DECISION ANALYSIS
Vol. 6, No. 1, March 2009, pp. 4–13
ISSN 1545-8490 | EISSN 1545-8504 | 09 | 0601 | 0004

informs®

DOI 10.1287/deca.1080.0132

A Decision Analysis Tool for Evaluating Fundraising Tiers

Kevin F. McCardle, Kumar Rajaram, Christopher S. Tang
Anderson School of Management, University of California, Los Angeles, Los Angeles, California 90095
{kevin.mccardle@anderson.ucla.edu, krajaram@anderson.ucla.edu, ctang@anderson.ucla.edu}

This paper presents a utility function model of donors who need to determine their donation to a charity organization that structures and publishes donations by tiers. By considering the prestige associated with each tier level, our analysis suggests that a tiered scheme generates an incentive for donors to raise their donation to the next tier when the originally intended donation is close to the minimum amount for the next tier level. In addition, we develop a decision analysis tool to illustrate how a charity can evaluate the effectiveness of different tier structures. Using publicly available federal tax return data and actual donations to a private high school, we present a method to estimate the model parameters. By taking other nonquantifiable factors into consideration, our tool can guide a charitable organization to determine an effective fundraising tier strategy.

Key words: Cobb-Douglas utility; public policy; optimization; decision analysis
History: Received on August 15, 2008. Accepted on November 20, 2008, after 1 revision. Published online in *Articles in Advance* January 29, 2009.

1. Introduction

An increasing number of charitable organizations such as relief agencies, hospitals, schools, universities, museums, arts organizations, and nonprofit social-service agencies solicit annual gift donations by using fundraising tiers. Consider, for example, the annual disaster giving program of the American Red Cross. The Red Cross categorizes major donations in four tiers: Bronze ($100,000–$199,999), Silver ($200,000–$499,999), Gold ($500,000–$999,999), and Platinum (above $1 million). Donors are publicly listed for each tier, alphabetized within the tier—that is, exact dollar figures for each donation are not published.[1] Another example is provided by Yale University, whose annual fund donors become members of tiered associations: Woolsey Associates ($1,000–$2,499), Elihu Yale Associates ($2,500–$4,999), Sterling Associates ($5,000–$9,999), Hillhouse Associates ($10,000–$14,999), Woodbridge Circle ($25,000–$49,000), and Fourth Century Circle (above $50,000). It is interesting to note that the *range* of each tier of the Yale annual fund increases from the lowest to the highest tier with the range being $1,500 at the lowest level and $25,000 at the highest level. A similar pattern is observed in the Red Cross example and in other fundraising campaigns as well.

In addition to segmenting donors, the tier structure may enable an organization to increase overall donations by providing an opportunity for donors to gain more prestige associated with higher tiers. Although fundraising tiers are prevalent at many organizations, analyzing whether to construct a tier scheme or evaluating an existing tier structure are challenging problems. This is because it requires an understanding of donor behavior and the wealth distribution of the population of donors, and then blending this information within an analytical framework.

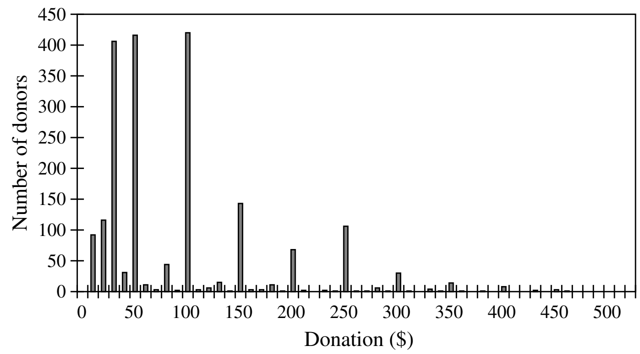
Despite the practical relevance of this problem, we have not found any academic research that directly addresses all of these issues. For example, in their survey of decision-analysis applications, Keefer et al. (2004) list no papers that address any of these issues. There are a few papers, however, mainly in the economics literature, that address somewhat related topics. Economists have developed analytical models and

[1] See http://www.redcross.org/sponsors/adgp/members.html for details.

gathered empirical evidence that support the existence of "warm glow," a desirable *intrinsic value* that helps explain why people make donations to charitable organizations. The reader is referred to Andreoni (1990) and Harbaugh (1998) and the references therein for details. Harbaugh (1998) models the impact of the prestige effect associated with donors who have a taste for making their donations public. He hypothesizes that as this prestige effect increases, the organization can increase donations by using tiers. His paper also discusses the impact of the prestige effect on competition between charities. However, Harbaugh (1998) does not provide an analytical framework for studying optimal donor behavior in the presence of tiers, whether a charity should implement a tier structure, or how a charity should evaluate and improve an existing tier structure. Romano and Yildirim (2001) develop a model to understand why charities announce donations. They show that when donor utility functions contain components to represent additional effects such as warm glow and prestige, then it is beneficial for charities to announce donations. However, they do not extend this work to examine the interaction between these types of utility functions and a fundraising tier structure. Desmet and Feinberg (2003) consider the impact of setting a suggested donation amount or appeals scale on charitable donations. They study the relationship between what is donated and what is requested by incorporating prior donation history into a model of donation behavior. Using data from a French charity, they show that donations can be strongly influenced by the choice of an appropriate appeals scale, but they do not explore the impact of donation tiers and their potential use as a mechanism to effectively achieve the targeted appeal scales. Duncan (2004) emphasizes the importance of understanding donor behavior in modeling charitable contributions. However, his work does not extend this idea to the problem of evaluating fundraising tiers.

