{c}$ and $G_2 = \frac{F}{c}$, where $c \ 2 \quad c^L; c^H$. A good manager type, irrespective of his true costs, maximizes his expected utility by always choosing to be truthful and by producing the maximum feasible amount of the public good, and therefore, produces no waste.[10]

We now turn to the manager type $(bad; c^H)$.

[9]The proofs of lemmas are in appendix A.

[10]Notice that by \irrespective of his true costs" we mean that the good manager type $(good; c^L)$ will not pretend to be $(good; c^H)$ because he will not bene t from that behavior. However, the costs do matter when the manager has to decide how much public good to produce.

Lemma 2 (($bad; c^H$) type's equilibrium strategies). *In any sequential equilibrium of , a bad manager type ($bad; c^H$) will choose to reveal his true type (and not impersonate ($good; c^H$) type), produce $G_1 = 0$ and create maximum amount of waste in the first period, if and only if $F \quad \frac{1}{2}$.*

We can think of this scenario as the case where the manager is able to extract some informational rent from the donor. This is the case where if the donor was able to control the initial operating budget of the charity manager, the donor would be buying information from the manager by providing him more than $\frac{1}{2}$ of the donor's wealth available for contributions in the first period. The donor needs to make sure that the manager's budget in the first period is high enough in order to induce the manager to reveal his true type. The manager profits from having informational advantage over the donor, and therefore, he is able to extract some informational rent from the donor in the first period. This is a grim result. It suggests that the only way to determine whether a manager is wasting the donor's contribution is to give him a sufficiently large amount of money to waste.

Alternatively, this is the case where the charity manager has a sufficiently large existing operating budget relative to the potential contribution that the manager could receive from the donor. Therefore, it does not pay for the charity manager to pretend to be a good type. The personal gain that the manager derives by creating waste in the first period gives him a larger expected payoff than the potential personal gain he could derive from pretending in the first period and then wasting the donation in the second period. In other words, the donor has not pledged sufficiently large amount that would give an incentive to the manager to cheat. This conclusion suggests that donors should pledge to give small amounts if they expect managers to play truthfully.

Lemma 3 (($bad; c^H$) type's equilibrium strategies). *In any sequential equilibrium of , a bad manager type ($bad; c^H$) will choose to impersonate ($good; c^H$) type, produce $G_1 = \frac{F}{c^H}$ and create no waste in the first period, if and only if $F < \frac{1}{2}$.*

Next we examine the equilibrium strategies of the manager type ($bad; c^L$).

Lemma 4 (($b; c^L$) type's equilibrium strategies). *In any sequential equilibrium of , a bad manager type ($bad; c^L$) will choose to reveal his true type (and not impersonate ($good; c^H$) type), produce $G_1 = 0$ and create maximum amount of waste in the first period, if and only if $F \quad \frac{c^H}{c^H + c^L}$.*

Case 1	$\frac{c^H}{c^H+c^L} > F \quad \frac{1}{2}$
Case 2	$F \quad \frac{1}{2}$ and $F \quad \frac{c^H}{c^H+c^L}$
Case 3	$\frac{1}{2} > F \quad \frac{c^H}{c^H+c^L}$
Case 4	$F < \frac{1}{2}$ and $F < \frac{c^H}{c^H+c^L}$

Table 3: Assumptions on parameter values

Again, we can think of this scenario as the case where the manager is able to extract some informational rent from the donor. Now, the donor is buying information from the manager by providing more than half of the donor's wealth available for contributions in the rst period to the manager. As a result, the manager pro ts from having informational advantage over the donor, and so, he is able to extract informational rents in the rst period.

Lemma 5 (($(b; c^L)$ type's equilibrium strategies) In any sequential equilibrium of , a bad manager type $(bad; c^L)$ will choose to impersonate $(good; c^H)$ type, produce $G_1 = \frac{F}{c^H}$ and create $c^H \quad c^L \quad G_1 = w_1$ amount of waste in the rst period, if and only if $F < \frac{c^H}{c^H+c^L}$.

Evidently, these results suggest that there are four potential sequential equilibria. For ease of reference, let us summarize the assumptions regarding the relative values of parameters F, , c^H and c^L in Table 3 and Figure 2.

Case 1 is a candidate for a pooling equilibrium where the bad manager type $(b; c^L)$ impersonates the good manager type $g(c^H)$.

Case 2 is a candidate for a quasi-separating equilibrium where both the low and high cost bad manager types play revealing strategies $G_1 = 0$ in the rst period. Since F cannot be bigger than , we can rewrite this condition as $\quad F \quad \frac{c^H}{c^H+c^L}$.

Case 3 is a candidate for a pooling equilibrium where the bad manager type $(b; c^H)$ impersonates the good manager type $g(c^H)$.

Case 4 is a candidate for a pooling equilibrium where both the low and high cost bad manager types play impersonating strategy $G_1 = \frac{F}{c^H}$ in the rst period. Since the lower bound on F is 0, we can rewrite this condition as $0 \quad F < \frac{1}{2}$.

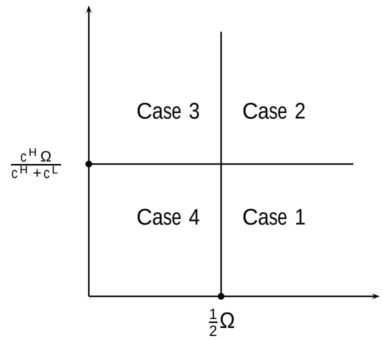

Figure 2: Equilibrium candidates

Figure 2 is an alternative way to represent all the potential equilibrium candidates. In the following section we characterize all possible pure strategy sequential equilibria of .

4. Pure Strategy Equilibria

Proposition 1. There exists no pooling equilibrium of the game where the bad manager type $(b; c^H)$ pretends to be the good manager type $(g; c^H)$.[11]

Proof. In order for such an equilibrium to exist, the condition for Case 3 in Table 3 would have to be satisfied. However, there exists no F that satisfies $\frac{1}{2} > F \quad \frac{c^H}{c^H + c^L}$. For the condition to be satisfied, there should exist c^L and c^H such that $\frac{c^H}{c^H + c^L} \quad \frac{1}{2}$. Since we have assumed that $c^L < c^H$, there are no c^L and c^H that would satisfy this condition.

