Fundraising and Government Crowd-out of Private Contributions to Public Radio: An Empirical Study

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This draft is preliminary and incomplete.
Comments and suggestions are very welcome.

Section I: Introduction

Government crowd-out of charitable contributions has been a primary research question in the study of nonprotits for some time, but there has been relatively little economic research on fundraising. Accurate measurement of crowd-out is not possible, however, unless fundraising activity is also accounted for (Steinberg, 1991). Explicit attention to fundraising is important not only because it permits a more accurate measurement of crowd-out, but also because it provides evidence on more fimdamental questions like the economic objectives of nonprofit firms. This paper uses financial data from noncommercial radio stations to estimate returns to fundraising and the magnitude of crowd-out in the public radio industry.

The data collected for this paper offer advantages over previously studied data sets. Recent empirical research on nonprofits has used data from Form 990 tax return samples drawn by the IRS's Statistics of Income Division (Okten & Weisbrod, 1998; Segal and Weisbrod, 1998; and Payne, 1998). These data cover all nonprotits with assets greater than $10 million, and a small probability sample of smaller organizations. Construction of longitudinal data sets from these tapes has been complicated by the fact that random samples of all but the largest organizations are taken each year. The problem is aggravated by the extreme heterogeneity of organizations across nonprofit industries. The data 1 have collected for this paper come from financial reports submitted annually by noncommercial radio stations to the Corporation for Public Broadcasting (CPB). This comprehensive panel of public radio stations represents an industry-level data set with the same advantage as Kingma's (1989) data on individual contributions to public radio, namely that comparable fundraising environments across agents can plausibly be assumed. In addition to the CPB data, I have also collected IRS data from a different time period for a sub-set of the stations in my sample. The IRS data will be used to run out-of-sample simulations.

My empirical specification also represents a significant departure from the standard approach, which was first employed by Weisbrod and Dominguez (1986)[1]. The specification used in this paper is derived from a theoretical model of fundraising. The resulting specification is nonlinear in both fundraising expenditures and government contributions. The nonlinearity implies that endogenous fundraising decisions will vary with the level of government support.

The CPB data were received too recently to permit estimation results in time for this presentation. Preliminary results based on IRS data will be presented, however.

The rest of this paper is organized as follows. Section II presents the theoretical framework. Section III describes the data. Section IV specifies the empirical model. Preliminary estimation results are presented in Section V. Section VI concludes.

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[1] Papers in this tradition include the studies of Form 990 data cited in the previous paragraph as well as studies of UK data, for example, Khanna, Posnett, and Sandler (1995)

Section II: Theoretical Framework

Payne (1998) presents a three-stage model in which the government contribution to a public good is determined by a political process in the first stage. In the second stage, individuals make private contributions, taking donations by the government and other individuals as given. Nonprofit firms are modeled as passive players in Payne's model. They receive the government and private contributions and produce a charitable good in the third stage of her game.

The fundraising environment in this paper is also modeled as a sequential game between the government, a fundraiser, and individual contributors. The game is depicted in Figure 1, and motivated in the remainder of this section. There are two primary differences between Payne's model and my model. The first is the explicit attention given to fundraising decisions by nonprofit managers in my framework. The second is the different approach I take in modeling endogenous government contributions.

The game described in this section generalizes a standard model that has been used extensively to study private provision of a public good (e.g. Bergstrom, Blume, and Varian 1986). The first part of this section describes the standard model in its most basic form. Parts 2 and 3 generalize the standard model to allow for fundraising and government contributions respectively. The forth and final part of this section summarizes the model in terms of Figure 1.

Section II, part I: The standardproblem

The following description of the standard model follows Section 3 of Andreoni (1997).

Individual preferences are defined over a public good, P, and a Hicksian composite commodity of all other goods, x. The preferences, summarized by individual utility functions, $u_i[x, P]$, are assumed to be continuous in both goods and strictly quasi-concave. Exogenously determined endowments of money, μ_i, can be allocated between consumption of the private good and contributions to the public good. An individual's contribution is denoted c_i. The sum of contributions by all others is denoted C_{-i}. Units are normalized so that both goods can be measured in dollars. The total amount of the public good in the economy is then $P = c_i + C_{-i}$.

The utility maximization problem facing an individual can thus be summarized as follows:

$$\max_{x,\, c_i} \quad u_i[x, c_i + C_{-i}]$$

$$\text{s.t.} \quad x + c_i = \mu_i$$
$$c_i \geq 0$$

The first constraint is a standard budget constraint. Note that the price of both goods is one by definition in this application. The second constraint prohibits negative contributions.