As articulated in Harbaugh (1998), the underlying intention of the tier structure is to create an implicit "prestige," an *extrinsic value* that serves as an incentive for each donor to raise his donation to a higher tier level. Based on the data reported in Harbaugh (1998), it appears that most donors tend to give exactly the minimum amount necessary to get into a higher tier. We observed a similar pattern based on the annual gift

Figure 1 **St. Mark's 2004–2005 Annual Fund: Small Gifts with Tiers $25, $50, $100, and $250**



data provided by St. Mark's, a Catholic high school in Wilmington, Delaware (Figure 1). We also found a number of donations that are close to but above the minimum for each tier; however, we found almost no donations that are close to but below the minimum. This suggests that a donor is willing to raise his or her donation to the minimum amount at the next tier if the originally intended (or tierless) donation is close to this minimum, but there is no clear evidence supporting decreased donations. Based on these two observations (relatively large numbers of donations at tier minimum amounts and just above, and almost no donations close to but below tier minimum amounts), we anticipate that the net effect of tiers, although positive, will be small as a proportion of total giving.

In this paper, we first develop a model of rational donors who would take warm glow and prestige into consideration when determining their optimal donation. We then use this model to understand how donations change under a tier structure. Finally, by anticipating each donor's optimal donation behavior, we develop a decision-analysis tool to evaluate the total amount of donations for different tier structures. Our focus is on a decision-analysis tool that will help a charitable organization blend analysis with experience to perform "what if" analyses. By considering the additional costs (i.e., promotional and administrative costs) for managing different numbers of tiers, our analyses provide insights that could eventually guide the charity to determine an improved tier structure satisfying certain quantifiable or nonquantifiable constraints. To summarize, this paper makes three main contributions: first, it develops a model of a rational donor; second, it analyzes optimal donor behavior in the presence of a tier structure; and third, it develops a decision-analysis tool for the charitable organization to evaluate different tier structures.

This paper is organized as follows. In the next section, we describe the analysis framework. We develop the model of a rational donor, develop structural properties of the optimal donation, and determine when the donor would donate a larger amount in the presence of a tiered scheme. We use these results to develop the decision-analysis tool to calculate the total amount of donations that can be expected for a given tier structure and to evaluate changes in tier structures. In §3, we use real data to fit our model and use this data to develop an illustrative example. In §4, we summarize our work and provide future research directions.

2. The Donation Model

Consider the case when a charitable organization prespecifies M tiers of donation levels so that tier level i is specified by the interval $[T_i, T_{i+1})$. Hence, the T_is where $i = 1, \ldots, M$ are the minimum amounts for different tier levels and $0 = T_0 < T_1 < T_2 < \cdots < T_i < \cdots < T_M$. In the Yale University example, there are seven tier levels and the minimum amount of each tier is $T_1 = 1{,}000$, $T_2 = 2{,}500$, $T_3 = 5{,}000$, $T_4 = 10{,}000$, $T_5 = 15{,}000$, $T_6 = 25{,}000$, and $T_7 = 50{,}000$. Although information about tier levels is public knowledge, we assume that each solicitation is conducted in private (direct mail or direct call) so that a donor does not have information about other donors' donations. Hence, the issues of peer pressure, herd behavior, and informational cascades can be neglected (cf. Banerjee 1992, Bikhchandani et al. 1992).

Given these M donation levels, we now consider a donor who uses his wealth w to make a donation d, so that his *net wealth*[2] is $n = w - d$. We assume that the donor's utility function $f(n, d)$ is comprised of two parts: $g(n, d)$, which represents the intrinsic utility of consumption of the net wealth n and the warm glow of the donation d; and $V(d, T)$, which represents the extrinsic prestige of donating in a particular tier. Specifically,

$$f(n, d) = g(n, d) + V(d, T), \quad \text{where}$$
$$g(n, d) = n^a d^b, \quad \text{and}$$
$$V(d, T) = v_i \quad \text{for } T_{i-1} \le d < T_i,\ i = 1, \ldots, n. \tag{1}$$

The first term $g(n, d)$ follows a Cobb-Douglas functional form that represents the utility derived from two internal factors: self-satisfaction derived from a private good (i.e., net wealth n), and warm glow generated from a public good (i.e., donation d). Parameters a and b represent the elasticities associated with net wealth and donation, respectively.[3]

To capture the likely scenario that the utility derived from net wealth is higher than that from the warm glow, we assume that $0 < b < a < 1$. To capture the diminishing returns of utility with respect to net wealth and donation, we assume that $a + b \le 1$ so that the utility function $g(n, d)$ is jointly concave in n and d. We estimate a, b, and v_i using real data in §3.

The second term of $g(n, d)$ is $V(d, T) = v_i$, which represents the external prestige created by the charity for tier i, $i = 1, 2, \ldots, M$. Prestige is assumed increasing in the tier level so $0 < v_1 < v_2 < \cdots < v_M$. We assume that the prestige value v_i depends only on the tier thresholds T_i based on the fact that the charity reports donations only according to the tiers and, hence, the prestige is assumed to be fully captured by the tier thresholds. Although it is possible that the prestige value depends on other factors such as the number of tiers M, the number of spots reserved for the top tier levels, and the donor's wealth w, we do not consider these additional factors here. Our model can be extended to incorporate these factors if there is sufficient donation data associated with different tier structures so that the various parameters associated with these additional factors can be estimated. Also,

[2] For donations that are solicited on an annual basis, a donor may use his annual income I instead of his wealth w when determining his donation d. Because the U.S. tax laws allow for tax deduction for charitable donations, this scenario is more probable in the United States. More information is available at http://us.bbb.org/WWWRoot/SitePage.aspx?site=113&id=e6920967-8ebd-4a31-9986-de07de38e7bc.