For ease of reference, we summarize the relevant parameter values in Table 4.

Equilibrium IC	$0 \quad F^{IC} < \frac{1}{2}$
Equilibrium P	$\frac{1}{2} \quad F^{P} < \frac{c^H}{c^H + c^L}$
Equilibrium S	$\frac{c^H}{c^H + c^L} \quad F^{S}$

Table 4: Relevant parameter values

[11] This eliminates case 3 from the previous section as an equilibrium candidate.

Proposition 2 (Equilibrium P). In the signaling game , under the following assumptions

1. $\frac{c^H}{c^H + c^L} > F \quad \frac{1}{2}$,
2. $1 \quad (1 \quad) c^L$ and $p \quad (1 \quad) c^H (p \; + (1 \quad p)(1 \quad))$,

a quasi-pooling equilibrium exists. In this equilibrium, the donor's sequentially rational equilibrium strategies are

$$_d \;(\quad F) | \frac{F}{c^L} \; = 1; \qquad _d \;(\quad F) | \frac{F}{c^H} \; = 1; \qquad _d \;\; 0 | G_1 \neq \frac{F}{c^L}; \frac{F}{c^H} \; = 1:$$

The manager's sequentially rational equilibrium strategies in the rst period are

$$^{(g;c^L)}_m \;\; G_1 = \frac{F}{c^L} \; = 1; \qquad ^{(g;c^H)}_m \;\; G_1 = \frac{F}{c^H} \; = 1;$$

$$^{(b;c^L)}_m \;\; G_1 = \frac{F}{c^H} \; = 1; \qquad ^{(b;c^H)}_m (G_1 = 0) = 1:$$

The donor's posterior beliefs, consistent with the equilibrium strategies, are[12]

$$G_1 = \frac{F}{c^L} \; = 1; \qquad (G_1 = 0) = 1;$$

$$G_1 = \frac{F}{c^H} \; = \frac{p}{p \; + (1 \quad p)(1 \quad)}; \qquad G_1 = \frac{F}{c^H} \; = \frac{(1 \quad p)(1 \quad)}{p \; + (1 \quad p)(1 \quad)}:$$

Proof. See appendix A.

Equilibrium P is a quasi-pooling equilibrium, as only manager type $(b; c^L)$ plays $G_1 = \frac{F}{c^H}$ with certainty, and therefore impersonates $(g; c^H)$ manager type. Manager type $(b; c^H)$ reveals his type in this equilibrium. In addition, the donor believes with certainty that the manager is type $(g; c^L)$ whenever he observes $G_1 = F/c^L$. The donor also believes with certainty that the manager is bad type whenever he observes $G_1 = 0$, irrespective of manager's

[12]Since it has to be that $+ \; + \; + \; = 1$ then $Pr(g; c^L | G_1 = \frac{F}{c^H}) = Pr \; g; c^L | G_1 = 0 \; = Pr(g; c^H | G_1 = \frac{F}{c^L}) = Pr \; g; c^H | G_1 = 0 \; = Pr(b; c^L | G_1 = \frac{F}{c^L}) = Pr \; b; c^L | G_1 = 0 \; = Pr(b; c^H | G_1 = \frac{F}{c^L}) = Pr(b; c^H | G_1 = \frac{F}{c^H}) = 0$.

true production costs. When the donor observes $G_1 = F = c^H$, the donor believes with positive probabilities that the manager is type $(g; c^H)$ and $(b; c^L)$. Therefore, upon observing $G_1 = \frac{F}{c^L}$ or $G_1 = \frac{F}{c^H}$ the donor's best response is to play $v_2 = \quad F$ with certainty. And if the donor observes any other G_1 then his best response is to play $_2 = 0$ with certainty.

Proposition 3 (Equilibrium S). In the signaling game , under the following assumptions

1. $F \quad \frac{c^H}{c^H + c^L}$,
2. $1 \quad (1 \quad)c$ and $c \; 2 \quad c^L; c^H$,

a quasi-separating equilibrium exists. In this equilibrium, the donor's sequentially rational equilibrium strategies are

$$_d \; (\quad F)|\frac{F}{c^L} \quad = 1; \qquad _d \; (\quad F)|\frac{F}{c^H} \quad = 1; \qquad _d \quad 0|G_1 \neq \frac{F}{c^L}; \frac{F}{c^H} \quad = 1:$$

The manager's sequentially rational equilibrium strategies in the rst period are

$$^{(g;c^L)}_m \quad G_1 = \frac{F}{c^L} \quad = 1; \qquad ^{(g;c^H)}_m \quad G_1 = \frac{F}{c^H} \quad = 1;$$

$$^{(b;c^L)}_m (G_1 = 0) = 1 \; ; \qquad ^{(b;c^H)}_m (G_1 = 0) = 1 \; :$$

The donor's posterior beliefs, consistent with the equilibrium strategies, are[13]

$$G_1 = \frac{F}{c^L} \quad = 1; \qquad (G_1 = 0) = \; p;$$

$$G_1 = \frac{F}{c^H} \quad = 1; \qquad (G_1 = 0) = (1 \quad p):$$

Proof. See appendix A.

Equilibrium S is a quasi-separating equilibrium, as manager types $(b; c^L)$ and $(b; c^H)$ play $G_1 = 0$ with certainty. Upon observing this G_1 the donor believes the manager is $(b; c^L)$ type with probability $1 \quad p$, and $(b; c^H)$ type with probability p. Since the donor cannot be certain of the manager's true cost type upon observing $G_1 = 0$, we call this a quasi-separating equilibrium.

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[13] Since it has to be that $\; + \; + \; + \; = 1$ then $Pr(g; c^L|G_1 = \frac{F}{c^H}) = Pr \;\; g; c^L|G_1 = 0 \;\; = Pr(g; c^H|G_1 = \frac{F}{c^L}) = Pr \;\; g; c^H|G_1 = 0 \;\; = Pr(b; c^L|G_1 = \frac{F}{c^L}) = Pr(b; c^L|G_1 = \frac{F}{c^H}) = Pr(b; c^H|G_1 = \frac{F}{c^L}) = Pr(b; c^H|G_1 = \frac{F}{c^H}) = 0$.