The solution to the problem is modeled as the outcome of a simultaneous play Nash equilibrium game in which each person takes the contributions of others as given. By this assumption (the Nash assumption) we can think of C_{-i} as being part of agent i's endowment. Adding it to both sides of the constraints results in the following equivalent formulation of the problem:

$$\max_{x,\,P} \quad u_i[x, P]$$
$$\text{s.t.} \quad x + P = \mu_i + C_{-i}$$
$$P \geq C_{-i}$$

In this formulation, we think of the individual as choosing the level of the public good rather then simply choosing her own contribution, c_i. Interior solutions to the problem can be summarized by a Marshallian demand function, $C^* = f_i[\mu_i + C_{-i}]$. Marshallian demands depend on prices and endowments, but all prices are fixed by assumption in this application. The agent's optimal contribution in this case is $c_i = f_i[\mu_i + C_{-i}] - C_{-i}$. Comer solutions are accomodated by honoring the inequality constraint: $c_i = \max\{0, f_i[\mu_i + C_{-i}] - C_{-i}\}$.

Bergstrom, Blume, and Varian (1986) have shown that a unique Nash equilibrium in contributions exists if both the private and public goods are normal $[f_i' \in (0, 1)]$. This assumption also implies that free riding induced by additional contributions from others will be less than dollar-for-dollar, since the derivative of c_i with respect to C_{-i} is $f_i' - 1 \in (-1,0)$. Additional assumptions required to rule out trivial cases are that aggregate contributions, $C = \sum_i c_i$, are always positive in equilibrium, and that at least two individuals make positive contributions.

The remainder of this section is devoted to generalizing the standard model to make it applicable to the study of fundraising and crowd-out.

Section II, part 2: Fundraising

The standard model was developed to study the private provision of public goods. Fundraising plays an important role in many real-world applications of public good provision – charities and public broadcasting are two notable examples. The absence of a role for fundraising in the standard model derives primarily from the maintained assumption of perfect information. Everyone is aware of their preference for the public good and the method by which they can contribute. I create a role for fundraising by assuming an extreme form of imperfect information, namely that no one is aware of the public good's existence unless solicited. Prior to solicitation, individuals derive all their utility from the private good exclusively. Once solicited, an individual begins deriving utility from the public good immediately, whether they contribute or not.

The implication for the standard model is that the game that was previously played among all members of the population is now played only among the subset of the population that is solicited. The fundraiser's job is to choose a subset of the population to solicit. In specifying the fundraiser's objective, I will focus on the case of net revenue maximization.[2]

In its deterministic form, the fundraiser's problem is specified as follows. I assume a population of N individuals indexed by the elements of the set $\{1, 2, . . , N\}$. The fundraiser can solicit each member of the population at a constant marginal cost of κ. Denote the set of solicited individuals by $S \subseteq \{1, 2, . . , N\}$. The cardinality of S is $n \leq N$. Total fundraising expenditures are simply $F = n\kappa$. The fundraiser's objective is to maximize the level of the public good net of fundraising expenditures: $P = C - F$.

Assuming that individuals derive utility from the net level of the public good results in the following generalized optimal contribution function: $c_i^* = \max\{0, f_i[\mu_i + C_{-i} - F] - C_{-i} + F\}$.

Section II, part 3: Government provision

When discussing her model, Payne (1998) emphasizes that government grants to nonprofit organizations are determined by a political process. She uses this fact to motivate her choice of instruments for endogenous government contributions[3]. Government contributions are also endogenous in my model, but I will not use an instrumental variables approach to account for this endogeneity. Instead, I explicitly specify the government's grant allocation formula as a linear function of private contributions:

$$G = G_\ell + G_m C.$$

The intercept term, G_ℓ, represents a lump sum grant. The second term is a matching grant. The slope parameter, G_m, is the rate at which the government matches private contributions. The linear form is based on institutional realities of the Corporation for Public Broadcasting's (CPB's) grant allocation process, which I will now describe.

The CPB collects Annual Financial Reports from all of it's grant recipients. (The data analyzed in this study come from those reports. See Section III.) The primary purpose of these reports is to determine the level of Nonfederal Financial Support (NFFS) for each station. As its name implies, NFFS is a measure of revenue raised at each station from sources other than the federal government or the CPB. In addition to private contributions from listeners, NFFS would include underwriting revenue from private businesses, and the proceeds from special fundraising events. (See Appendix __).