[3] For clarity of exposition, we focus our analysis on the Cobb-Douglas utility function that has been used extensively in the literature (cf. Douglas 1976). We have developed alternative models based on the exponential utility function and a general utility function, and obtained similar structural results. Furthermore, the Cobb-Douglas function provides a marginally better fit to the federal tax returns data to be presented in §3.1.

the function $g(n, d)$ does not include a term[4] that captures the utility derived from total donations provided by all donors (as proposed by Andreoni 1990).

We assume that the donor will select his/her donation, d^*, to maximize the donor's utility function $f(n, d)$ by solving the following problem (P1):

$$\text{(P1)} \qquad \operatorname*{Max}_{d} \; \{f(n, d)\} = \operatorname*{Max}_{d}\{g(n, d) + V(d, T)\},$$
$$\text{subject to } \; n + d = w \quad \text{and} \quad n, d \geq 0.$$

Because the function $g(n, d)$ is concave in d, it is easy to check that $f(n, d)$ is a piecewise concave function in d.

To determine the optimal donation d^*, first consider $\hat{d}$, where $\hat{d} = \arg\max\{g(n, d)\}$. Notice that $\hat{d}$ corresponds to the donor's *originally intended* (*or prestige-free*) *donation* when the charity does not categorize donations by tiers. By setting $n = w - d$ and differentiating $g(n, d)$ with respect to d, we obtain the first-order condition that yields

Lemma 1. *Suppose the charity does not categorize donations by tiers. Then the donor's prestige-free donation $\hat{d}$ satisfies*

$$\hat{d} = \frac{b}{a+b} w. \tag{2}$$

Lemma 1 establishes that, in the absence of the prestige effect, each donor will donate a certain fraction of his wealth. This fraction is increasing in the donation or warm-glow elasticity b and decreasing in the net-wealth elasticity a. The prestige-free solution is akin to the tithing advocated by many religious organizations, wherein each member is encouraged to donate a specific fraction (usually 10%) of her annual income to charity. This solution structure is also important for estimating the aggregate values of parameters a and b, as illustrated in the next section.

We now examine the impact of a tier structure on donation behavior. In particular, we consider how the prestige v_i associated with tier level T_i would entice the donor to raise his donation from $\hat{d}$ to higher amount d^*, where d^* is the optimal solution to problem (P1). In preparation, let $k = \arg\min\{i = 1, \ldots, M\colon \hat{d} < T_i\}$ so that $T_{k-1} \leq \hat{d} < T_k$. Thus, $T_k - \hat{d}$ is the minimum additional amount that the donor needs to give to get into the next tier.

By using the facts that $g(w - d, d)$ is concave in d, $\hat{d}$ is the optimum of $g(w - d, d)$, $T_{k-1} \leq \hat{d} < T_k$, and v_i is positive and increasing in i, it is easy to check that (a) $f(w - d, d) < f(w - \hat{d}, \hat{d})$ for any $d < \hat{d}$, (b) $f(w - d, d) < f(w - \hat{d}, \hat{d})$ for any $d \in (\hat{d}, T_k)$, and (c) $f(w - d, d) < f(w - T_i, T_i)$ for any $d \in (T_i, T_{i+1})$ for $i = k, \ldots, n$. These observations yield

Proposition 1. *Suppose each tier level i provides a prestige value v_i, $i = 1, \ldots, M$. Then it is optimal for the donor to donate d^*, which satisfies*

$$d^* = \begin{cases} \hat{d} & \text{if } f(\hat{d}) > f(T_j), \\ T_j & \text{otherwise,} \end{cases} \tag{3}$$

where $j = \arg\max\{f(T_i)\colon i = k, \ldots, M\}$.

Proposition 1 demonstrates that in the presence of prestige for each tier, it is optimal for the donor to donate either the originally intended amount $\hat{d}$ or one of the thresholds T_j, $j = k, \ldots, M$. By noting that $\hat{d} < T_k \leq T_j$, it is easy to check from (3) that $d^* \geq \hat{d}$; i.e., the donor will never donate less than the original intended amount when donations are categorized by tiers. The prestige associated with tiers provides an incentive for donors to increase their donations. If there are no costs associated with setting up a tiered scheme, we have

Corollary 1. *The organization will never be worse off by categorizing donations into tiers.*

We now establish the conditions under which the donor will raise his donation from the originally intended donation $\hat{d}$ to a higher tier. If the tier levels T_i are close to each other, then it is possible for a donor, in going from $\hat{d}$ to d^*, to skip over the next tier;

[4] We elected to neglect this term because it would require the organization to reveal advance information on the total number of donors solicited and the total donations targeted. Typically, such information is not revealed in organizations that employ a tiered scheme because this information could influence a donor's behavior and could yield undesirable outcomes. For example, consider the case where the organization announces in advance that many potential donors are being solicited so as to generate an estimated total donation. This information may create an impression that many other donors are going to donate, which could reduce the "prestige" effect. Consequently, each donor may donate less than the original intended amount or may even feel less obligated to make a donation. Therefore, we omit this term in $g(n, d)$ because this may not be appropriate for the tiered scheme.

and if the tiers are sufficiently far apart, then a donor is more likely to remain at $\hat{d}$, the originally intended donation. The optimal donation d^* clearly depends on the selection of the tier levels T_i.