Proposition 4 (Equilibrium IC). In the signaling game , under the following assumptions

1. $0 \quad F < \frac{1}{2}$,
2. $(1 \quad)c^L$, and $\frac{p}{c^H(1 \quad + p \ )} \quad (1 \quad)$

a quasi-pooling equilibrium exists. In this equilibrium, the donor's sequentially rational equilibrium strategies are

$$_d \ (\quad F)|\frac{F}{c^L} \quad = 1; \qquad _d \ (\quad F)|\frac{F}{c^H} \quad = 1; \qquad _d \ 0|G_1 \neq \frac{F}{c^L}; \frac{F}{c^H} \quad = 1:$$

The manager's sequentially rational equilibrium strategies in the rst period are

$$^{(g;c^L)}_m \ G_1 = \frac{F}{c^L} \quad = 1; \qquad ^{(g;c^H)}_m \ G_1 = \frac{F}{c^H} \quad = 1;$$

$$^{(b;c^L)}_m \ G_1 = \frac{F}{c^H} \quad = 1; \qquad ^{(b;c^H)}_m \ G_1 = \frac{F}{c^H} \quad = 1:$$

The donor's posterior beliefs, consistent with the equilibrium strategies, are[14]

$$G_1 = \frac{F}{c^L} \quad = 1; \qquad G_1 = \frac{F}{c^H} \quad = \frac{p(1 \quad)}{1 \quad + p};$$

$$G_1 = \frac{F}{c^H} \quad = \frac{p}{1 \quad + p}; \qquad G_1 = \frac{F}{c^H} \quad = \frac{(1 \quad p)(1 \quad)}{1 \quad + p};$$

$$(G_1 = 0) = (1 \quad p) \ ; \qquad (G_1 = 0) = \ p(1 \quad);$$

$$(G_1 = 0) = \ p \ ; \qquad (G_1 = 0) = (1 \quad p)(1 \quad):$$

Proof. See appendix A.

In this equilibrium, the donor believes with certainty that the manager is type $(g; c^L)$ whenever he observes $G_1 = F=c^L$. Whenever the donor observes $G_1 = 0$, he believes with positive probabilities that it can be any possible type. When the donor observes $G_1 = \frac{F}{c^H}$, the donor believes with positive probabilities that the manager is type $(g; c^H)$, $(b; c^L)$ and $(b; c^H)$. In addition, $(b; c^H)$, $(b; c^L)$ and $(g; c^H)$ manager types play $G_1 = \frac{F}{c^H}$, and $(g; c^L)$ manager type plays $G_1 = \frac{F}{c^L}$.

[14] Since it has to be that $\quad + \quad + \quad + \quad = 1$ then $Pr(g; c^L|G_1 = \frac{F}{c^H}) = Pr(g; c^H|G_1 = \frac{F}{c^L}) = Pr(b; c^L|G_1 = \frac{F}{c^L}) = Pr(b; c^H|G_1 = \frac{F}{c^L}) = 0$.

Proposition 5. There exist no fully separating and fully pooling sequential equilibria of the signaling game .

Proof. A fully separating equilibrium is an equilibrium in which, upon observing the equilibrium amount of the public good produced in the rst period, the donor would be able to dicern the speci c type of the manager he encountered given the all four possible types. As we have already shown, in any sequential equilibrium of the game , type $(g; c^L)$ plays $G_1 = \frac{F}{c^L}$ and type $(g; c^H)$ plays $G_1 = \frac{F}{c^H}$. Let the equilibrium strategies that types $(b; c^L)$ and $(b; c^H)$ play be $G_1 = Y$ and $G_1 = Z$, respectivelly. A fully separating sequential equilibrium of the game would require that $Y \neq Z \neq \frac{F}{c^H} \neq \frac{F}{c^L}$. However, as we have shown, in any equilibrium both types $(b; c^L)$ play either $G_1 = 0$ or $G_1 = \frac{F}{c^H}$. Therefore, there is no fully separating equilibrium of the game .

4.1. Intuitive Criterion

Signaling games are plagued by the multiplicity of equilibria due to the wealth of o -the-equilibrium path beliefs that can be imposed on the uninformed player. In order to reduce the number of equilibria of the signaling game , we use the re nement known as the Intuitive Criterion of Cho and Kreps (1987). The Intuitive Criterion requires that we put some restrictions on o -the-equilibrium path beliefs. Loosely speaking, the manager will not play a strategy that is not a part of an equilibrium. Therefore, we should restrict the donor's beliefs by placing a zero probability on such events. In other words, we remove from the game the possiblity that the manager will play o -the-equilibrium path strategy. Let us now state this formally.

De nition 1 (Wolfstetter (1999)). Consider an equilibrium and associated belief system. The belief system satis es the Intuitive Criterion if, for all out-of-equilibrium actions y, it puts zero probability on that type who is sure to lose by taking this action y, relative to that type's payo in the assumed equilibrium.

We apply the Intuitive Criterion of Cho and Kreps (1987) to all our equilibria, and examine which one, if any, fail the Intuitive Criterion. We summarize our ndings as follows.

Proposition 6. The Intuitive Criterion rules out the pooling equilibrium, equilibrium IC, of the signaling game . The quasi-separating and pooling equilibria of the signaling game , equilibrium P and equilibrium S, respectively, pass the Intuitive Criterion.

Proof. Recall that the donor places positive probability $(G_1 = 0) = (1$ $p)$ on the event that type $(g; c^L)$ makes an out-of-equilibrium move $G_1 = 0$.[15] Fix the amount of the public good produced in the second period to $\overline{G}_2$. If this manager type were to make this out-of-equilibrium move $G_1 = 0$, his expected payo would be $\overline{G}_2$. And if this manager type played his equilibrium strategy $G_1 = \frac{F}{c^L}$, his exptected payo would be $G_1 = \frac{F}{c^L} + \overline{G}_2$. Therefore, the manager would reduce his expected payo if he made this out-of-equilibrium move instead of play his equilibrium strategy. Consequently, the donor should place zero probability on the event that this manager type plays $G_1 = 0$, or $(G_1 = 0) = 0$. Similar analysis can be applied to obtain the results for equilibria P and S.

Therefore, we rule out equilibrium IC as a solution of the signaling game . In the next section, we examine e ciency of our results for equilibria P and S.