For clarity of exposition, we first analyze the case when a donor will not skip over the next tier: $f(w - T_k, T_k) > f(w - T_j, T_j)$, $j = k+1, \ldots, M$. In this case the donor will obtain a greater utility from raising his donation to the next tier than from raising it to other still higher tiers. Intuitively, this will occur if the thresholds are spread sufficiently further apart at higher tiers. To establish the validity of this intuition, use the fact that $\hat{d} = (b/(a+b))w < T_k < T_{k+1} < \cdots < T_M$ to show that $g(w - T_i, T_i) = (w - T_i)^a T_i^b$ is decreasing in i for $i \geq k$. Therefore, if T_j is sufficiently greater than T_k (relative to the difference between v_j and v_k), then $f(w - T_k, T_k) = v_k + (w - T_k)^a T_k^b > v_j + (w - T_j)^a T_j^b = f(w - T_j, T_j)$ for $j = k+1, \ldots, M$.[5] To elaborate, suppose we set $T_j = x_j T_k$, where $x_j > 1$. It is then easy to check that the donor will not skip over the next tier k if x_j is large enough so that $(w - T_k)^a \cdot T_k^b[1 - (1 - ((x_j - 1)T_k/(w - T_k)))^a x_j^b] > v_j - v_k > 0$ for $j = k+1, \ldots, M$. Because the donations depend on the width of each tier level, the charitable organization can use the tier levels to segment the donors. Spreading the thresholds further apart for higher tiers is commonly observed in practice, as, for example, in the Yale tiers discussed previously: $T_1 = 1{,}000$, $T_2 = 2{,}500$, $T_3 = 5{,}000$, $T_4 = 10{,}000$, $T_5 = 15{,}000$, $T_6 = 25{,}000$, and $T_7 = 50{,}000$.

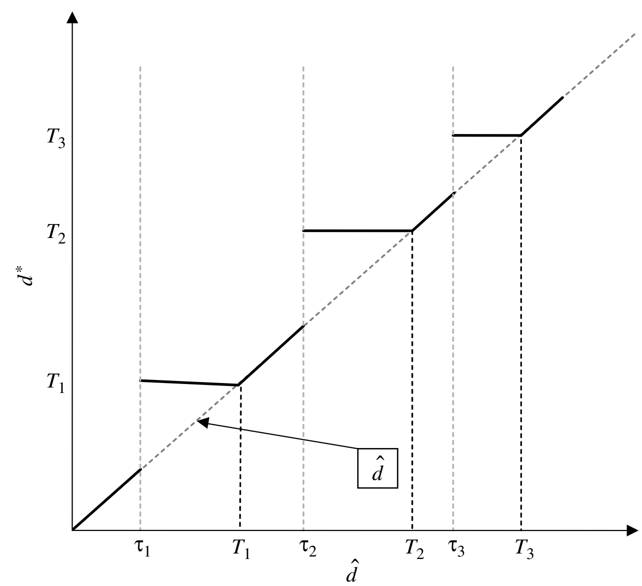
Suppose the organization sets the thresholds in a way that a donor will not skip the next level k. To determine the conditions under which a donor will raise his donation from $\hat{d}$ to T_k, we compare the respective utility functions $f(w - \hat{d}, \hat{d})$ and $f(w - T_k, T_k)$, getting

Corollary 2. *Let τ_k be the cutoff point that satisfies $\tau_k < T_k$ and*

$$v_k - v_{k-1} + \left(\frac{a+b}{b}\tau_k - T_k\right)^a T_k^b - \left(\frac{a}{b}\right)^a \tau_k^{(a+b)} = 0. \quad (4)$$

[5] From a practical standpoint, spreading the thresholds further apart this way allows the organization to plan the targeted number of donors for each tier level. Such plans are then independently executed for each tier by solicitors who are responsible for meeting these targets for each category (cf. Bason 2007).

Figure 2 **Structure of the Optimal Donation** d^*



The optimal donation d^* satisfies

$$d^* = \begin{cases} \hat{d} & \text{if } \hat{d} < \tau_k, \\ T_k & \text{if } \hat{d} \geq \tau_k. \end{cases} \quad (5)$$

Proof of Corollary 2. All proofs are provided in the appendix.

Because $\hat{d} < T_k$ and $\tau_k < T_k$, Equation (5) implies that the donor will raise his donation to the next level T_k if $\hat{d}$ is close enough to T_k (Figure 2). Corollary 2 implies that donors will not donate amounts less than but close to T_k because these donors would prefer to raise their donation to the next tier and earn the enhanced prestige. This pattern is observed in the St. Mark's data (Figure 1) as well as in the data reported in Harbaugh (1998). In the next section, we use real data and describe these cutoff points and employ this to compute the prestige values of each tier.

Corollary 3. *The cutoff point τ_k is increasing in T_k.*

Corollary 3 has the following implications. Suppose an organization increases a tier threshold from T_k to T_k'. Then, by Corollary 3, the cutoff point τ increases. Observe from Figure 2 that some donors who had been giving between T_k and T_k' would increase their donations to the increased value of T_k', whereas other donors who had been giving T_k would revert to their originally intended donation $\hat{d}$ given in (2) instead of increasing to T'_k. Therefore, when evaluating different threshold values of T_i, it is critical to examine the impact of the tier thresholds on the optimal donation d^* of different donors.

In summary, the optimal donation d^* depends on several key elements: the thresholds T_i and their associated prestige values v_i, and the originally intended donation $\hat{d}$, where $\hat{d}$ depends on the donor's wealth w and the utility parameters a and b (which may vary by individual). In particular, the optimal donation d^* can be expressed as a function of wealth w by substituting (2) into (5), yielding

$$d^* = \begin{cases} \dfrac{b}{a+b} w & \text{if } w < \dfrac{a+b}{b}\tau_k, \\ T_k & \text{if } w \geq \dfrac{a+b}{b}\tau_k. \end{cases} \tag{6}$$

By applying (6) to the case of M tier levels, it is easy to show that the donation of each donor can be specified according to the wealth w so that $d^*(w) = \hat{d}$ when $w \in [((a+b)/b)T_{k-1}, ((a+b)/b)\tau_k)$ and $d^*(w) = T_k$ when $w \in [((a+b)/b)\tau_k, ((a+b)/b)T_k)$. Hence, for any N donors with a wealth distribution $h(w)$ donating to an organization with tier structure $T = (T_1, T_2, \ldots, T_i, \ldots, T_M)$, the total donation, $D(T)$, can be expressed as

$$D(T) = \sum_{[((a+b)/b)T_{k-1},\, ((a+b)/b)\tau_k)} \hat{d} * h(w) + \sum_{[((a+b)/b)\tau_k,\, ((a+b)/b)T_k)} T_k * h(w),$$

where τ_k is given in (4), and $h(w)$ equals the number of donors with wealth value w ($h(w)$ equals 0 almost everywhere). For a fixed number of tiers M, the total donation $D(T)$ depends on the tier value T_k and the income distribution of the donors $h(w)$. Hence, a charity can improve its total amount of donations by determining a tier structure that matches the income distribution of the target donors. For example, if there is an accumulation of donors around a certain wealth level, and if a and b are known, then the charity could increase total donations by inserting a tier value T somewhat above the originally intended donation for that wealth level. In addition to performing the "what if" analysis that we explain in the next section, having more accurate information about donors' income/wealth is also critical for the charity.

3. An Illustrative Example

To illustrate how our model developed in §2 can be used to evaluate the effectiveness of different tier structures, we present an example motivated by the annual fund drive at St. Mark's High School, a private Catholic high school located in Wilmington, Delaware. To solicit donations for its 2004–2005 annual fund, this school employed a nine-tiered scheme. Between July 1, 2004, and June 30, 2005, St. Mark's received a total of $443,712 in donations from 2,173 donors to its annual fund. The tier structure and the summary statistics of those 2,173 donations are presented in Table 1.

To evaluate the effectiveness of St. Mark's implemented nine-tiered scheme (base case), we will compare the actual total donation that St. Mark's received in the base case and the estimated total donation St. Mark's would have received had they employed one of several other possible schemes: (1) no tiers, (2) fewer tiers (e.g., combine some of the existing tiers), and (3) fewer and different tiers (e.g., reduce the number of tiers and use different tier thresholds T_i). To estimate the total donations associated with different schemes, we next describe how we estimated the model parameters.

3.1. Parameter Estimation

In this section, we explain how we estimated the model parameters. These include (1) the parameters associated with the Cobb-Douglas utility function

Table 1 Donations for St. Mark's 2004–2005 Annual Fund

Tier name	Tier range ($)	Tier (i)	Number of donors	Average donation within each tier ($)
Contributors	<50	0	651	22.70
Green-White-Gold Club	50–99	1	471	52.90
Spartan Club	100–249	2	678	142.20
Principal's Club	250–499	3	181	283.90
Chairman's Club	500–999	4	84	548.00
St. Mark's Patron Society	1,000–2,499	5	76	1,221.60
Father Delaney Leadership Society	2,500–4,999	6	21	2,882.00
Bishop Mardaga Benefactor's Society	5,000–9,999	7	10	5,856.00
Bishop Hyle Founder's Society	>10,000	8	1	10,415.00
Total			2,173	$443,712.00
Mean				$204.00
Median				$75.00
Standard deviation				$508.00

(i.e., a and b), (2) the prestige values v_i associated with St. Mark's current tier structure, and (3) the income level and resulting optimal donations of each of the 2,173 donors.[6]

3.1.1. Estimation of Cobb-Douglas Utility Function Parameters. In the absence of income data for St. Mark's donors, we used the publicly available federal tax return data from the U.S. Internal Revenue Service (2004) to estimate the parameters a and b associated with the Cobb-Douglas utility function. This federal database provides detailed information on annual incomes and deductions for charitable donations made for the 2004 tax year. The estimation of a and b is based on two assumptions: (a) the utility function of all donors (including St. Mark's donors) is the same as the average for the whole (tax-filing) population in the United States, and (b) the charitable deductions declared in the tax returns are based on donations without a tier structure.[7] These two assumptions enable us to estimate the values of a and b by running a simple linear regression based on Equation (2), using the income level I as a proxy of wealth w; i.e., $\hat{d} = (b/(a+b))I + \varepsilon$, where ε corresponds to the error term. For this regression, the estimated coefficient is $b/(a+b) = 0.037$ with a significance level $\alpha < 0.001$. To ensure that our modeling assumptions—$1 > a > b > 0$ and $a + b \leq 1$—are satisfied,[8] we set $a = 0.95$ so that $b = 0.036$. Hence, the Cobb-Douglas utility function of a St. Mark's donor with an annual income level I satisfies