5. E ciency of Equilibria P and S

In this section we evaluate e ciency implications of each equilibrium outcome of the signaling game . We do not use the standard notion of e ciency, Pareto e ciency. Instead, we de ne an equilibrium outcome that results in the lowest expected waste as the more e cient and desirable equilibrium.

In order to evaluate and compare e ciency of the equilibrium outcomes of the signaling game , we make a comparison between total expected wastes in each equilibrium. Let EW^P be the total expected waste in equilibrium P. EW^P is calcualted as follows.

$$EW^P = (1 \quad)(1 \quad p) \qquad F^P + (c^H \quad c^L)F^P \quad + (1 \quad)pF^P$$
$$= (1 \quad)(1 \quad p) \quad + (\ c^H \quad c^L)F^P \quad :$$

Let EW^S be the total expected waste in equilibrium S. EW^S is calcualted as follows.

$$EW^S = (1 \quad)pF^S + (1 \quad)(1 \quad p)F^S =$$
$$= (1 \quad)F^S:$$

---

[15] For detailed calculations, refer to appendix A.

Since the intuitive criterion rules out equilibrium IC, we only compare the total expected waste obtained in equilibria P and S, which are summarized in Table 5.

EW^P	$(1 \quad)(1 \quad p) \quad + (\quad c^H \quad c^L)F^P$
EW^S	$(1 \quad)F^S$

Table 5: Expected waste

Let us rst note some observations.

The higher the F, ceteris paribus, the greater the expected waste in both equilibria.

The higher the di erence between the high production cost c^H and the low production cost c^L, ceteris paribus, the higher the expected waste in equilibrium P.

The higher the probability of a high unit cost, p, ceteris paribus, the lower the expected waste in the pooling equilibrium.

Let the amount of the rst period donation in the pooling equilibrium be the smallest feasible amount, $F^P = \frac{1}{2}$. Also, let the amount of the rst period donation in the separating equilibrium be the largest feasible amount, $F^S = \;$.

Proposition 7. Ceteris paribus, the higher the high unit cost c^H relative to the low unit cost c^L, the higher the expected waste in the pooling equilibrium. Ceteris paribus, the higher the probability of the low unit cost $(1 \quad p)$, the higher the expected waste in the pooling equilibrium.

Proof. Replace the rst period donations in the two equilibrium outcomes with the smallest feasible amount, $F^P = \frac{1}{2}$ and the largest feasible amount, $F^S = \;$, and normalize the low unit cost c^L. Let the di erence $EW^S \quad EW^P$ be $EW = 1 \quad \frac{1}{2}(1 \quad p)c^H$, which we calculate as follows,

$$EW = (1 \quad) \quad (1 \quad)(1 \quad p) \quad + (\quad c^H \quad c^L)\frac{1}{2} \quad ;$$

$$EW = 1 \quad \frac{1}{2}(1 \quad p)c^H :$$

Note that whenever EW 0, the expected waste in the separating equilibrium is at least as large the expected waste in the pooling equilibrium. Whenever EW 0, the expected waste in the pooling equilibrium is at least as large the expected waste in the separating equilibrium. Evidently, in terms of the expected waste, it is difficult to conclude which equilibrium is more desirable, since the comparison depends on several parameter values. For certain high values of c^H and $(1 - p)$, the separating equilibrium is more desirable. Conversely, if c^H is relatively small comapared to c^L, and $(1 - p)$ is small, then the pooling equilibrium is more desirable. In this instance, the public good production in the first period is beneficial to the society more than the creation of waste is harmful.

6. Conclusion

The main contribution of this paper consists of designing a two-period model of the philanthropic sector in which both a wealthy donor and a charity manager are strategic players. The existing literature regarding charitable giving typically assumes perfect information. We argue that, due to numerous factors including the lack of regulation of the philanthropic sector, it is difficult to evaluate a charity's success and efficiency. Therefore, our model assumes imperfect information regarding the types of the manager the donor faces. We examine moral hazard and adverse selection problems that arise in the specified game.

Sequential equilibria of the game are characterized. We find two surviving equilibria after we apply intuitive criterion of Cho and Kreps (1987): a pooling equilibrium and a separating equilibrium. Our results suggest that the donor could induce his desired equilibrium by selecting an appropriate contribution amount in the first period. In the pooling equilibrium, a bad manager type pretends to be a good manager type in the first period of the game in order to obtain the donation from the donor in the second period of the game. The manager produces the public good in the first period but wastes the donation in the second period. In the separating equilibrium, bad manager types waste the first period donation. As a result, no public good is produced.

To deal with the problem of multiple equilibria, in future research we might use a commitment device as a mechanism to overcome a bad manager type's incentive to pool with the good manager type. In order to overcome this problem, the donor must offer some sort of compensation to the manager in order to induce him to play truthfully. The donor's o er must allow the manger to maximize his expected utility under participation and incentive compatibility constraints and give him at least as much utility as he would get if he played according to the original speci cations of the game.

Our results suggest that the donor cannot achieve the maximum feasible production of the public good whenever he is facing wasteful managers. In the separating equilibrium, if the donor faces a wasteful manager, the public good will not be produced. In pursuit to overcome this grim result, in future research we might modify our model by utilizing an overlapping generations model of donors.

A. Appendix

Proof of Lemma 1.

Proof. The good manager type, regardless of his true costs, produces the maximum feasible amount of the public good in both periods, since this will maximize his expected utility. In other words, if the manager type is $(good; c^H)$, he will produce $G_1 = \frac{F}{c^H}$, which gives him $EU = \frac{F}{c^H} + G_2$, where $G_2 = \frac{F}{c^H}$. It is infeasible for him to produce $G_1 = \frac{F}{c^L}$. If he produces $G_1 = 0$, his expected utility is $EU = 0$. Similar analysis goes for the manager type $(good; c^L)$. This manager type will not pretend to be type $(good; c^H)$ since $\frac{F}{c^L} > \frac{F}{c^H}$. Being truthful and producing $\frac{F}{c^L}$ in the rst period will result in the highest expected utility for the manager. Therefore, the dominant strategy for the good manager type is to be honest and produce $G_1 = \frac{F}{c^L}$ and $G_2 = \frac{F}{c^L}$ whenever he is a low-cost type, or $G_1 = \frac{F}{c^H}$ and $G_2 = \frac{F}{c^H}$ whenever he is a high-cost type. There are no pro table deviations for the good manager type.