$$g(I, d) = (I-d)^a d^b = (I-d)^{0.95} d^{0.036}.$$

3.1.2. Estimation of Tier Prestige Values. Next we estimate the prestige values v_i associated with each of the nine tiers. To do so, we first determine the cutoff points τ_i. As established in Corollary 2, for each tier i, there exists a cutoff point $\tau_i < T_i$ so that each donor will donate T_i if his originally intended donation $\hat{d} \geq \tau_i$. The cutoff points for different tiers can be easily observed in the St. Mark's data. For example, as shown in Figure 1, no one donates $45, but there is a surge in the number of donors at the next tier threshold $T_1 = \$50$. Similarly, virtually no one donates any amount between $90 and 99, but there is a surge in the number of donors at the next tier threshold $T_2 = 100$. Using the same approach, we determine all of the cutoff points τ_i.[9] Then we can use the estimated parameters a and b in Equation (4) to estimate the prestige value v_i. The results are summarized in Table 2. Notice that the prestige value is low at the lower tiers, but it increases exponentially as the tier level increases.

Table 2 Cutoff Points and Prestige Values Based on St. Mark's Donation Data

Tier (i)	Tier range ($)	Tier threshold T_i ($)	Cutoff point τ_{i+1} ($)	Prestige value v_i (utils)
0	<50	0	45	0
1	50–99	50	90	0.2
2	100–249	100	225	0.4
3	250–499	250	450	1
4	500–999	500	800	2
5	1,000–2,499	1,000	2,000	16.5
6	2,500–4,999	2,500	3,500	40.9
7	5,000–9,999	5,000	5,700	190.7
8	>10,000	10,000	—	829.7

3.1.3. Estimation of Donor Income Levels. We now use the cutoff point τ_i to estimate the income level of each St. Mark's donor. First, observe Figure 3 (based on Figure 2 in §2), which highlights the relationship between d^*, the actual donation of a St. Mark's

[6] Based on our discussions with various charities, including St. Mark's, personal income and wealth of donors are rarely known, nor are they elicited out of respect for the donor's privacy.

[7] This assumption is reasonable because donors usually make charitable donations annually to multiple organizations, such as the American Cancer Society and the American Diabetes Association, that are not based on any tiered structure.

[8] Clearly, the values of a and b are not unique. Specifically, within the feasible range for a and b, we select a large value of $a = 0.95 < 1$ to ensure $b = 0.036$ is reasonably high so as to reflect the utility associated with charitable donations.

[9] We recognize that our approach for determining τ_i is ad hoc. However, without information about the actual income of each donor, it is very difficult to establish an analytical approach. Perhaps one can consider the following iterative approach.

Step 0. Use our ad hoc approach to set the initial value of $\tau_i^{(0)}$ and set $n = 0$.

Step 1. For iteration n, use $\tau_i^{(n)}$ and our subsequent analysis to estimate the income level and use (2) to determine $\hat{d}$ for each donor.

Step 2. Determine a new set of values of $\tau_i^{(n+1)}$ that would minimize the distance between the estimated donation of each donor as predicted in (5) and the actual donation given in the data set.

Step 3. If $|\tau_i^{(n+1)} - \tau_i^{(n)}| < \varepsilon$ for all i, stop; otherwise, set $n = n + 1$ and go to Step 1.

Figure 3 Mapping d^* to $\hat{d}$ for St. Mark's Donors for Lower Tiers

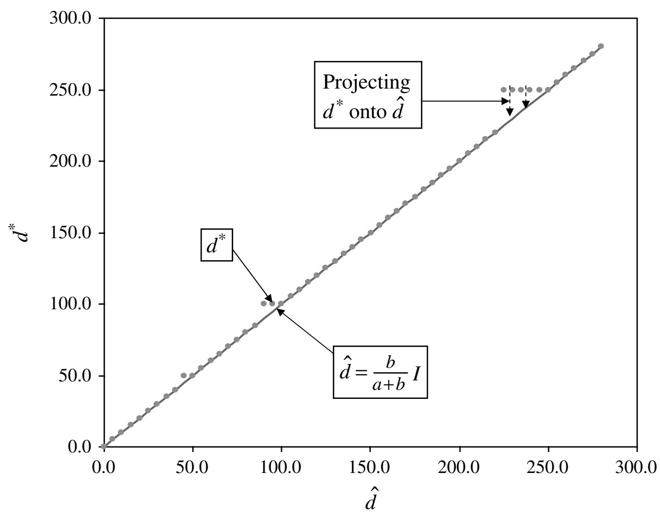


Table 3 Summary of Scenario Analysis

Scenario number	Scenario description	Estimated total donation ($)	Relative to the base case ($)
Base case	Nine tiers	443,712 (actual)	
1	No tiers	430,143	−13,569
2	Three tiers	436,609	−7,103
3	Different tiers	430,318	−13,394

donor based on the nine-tiered structure, and the corresponding donation $\hat{d}$, when there is no tiered structure. For those donors who donate $d^* \in [T_{i-1}, \tau_i)$, set $\hat{d} = d^*$. For those who donate T_i, Corollary 2 establishes that $\hat{d} \in [\tau_i, T_i)$. We assume that donors are uniformly distributed in that interval, and then select the mean of the interval as the estimated donation, i.e., $\hat{d} = (\tau_i + T_i)/2$

Given the originally intended donation $\hat{d}$, we use the estimated values of a and b and our regression model $\hat{d} = (b/(a+b))I + \varepsilon$ to estimate the income level I of each St. Mark's donor. Set $I = ((a+b)/b)(x\hat{d})$, where $x = 16.9$ is the *scaling factor* that adjusts for the average charitable deductions declared on the tax returns form ($3,447) and the average donation made to St. Mark's ($204). This suggests that, on average, for a St. Mark's donor, donating $\hat{d}$ to St. Mark's is equivalent to declaring charitable deductions of $(3{,}447/204)\hat{d} = 16.9\hat{d} = x\hat{d}$.