Proof of Lemma 2.

Proof. $(bad; c^H)$ manager type has a choice to either pretend to be a good manager or to reveal his true type. In other words, the manager can play the following:

1. $G_1 = \frac{F}{c^H}$, in which case his expected utility is $EU_m^{b;c^H} = 0 + (\quad F)$, or
2. $G_1 = 0$, in which case his expected utility is $EU_m^{b;c^H} = F$.

Playing $\frac{F}{c^L}$ is infeasible since $\frac{F}{c^L} > \frac{F}{c^H}$, and this manager type can a ord to produce at most $\frac{F}{c^H}$. The manager will choose to reveal his true type if $F \quad \frac{1}{2}$, as this will maximize his expected utility.

Proof of Lemma 3.

P r o o f. $(bad; c^H)$ manager type has a choice to either pretend to be a good manager or to reveal his true type. In other words, the manager can play the following:

1. $G_1 = \frac{F}{c^H}$, in which case his expected utility is $EU_m^{b;c^H} = 0 + (\quad F)$, or
2. $G_1 = 0$, in which case his expected utility is $EU_m^{b;c^H} = F$.

Playing $\frac{F}{c^L}$ is infeasible since $\frac{F}{c^L} > \frac{F}{c^H}$, and this manager type can a ord to produce at most $\frac{F}{c^H}$. The manager will choose to pretend if $F < \frac{1}{2}$, as this will maximize his expected utility.

Proof of Lemma 4.

P r o o f. $(b; c^L)$ manager type also has a choice to either pretend to be a good manager or to reveal his true type. Let $c^H \quad c^L \quad G_1 = w_1$ be the amount of waste that this bad manager type can create in the rst period if he pretends to be a good manager with high production costs. In other words, the manager produces $G_1 = \frac{F}{c^H}$. Therefore, the manager can play the following:

1. $G_1 = \frac{F}{c^L}$, in which case his expected utility is $EU_m^{b;c^L} = 0 + (\quad F)$,
2. $G_1 = \frac{F}{c^H}$, in which case his expected utility is $EU_m^{b;c^L} = w_1 + (\quad F)$, or
3. $G_1 = 0$, in which case his expected utility is $EU_m^{b;c^L} = F$.

Playing $\frac{F}{c^L}$ is feasible since $\frac{F}{c^L} > \frac{F}{c^H}$, and this manager type can a ord to produce at most $\frac{F}{c^L}$. Notice that if this bad manager type decides to impersonate a good manager type he will always nd it more pro table to pretend to be $(g; c^H)$ type than $(g; c^L)$ type since $w_1 + (\quad F) \quad (\quad F)$. Therefore, he will never choose to impersonate $(g; c^L)$ type. When $F \quad \frac{c^H}{c^H + c^L}$, pretending to be a good type will not result in a higher expected utility, and therefore, this manager type will choose to reveal his true type by creating the maximum amount of waste in the rst period.

Proof of Lemma 5.

P r o o f. $(b; c^L)$ manager type also has a choice to either pretend to be a good manager or to reveal his true type. Let $c^H \quad c^L \quad G_1 = w_1$ be the amount of waste that this bad manager type can create in the rst period if he pretends to be a good manager with high production costs. In other words, the manager produces $G_1 = \frac{F}{c^H}$. Therefore, the manager can play the following:

1. $G_1 = \frac{F}{c^L}$, in which case his expected utility is $EU_m^{b;c^L} = 0 + (\quad F)$,
2. $G_1 = \frac{F}{c^H}$, in which case his expected utility is $EU_m^{b;c^L} = v_1 + (\quad F)$, or
3. $G_1 = 0$, in which case his expected utility is $EU_m^{b;c^L} = F$.

Playing $\frac{F}{c^L}$ is feasible since $\frac{F}{c^L} > \frac{F}{c^H}$, and this manager type can a ord to produce at most $\frac{F}{c^L}$. Notice that if this bad manager type decides to impersonate a good manager type he will always nd it more pro table to pretend to be $(g; c^H)$ type than $(g; c^L)$ type since $v_1 + (\quad F) \quad (\quad F)$. Therefore, he will never choose to impersonate $(g; c^L)$ type. When $F < \frac{c^H}{c^H + c^L}$, pretending to be a good type will result in a higher expected utility, and therefore, this manager type will choose to pretend to be a good type by producing $G_1 = \frac{F}{c^H}$.

Proof of Proposition 2.

Proof. Let us rst present a complete speci cation of equilibrium P, and then show that the condition regarding the consistency of strategies and beliefs is satis ed. The donor's equilibrium beliefs are speci ed in Table 6. The table shows that the donor will believe with certainty that the manager is type $(g; c^L)$ whenever he observes $G_1 = F = c^L$. The donor also believes with certainty that the manager is bad type whenever he observes $G_1 = 0$, irrespective of manager's true production costs. When the donor observes $G_1 = F = c^H$, the donor believes with positive probabilities that the manager is type $(g; c^H)$ and $(b; c^L)$.

Table 7 summarizes the manager's equilibrium strategies. The table shows that $(b; c^H)$ manager type plays $G_1 = 0$, $(b; c^L)$ and $(g; c^H)$ manager types play $G_1 = \frac{F}{c^H}$, and $(g; c^L)$ manager type plays $G_1 = \frac{F}{c^L}$.

Table 8 summarizes the donor's equilibrium strategies. The table shows that upon observing $G_1 = \frac{F}{c^L}$ or $G_1 = \frac{F}{c^H}$ the donor's best response is to play $v_2 = \quad F$ with certainty. And if the donor observes any other G_1 then his best response is to play $v_2 = 0$ with certainty. We now show that the beliefs and strategies are consistent. We start by rewriting the manager's strategies in Table 9 such that each feasible strategy is played with positive probability. Then we apply Bayes' rule to derive the donor's beliefs $(; ;)$ using the manager's behavior strategy . Let > 0 be some small positive number.

$(G_1 = \frac{F}{c^L}) = 1$	$(G_1 = \frac{F}{c^H}) = 0$	$(G_1 = 0) = 0$
$(G_1 = \frac{F}{c^L}) = 0$	$(G_1 = \frac{F}{c^H}) = \frac{p}{p \ \ +(1 \ \ p)(1 \ \ \ )}$	$(G_1 = 0) = 0$
$(G_1 = \frac{F}{c^L}) = 0$	$(G_1 = \frac{F}{c^H}) = \frac{(1 \ \ p)(1 \ \ \ )}{p \ \ +(1 \ \ p)(1 \ \ \ )}$	$(G_1 = 0) = 0$
$(G_1 = \frac{F}{c^L}) = 0$	$(G_1 = \frac{F}{c^H}) = 0$	$(G_1 = 0) = 1$

Table 6: Donor's beliefs in equilibrium P

Nature	types	$G_1 = 0$	$G_1 = \frac{F}{c^H}$	$G_1 = \frac{F}{c^L}$
(1 p)	$(g; c^L)$	0	0	1
p	$(g; c^H)$	0	1	infeasible
(1 p)(1)	$(b; c^L)$	0	1	0
p(1)	$(b; c^H)$	1	0	0

Table 7: Manager's strategies in equilibrium P

$$
\begin{aligned}
(G_1 = \frac{F}{c^L}) &= \frac{(1 \quad p) \ (1 \quad 2\ )}{(1 \quad p) \ (1 \quad 2\ ) + (1 \quad p)(1 \quad \ ) \ + (1 \quad \ )p} \\
&= \frac{(1 \quad p) \ (1 \quad 2\ )}{(1 \quad p) \ (1 \quad 2\ ) + \ (1 \quad \ )} \\
&= \quad ! \ 1
\end{aligned}
$$

$$
\begin{aligned}
(G_1 = \frac{F}{c^H}) &= \frac{p \ (1 \quad 2\ )}{p \ (1 \quad 2\ ) + (1 \quad p) \quad + (1 \quad p)(1 \quad \ )(1 \quad 2\ ) + (1 \quad \ )p} \\
&= \frac{p \ (1 \quad 2\ )}{[p \ \ + (1 \quad p)(1 \quad \ )(1 \quad 2\ )] + \ (\ \ + p)} \\
&= \quad ! \ \frac{p}{p \ \ + (1 \quad p)(1 \quad \ )}
\end{aligned}
$$

$$
\begin{aligned}
(G_1 = \frac{F}{c^H}) &= \frac{(1 \quad p)(1 \quad \ )(1 \quad 2\ )}{(1 \quad p)(1 \quad \ )(1 \quad 2\ ) + (1 \quad p) \quad + p \ (1 \quad 2\ ) + (1 \quad \ )p} \\
&= \frac{(1 \quad p)(1 \quad \ )(1 \quad 2\ )}{[p \ \ + (1 \quad p)(1 \quad \ )(1 \quad 2\ )] + \ (\ \ + p)} \\
&= \quad ! \ \frac{(1 \quad p)(1 \quad \ )}{p \ \ + (1 \quad p)(1 \quad \ )}
\end{aligned}
$$

G_1	$\frac{F}{c^L}$	$\frac{F}{c^H}$	$\not\in \frac{F}{c^L}; \frac{F}{c^H}$
$v_2(\quad F)$	1	1	0
$v_2(0)$	0	0	1

Table 8: Donor's equilibrium strategies

Nature	types	$G_1 = 0$	$G_1 = \frac{F}{c^H}$	$G_1 = \frac{F}{c^L}$
$(1 \quad p)$	$(g; c^L)$			$1 \quad 2$
p	$(g; c^H)$		$1 \quad 2$	infeasible
$(1 \quad p)(1 \quad)$	$(b; c^L)$		$1 \quad 2$	
$p(1 \quad)$	$(b; c^H)$	$1 \quad 2$		

Table 9: Manager's strategies in equilibrium P

$$\begin{aligned}(G_1 = 0) &= \frac{(1 \quad p)(1 \quad)}{(1 \quad p)(1 \quad) + p \quad + (1 \quad p) \quad + (1 \quad)p(1 \quad 2)} \\ &= \frac{(1 \quad p)(1 \quad)}{p(1 \quad) + \quad (1 + 3p \quad 3p)} \\ &= \quad ! \ 0\end{aligned}$$

$$\begin{aligned}(G_1 = 0) &= \frac{p(1 \quad)(1 \quad 2)}{p(1 \quad)(1 \quad 2) + (1 \quad p) \quad + p \quad + (1 \quad p)(1 \quad)} \\ &= \frac{p(1 \quad)(1 \quad 2)}{p(1 \quad)(1 \quad 2) + \quad (1 \quad p + p \ )} \\ &= \quad ! \ 1\end{aligned}$$

We have checked that the strategies are sequentially rational in section 3.3. Here, we summarize that analysis and present an intuitive proof. Given that all the model parameters are common knowledge, the donor can correctly anticipate the manager's behavior. Under the assumption that $F > \frac{1}{2}$, the donor will correctly anticipate that the manager type $(b; c^H)$ will not pro t from pretending to be type $(g; c^H)$. Therefore, upon observing $\frac{F}{c^H}$ the donor believes with certainty that he has not encountered manager $(b; c^H)$ type. Upon observing $G_1 = 0$ the donor is certain he has encountered manager $(b; c^H)$ type. Similarly, the donor also correctly anticipates that the manager type $(b; c^L)$ will not pro t from pretending to be type $(g; c^L)$. Upon observing $\frac{F}{c^L}$ the donor believes with certainty that he has encountered a good manager,

$(g; c^L)$ type. The donor contributes when $\frac{1}{c^L}$ (1), which follows from inequality 4.

In this equilibrium, under the assumption that $F < \frac{c^H}{c^H + c^L}$, the donor predicts that the manager type $(b; c^L)$ will pretend to be type $(g; c^H)$. Therefore, when the donor observes $\frac{F}{c^H}$, he believes with positive probabilities that the manager is either type $(b; c^L)$ or type $(g; c^H)$. Does it make sense for the donor to give a contribution of $v_2 =$ F with certainty when he observes $\frac{F}{c^H}$, since there is a chance that the manager is a bad type? In other words, does this behavior still maximize the donor's payo ? It does if the inequality 4 is satis ed. This condition is satis ed when $\frac{p}{c^H (p + (1 \quad p)(1 \quad))}$ (1).

Proof of Proposition 3.