3.2. Scenario Analysis

Given the estimated income of St. Mark's donors and the estimated utility function, we now estimate the total donations that St. Mark's would have received had they implemented one of several other schemes: (1) no tiers, (2) fewer tiers (e.g., combine some of the existing tiers), and (3) fewer and different tiers. The results are summarized in Table 3. However, we do not consider the scenario when we add more tiers, even though Corollary 1 implies that adding tiers will generate larger donations because it provides additional "lifting" of some donors' donations from $\hat{d}$ to the next tier threshold. This is because more tiers may not be optimal for the charity because our analysis does not account for the additional promotional and administrative costs for managing additional tiers. A reliable estimate of these costs was not available to us. Finally, it is important to note that the analysis in this section is merely intended to illustrate ways to apply our model to evaluate the total donations associated with different scenarios; it is *not* intended to determine an optimal tier structure. Although it might be possible to develop a search algorithm to determine the optimal tier structure, we decided not to pursue optimality because actual implementation would be hard. This is because most organizations would like to incorporate other subjective aspects such as (a) targeting a number of actual donors or the percentage of potential donors who make donations, (b) planning and using solicitors who contact potential donors, and (c) creating additional prestige by prespecifying the maximum number of donors reserved for certain tier levels.

The results of the scenario analysis are summarized in Table 3. We now describe the analysis that led to these results.

3.2.1. Scenario 1: No Tiers. When there are no tiers, use the estimated income of each donor and apply Equation (2) to estimate the donation $\hat{d}$ of that donor. Summing the estimated donations of the 2,173 St. Mark's donors, we get $430,143, the estimated total donation under the no-tier structure. This is $13,569 below the base case. Consistent with Corollary 1, this numerical example illustrates that the tiered structure enables an organization to generate larger donations due to the prestige value.

3.2.2. Scenario 2: Three Tiers. We reduce the number of tiers from nine to three, with $T_0 = 0$,

$T_1 = 250$, and $T_2 = 1{,}000$. Observe from Table 2 that the prestige values associated with these tiers are $v_0 = 0$, $v_1 = 1$, and $v_2 = 16.5$. Given T_i and v_i, we can use Equation (4) and the Goal Seek function in Excel to determine the new cutoff point for each tier, getting $\tau_1 = 234$ and $\tau_2 = 818$. Given the income level of each donor, estimate $\hat{d}$ using (2) and then apply Corollary 2 to estimate the optimal donation d^* given in (5) for each donor. Summing the estimated donations of the 2,173 St. Mark's donors, we get that the total donation to be collected under the three-tier structure is equal to \$436,609. This is \$7,103 below the base case. Although the total donation is slightly lower than the base case, there may be other benefits associated with a simpler tier structure not captured in our model, including the reduced efforts in promoting fewer tiers and the reduced cost in managing and felicitating fewer tiers of donors.

3.2.3. Scenario 3: Different Tiers. To illustrate how our analysis can be used to evaluate a different tier structure, consider a different three-tiered scheme with $T_0 = 0$, $T_1 = 400$, and $T_2 = 800$. Because the tier-thresholds are now different, we need to reestimate the prestige values associated with these tiers. To do so, we fit a quadratic function to the prestige values v_i given in Table 2 as a function of T_i, getting $v = 4(10)^{-6}T^2 - 0.0028T + 1.4114$ for $T > 0$. This yields estimated prestige values $v_0 = 0$, $v_1 = 1.3425$, and $v_2 = 2.4625$. Given T_i and v_i, we then use Equation (4) and the Goal Seek function in Excel to determine the new cutoff point for each tier, getting $\tau_1 = 363$ and $\tau_2 = 752$. By using the same approach as in Scenario 2, we find that the total donation to be collected under this tier structure is \$430,318, which is \$13,394 below the base case.

A cursory glance at Table 3 may suggest that the benefit of the tier structure is marginal because it provides only a \$13,569 improvement over the case with no tiers. However, it is important to note that these results are specific to this data set. In particular, observe from Figure 1 that a majority of the donations are small; hence, tiers do not provide the scale of benefits that would accrue if the magnitude of the donations were larger. Furthermore, the increment to the next tier is usually small. Finally, note that these campaigns are repeated annually, and there may be benefits as donors move up tiers over time.

4. Conclusions

In this paper, we developed a utility function model for donors who need to determine their donation to a charity when the donations are categorized and published in tiers. We have used this model and shown that a tiered structure enables a charity to generate larger donations mainly because of the prestige associated with different tier levels. By using the federal tax returns data and the actual donations to St. Mark's High School, we demonstrated a simple method to estimate the model parameters and illustrated how one could utilize our model to evaluate different tier structures. This model along with practical experience could serve as a useful guide for decision making. In particular, it could be used by the organization to decide whether a tier structure should be instituted or not, and if employed, to evaluate and consider alternate tier levels.