Proof. Let us rst present a complete speci cation of equilibrium S, and then show that the condition regarding consistency of strategies and beliefs is satis ed. The donor's equilibrium beliefs are speci ed in Table 10. The table shows that the donor will believe with certainty that the manager is type $(g; c^L)$ whenever he observes $G_1 = F{=}c^L$ and type $(g; c^H)$ whenever he observes $G_1 = F{=}c^H$. When the donor observes $G_1 = 0$, the donor believes with positive probabilities that the manager is type $(b; c^H)$ and $(b; c^L)$.

Table 11 summarizes the manager's equilibrium strategies, and shows that $(b; c^H)$ and $(b; c^L)$ manager types play revealing strategy $G_1 = 0$, $(g; c^H)$ manager types play $G_1 = \frac{F}{c^H}$, and $(g; c^L)$ manager type plays $G_1 = \frac{F}{c^L}$.

Table 8 summarizes the donor's equilibrium strategies, which are the same in all equilibria. We now show that the beliefs and strategies are conistent.

$(G_1 = \frac{F}{c^L}) = 1$	$(G_1 = \frac{F}{c^H}) = 0$	$(G_1 = 0) = 0$
$(G_1 = \frac{F}{c^L}) = 0$	$(G_1 = \frac{F}{c^H}) = 1$	$(G_1 = 0) = 0$
$(G_1 = \frac{F}{c^L}) = 0$	$(G_1 = \frac{F}{c^H}) = 0$	$(1 = 0) = (1 \quad p)$
$(G_1 = \frac{F}{c^L}) = 0$	$(G_1 = \frac{F}{c^H}) = 0$	$(G_1 = 0) = p$

Table 10: Donor's beliefs in equilibrium S

We start by rewriting the manager's strategies in Table 12 such that each strategy is played with positive probability. Then we apply Bayes' rule to derive the donor's beliefs (; ;) using the manager's behavior strategy . Let > 0 be some small positive number.

Nature	types	$G_1 = 0$	$G_1 = \frac{F}{c^H}$	$G_1 = \frac{F}{c^L}$
(1 p)	$(g; c^L)$	0	0	1
p	$(g; c^H)$	0	1	infeasible
(1 p)(1)	$(b; c^L)$	1	0	0
p(1)	$(b; c^H)$	1	0	0

Table 11: Manager's strategies in equilibriumS

Nature	types	$G_1 = 0$	$G_1 = \frac{F}{c^H}$	$G_1 = \frac{F}{c^L}$
(1 p)	$(g; c^L)$			1 2
p	$(g; c^H)$		1 2	infeasible
(1 p)(1)	$(b; c^L)$	1 2		
p(1)	$(b; c^H)$	1 2		

Table 12: Manager's strategies in equilibriumS

$$\begin{aligned}(G_1 = \frac{F}{c^L}) &= \frac{(1 \quad p) \ (1 \quad 2\ )}{(1 \quad p) \ (1 \quad 2\ ) + (1 \quad p)(1 \quad) \ + (1 \quad)p} \\ &= \frac{(1 \quad p) \ (1 \quad 2\ )}{(1 \quad p) \ (1 \quad 2\ ) + \ (1 \quad)} \\ &= \ ! \ 1\end{aligned}$$

$$\begin{aligned}(G_1 = \frac{F}{c^H}) &= \frac{p \ (1 \quad 2\ )}{p \ (1 \quad 2\ ) + p \quad + (1 \quad p)(1 \quad) \ + (1 \quad)p} \\ &= \frac{p \ (1 \quad 2\ )}{p \ (1 \quad 2\ ) + \ (1 \quad p\ )} \\ &= \ ! \ 1\end{aligned}$$

$$\begin{aligned}(G_1 = 0) &= \frac{(1 \quad p)(1 \quad)(1 \quad 2\ )}{(1 \quad p)(1 \quad)(1 \quad 2\ ) + p \quad + (1 \quad p) \quad + (1 \quad)p(1 \quad 2\ )} \\ &= \frac{(1 \quad p)(1 \quad)(1 \quad 2\ )}{(1 \quad p)(1 \quad)(1 \quad 2\ ) + \quad p \quad + p \quad + p(1 \quad)(1 \quad 2\ )} \\ &= \frac{(1 \quad p)(1 \quad)(1 \quad 2\ )}{[(1 \quad p) + p][(1 \quad)(1 \quad 2\ )] + } \\ &= \ ! \ (1 \quad p)\end{aligned}$$

$$(G_1 = 0) = \frac{p(1 \quad)(1 \quad 2 \;)}{p(1 \quad)(1 \quad 2 \;) + (1 \quad p) \quad + p \quad + (1 \quad p)(1 \quad)(1 \quad 2 \;)}$$
$$= \frac{p(1 \quad)(1 \quad 2 \;)}{p(1 \quad)(1 \quad 2 \;) + \quad + (1 \quad p)(1 \quad)(1 \quad 2 \;)}$$
$$= \frac{p(1 \quad)(1 \quad 2 \;)}{[(1 \quad)(1 \quad 2 \;)][(p + 1 \quad p)] + }$$
$$= \quad ! \; p$$

We have checked that the strategies are sequentially rational in section 3.3. Here, we summarize that analysis and present an intuitive proof. Given that all the model parameters are common knowledge, the donor can correctly anticipate the manager's behavior. Under the assumption that F $\frac{c^H}{c^H + c^L}$, the donor correctly anticipates that the manager type $(b; c^H)$ cannot pro t from pretending to be type $(g; c^H)$. Therefore, upon observing $\frac{F}{c^H}$ the donor believes with certainty that he has not encountered manager $(b; c^H)$ type. Upon observing $G_1 = 0$ the donor is certain that he has encountered a bad manager type. Similarly, the donor also correctly anticipates that the manager type $(b; c^L)$ cannot pro t from pretending to be type $(g; c^L)$. Upon observing $\frac{F}{c^L}$ the donor believes with certainty that he has encountered a good manager, $(g; c^L)$ type. The donor contributes when $1 \quad (1 \quad)c$, $c = c^l; c^H$, which follows from inequality 4.

Proof of Proposition 4.

Proof. Let us rst present a complete speci cation of equilibrium IC, and then show that the condition regarding consistency of strategies and beliefs is satis ed. The donor's equilibrium beliefs are speci ed in Table 13. The table shows that the donor will believe with certainty that the manager is type $(g; c^L)$ whenever he observes $G_1 = F = c^L$. Whenever the donor observes $G_1 = 0$, he believes with positive probabilities that it can be any possible type. When the donor observes $G_1 = \frac{F}{c^H}$, the donor believes with positive probabilities that the manager is type $(g; c^H)$, $(b; c^L)$ and $(b; c^H)$.

Table 14 summarizes the manager's equilibrium strategies. The table shows that $(b; c^H)$, $(b; c^L)$ and $(g; c^H)$ manager types play $G_1 = \frac{F}{c^H}$, and $(g; c^L)$ manager type plays $G_1 = \frac{F}{c^L}$.

Table 8 summarizes the donor's equilibrium strategies, which are the same in all equilibria. We now show that the beliefs and strategies are conistent. We start by rewriting the manager's strategies in Table 15 such that each

$(G_1 = \frac{F}{c^L}) = 1$	$(G_1 = \frac{F}{c^H}) = 0$	$(G_1 = 0) = (1 \quad p)$
$(G_1 = \frac{F}{c^L}) = 0$	$(G_1 = \frac{F}{c^H}) = \frac{p}{1 \quad + p}$	$(G_1 = 0) = p$
$(G_1 = \frac{F}{c^L}) = 0$	$(G_1 = \frac{F}{c^H}) = \frac{(1 \quad p)(1 \quad)}{1 \quad + p}$	$(G_1 = 0) = (1 \quad p)(1 \quad)$
$(G_1 = \frac{F}{c^L}) = 0$	$(G_1 = \frac{F}{c^H}) = \frac{p(1 \quad)}{1 \quad + p}$	$(G_1 = 0) = p(1 \quad)$

Table 13: Donor's beliefs in equilibrium IC

Nature	types	$G_1 = 0$	$G_1 = \frac{F}{c^H}$	$G_1 = \frac{F}{c^L}$
$(1 \quad p)$	$(g; c^L)$	0	0	1
p	$(g; c^H)$	0	1	infeasible
$(1 \quad p)(1 \quad)$	$(b; c^L)$	0	1	0
$p(1 \quad)$	$(b; c^H)$	0	1	0

Table 14: Manager's strategies in equilibrium IC

strategy is played with positive probability. Then we apply Bayes' rule to derive the donor's beliefs (; ;) using the manager's behavior strategy . Let > 0 be some small positive number.

Nature	types	$G_1 = 0$	$G_1 = \frac{F}{c^H}$	$G_1 = \frac{F}{c^L}$
$(1 \quad p)$	$(g; c^L)$			$1 \quad 2$
p	$(g; c^H)$		$1 \quad 2$	infeasible
$(1 \quad p)(1 \quad)$	$(b; c^L)$		$1 \quad 2$	
$p(1 \quad)$	$(b; c^H)$		$1 \quad 2$	

Table 15: Manager's strategies in equilibrium IC

$$
\begin{aligned}
(G_1 = \frac{F}{c^L}) &= \frac{(1 \quad p) \ (1 \quad 2 \ )}{(1 \quad p) \ (1 \quad 2 \ ) + \ (1 \quad)} \\
&= \quad ! \ 1
\end{aligned}
$$

$$
\begin{aligned}
(G_1 = 0) &= \frac{(1 \quad p)}{(p \quad + (1 \quad p)(1 \quad) + \ p(1 \quad) + (1 \quad p) \ )} \\
&= \quad ! \ (1 \quad p)
\end{aligned}
$$

$$
\begin{aligned}
(G_1 = 0) &= \frac{p}{(p \quad + (1 \quad p)(1 \quad) + \ p(1 \quad) + (1 \quad p) \ )} \\
&= \quad ! \ p
\end{aligned}
$$

$$(G_1 = 0) = \frac{(1 \quad p)(1 \qquad)}{(p \quad + (1 \quad p)(1 \qquad) + \ p(1 \qquad) + (1 \quad p) \ \ )}$$

$$= \quad ! \ (1 \quad p)(1 \qquad)$$

$$(G_1 = 0) = \frac{p(1 \qquad)}{(p \quad + (1 \quad p)(1 \qquad) + \ p(1 \qquad) + (1 \quad p) \ \ )}$$

$$= \quad ! \ p(1 \qquad)$$

$$(G_1 = \frac{F}{c^H}) = \frac{p(1 \qquad)(1 \quad 2 \ )}{(1 \quad 2 \ )(p \quad + (1 \quad p)(1 \qquad) + \ p(1 \qquad) + (1 \quad p) \ \ )}$$

$$= \quad ! \ \frac{p(1 \qquad)}{1 \qquad + \ p}$$

$$(G_1 = \frac{F}{c^H}) = \frac{(1 \quad p)(1 \qquad)(1 \quad 2 \ )}{(1 \quad 2 \ )(p \quad + (1 \quad p)(1 \qquad) + \ p(1 \qquad) + (1 \quad p) \ \ )}$$

$$= \quad ! \ \frac{(1 \quad p)(1 \qquad)}{1 \qquad + \ p}$$

$$(G_1 = \frac{F}{c^H}) = \frac{p \ \ (1 \quad 2 \ )}{(1 \quad 2 \ )(p \quad + (1 \quad p)(1 \qquad) + \ p(1 \qquad) + (1 \quad p) \ \ )}$$

$$= \quad ! \ \frac{p}{1 \qquad + \ p}$$

We have checked that the strategies are sequentially rational in section 3.3. Here, we summarize that analysis and present an intuitive proof. Given that all the model parameters are common knowledge, the donor can anticipate the manager's behavior. Under the assumption that $0 \quad F < \frac{1}{2}$, the donor will correctly anticipate that the manager type $(b; c^L)$ will not pro t from pretending to be type $(g; c^L)$. Therefore, upon observing $\frac{F}{c^L}$ the donor believes with certainty that he has encountered manager type $(g; c^L)$. Upon observing $G_1 = 0$ the donor is not certain which manager type he is facing; he believes with positive probabilities that it can be any possible type. Upon observing $\frac{F}{c^H}$, the donor believes with certainty that he has not encountered manager type $(g; c^L)$, but any other manager type is possible. The donor contributes when $\quad (1 \quad)c^L$ and $\frac{p}{c^H(p \ \ +1 \quad)} \quad (1 \quad)$, which follow from inequality 4.

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