In addition, this model can serve as a building block for developing a system that would help a charity to develop an optimal tier structure. However, to do so, one needs to extend our model by considering the following issues: (a) the promotional and administrative costs for managing different number of tiers; (b) the prestige value v_i that may depend on other factors such as the number of tiers or the targeted number of donors reserved for certain top tier levels; (c) the capacity of running a fundraising campaign that depends on the number of campaign solicitors and the number of potential donors, and (d) the development of an optimization model and an efficient solution algorithm. All of these could be fruitful areas for future research. In addition to the issue of tier structure, another area for future research would be to study the impact of social influences (herd effect, peer pressure, etc.) on the donor's behavior, especially when the solicitations are conducted in public, such as at charity auctions and via public pledge drives.

In conclusion, we believe this paper provides a simple and effective framework for evaluating fundraising tiers in a charitable organization.

Acknowledgments

The authors thank St. Mark's High School of Wilmington, Delaware for providing donation data that enabled the illustrative examples in this paper. They are grateful to the associate editor and an anonymous referee for their constructive comments.

Appendix. Proofs

Proof of Corollary 2. By noting that $\hat{d} = (b/(a+b))w \in [T_{k-1}, T_k)$, the donor will raise his donation from $\hat{d}$ to T_k when the following inequality holds:

$$f(w - T_k, T_k) - f(w - \hat{d}, \hat{d}) = v_k - v_{k-1} + \left(\frac{a+b}{b}\hat{d} - T_k\right)^a T_k^b - \left(\frac{a}{b}\right)^a \hat{d}^{(a+b)} > 0. \quad (7)$$

By using the fact that $0 < b < a < 1$ and the fact that $\hat{d} < T_k$, one can show that the term $(((a+b)/b)\hat{d} - T_k)^a T_k^b - (a/b)^a \hat{d}^{(a+b)}$ is strictly increasing in $\hat{d}$. Combine this result with the fact that inequality (7) holds when $\hat{d} = T_k - \varepsilon$, where $\varepsilon \approx 0$, we can conclude that there exists a τ_k that satisfies $v_k - v_{k-1} + (((a+b)/b)\tau_k - T_k)^a T_k^b - (a/b)^a \tau_k^{(a+b)} = 0$, where $\tau_k < T_k$.

Now consider the case when $\hat{d} > \tau_k$. Because

$$\left(\left(\frac{a+b}{b}\right)\hat{d} - T_k\right)^a T_k^b - \left(\frac{a}{b}\right)^a \hat{d}^{(a+b)}$$

is strictly increasing in $\hat{d}$, we have

$$\begin{aligned} f(w - T_k, T_k) - f(w - \hat{d}, \hat{d}) &= v_k - v_{k-1} + \left(\frac{a+b}{b}\hat{d} - T_k\right)^a T_k^b - \left(\frac{a}{b}\right)^a \hat{d}^{(a+b)} \\ &> v_k - v_{k-1} + \left(\frac{a+b}{b}\tau_k - T_k\right)^a T_k^b - \left(\frac{a}{b}\right)^a \tau_k^{(a+b)} = 0. \end{aligned}$$

The last equality follows immediately from the definition of τ_k. Hence, it is optimal for the donor to raise his donation from $\hat{d}$ to T_k if and only if $\hat{d} > \tau_k$. □

Proof of Corollary 3. By differentiating $v_k - v_{k-1} + (((a+b)/b)\tau_k - T_k)^a T_k^b - (a/b)^a \tau_k^{(a+b)} = 0$ with respect to T_k using the implicit function theorem and by rearranging the terms, one can show that

$$\frac{d\tau_k}{dT_k} = \frac{[((a+b)/b)\tau_k - T_k]^{a-1} T_k^{b-1}(a+b)(T_k - \tau_k)}{a((a+b)/b)[((a+b)/b)\tau_k - T_k]^{a-1} T_k^b + (a+b)(a/b)^a \tau_k^{a+b-1}}$$

because $\tau_k < T_k$, $d\tau_k/dT_k > 0$. □

References

Andreoni, J. 1990. Impure altruism and donations to public goods: A theory of warm-glow giving. *Econom. J.* **100** 464–477.

Banerjee, A. 1992. A simple model of herd behavior. *Quart. J. Econom.* **107** 797–817.

Bason, R. 2007. Capital campaigns: What a feasibility study should do for your organization? Company notes, Charitable Funding Services, Santa Barbara, CA.

Bikhchandani, S., D. Hirshleifer, I. Welch. 1992. A theory of fads, fashion, custom, and cultural change as informational cascades. *J. Political Econom.* **100**(5) 992–1026.

Desmet, P., F. M. Feinberg. 2003. Ask and ye shall receive: The effect of the appeals scale on consumers' donation behavior. *J. Econom. Psych.* **24**(3) 349–376.

Douglas, P. H. 1976. The Cobb-Douglas production function once again: Its history, its testing, and some new empirical values. *J. Political Econom.* **84**(5) 903–916.

Duncan, B. 2004. A theory of impact philanthropy. *J. Public Econom.* **88**(9–10) 2159–2180.

Harbaugh, W. T. 1998. What do donations buy? A model of philanthropy based on prestige and warm glow. *J. Public Econom.* **67**(2) 269–284.

Keefer, D. L., C. W. Kirkwood, J. L. Corner. 2004. Perspective on decision analysis applications, 1990–2001. *Decision Anal.* **1**(1) 4–22.

Romano, R., H. Yildirim. 2001. Why charities announce donations: A positive perspective. *J. Public Econom.* **81**(3) 423–447.

U.S. Internal Revenue Service. 2004. http://www.irs.gov/pubs/irs-soi/04in11si.xls, http://www.irs.gov/pub/irs-soi/04in21id.xls.