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[2] Alternative objectives for nonprofit firms are plausible, and are discussed in Section IV, Part 4. Steinberg (1986), Khanna, Posnet and Sandler (1995), Segal and Weisbrod (1998), and Okten and Weisbrod (1998) present empirical evidence of heterogeneous objectives across nonprofit industries. The empirical specification used in this paper allows for a continuum of objectives that includes, but is not restricted to the objective of net revenue maximization. Indeed the empirical model is not identified if objectives are homogeneous in the sample. See Section IV, Part 4.

[3] Describe the "political variables" Payne uses for instruments here

CPB grant recipients receive matching grants based on their NFFS. They also receive a separate fixed amount that is the same for all stations in a given grant program. The fixed component of a CPB grant is called a "base grant." The rate at which the CPB matches NFFS is called an "incentive rate of return." Additional incentives are available for stations serving sparsely populated rural areas, minority populations, and other special cases. The stylized model in Figure 1 abstracts from all complexities but the base grant (G_ℓ) and the incentive rate of return (G,).

The timing of the CPB's grant cycle is as follows: Financial reports are collected from every station annually. The data reported by each station reflect financial activity in the most recently completed fiscal year. The NFFS computed from these data is used in turn to determine CPB funding for the following fiscal year. As a result, NFFS enters the CPB grant formula with a two-year lag.

The parameters G_ℓ, and G_m are not constant over time. Base grants, incentive rates of return, and other incentive programs are adjusted on an annual basis by the CPB[4]. The movement of these parameters certainly reflects changes in both the CPB's objectives and constraints over time. This raises questions about modeling G_ℓ, and G_m as exogenous parameters. I argue that the political processes determining CPB objectives and Congressional funding for the CPB are beyond the scope of this paper. I have also chosen not to model a link between individual tax payments and the level of government contributions to the public good. I rationalize this decision by noting that Congressional appropriations to the CPB from 1993 to 1999 were only 0.02% of federal spending over the same period[5]. This implies that only $ I. 14 of the average individual tax bill went towards funding the CPB[6]. Since the CPB distributes grants to hundreds of public broadcasters across the country, less than a penny of any individual's tax payment can be attributed to the public radio station in his or her area.

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[4] The values of G_ℓ and G_m are determined and made known to radio stations several months before grants are dispersed. For example, the values relevant to 1999 grants (based on 1997 NFFS) were determined and made public in May of 1999. The grants will be dispersed in October (?) of 1999. The actual values of G_ℓ (base grants) and G_m (incentive rates of return) for 1993 – 1999 are listed in Appendix __.

[5] Annual CPB Appropriations are reported at http://www.cpb.org/atwork/govrel/appropriation.html. Total federal government outlay was taken from the Council of Economic Advisors (1998), Table B-80, pg. 421. The calculation was made after first adjusting all values to constant 1994 dollars based on the consumer price index (Council of Economic Advisors, Table ?-??, pg. ???).

[6] An average individual tax bill of $6,100 is reported for 1994 in U.S. Department of Commerce (1998), Table 553, pg. 349.

Section II, Part 4: Summary in Terms of Figure I

The results of Parts 1 through 3 are combined in the 4-stage sequential game depicted in Figure 1.

In the first stage, the government announces that it will provide a lump sum grant of G_ℓ, and that it will match private contributions at a rate of G_m. Having the government announce G_ℓ and G_m in the first stage of the game makes their values common knowledge. This aspect of the model is an abstraction from reality. As stated in Part 3, private contributions enter the CPB's actual grant allocation formula with a two year lag, but the values of G_ℓ and G_m are not known (even by the CPB) until a few months before the grants are actually dispersed. This suggests that fundraisers and private contributors cannot know the relevant values of G_ℓ and G_m when making their fundraising and contribution decisions. In a more realistic model, fundraisers and private contributors would formulate expectations of G_ℓ and G,. Assuming that G_ℓ and G_m are common knowledge is equivalent to assuming fundraisers and private contributors can form perfectly accurate expectations. This greatly simplifies the exposition without changing the main implications of the model.

In the second stage, the fundraiser chooses a subset from the population of N individuals to solicit. This set is denoted $S \subseteq \{1, 2, \ldots, N\}$. The fundraiser's goal is to maximize the total amount of the public good (P). This amount is the sum of all private and government contributions, net of fundraising expenditures. The cardinality of the set S is denoted by n. A constant marginal cost of solicitation, κ, is assumed. Total fundraising expenditures are thus given by $F = n\kappa$.

Individual contributions are determined in the third stage as the outcome of a simultaneous Nash equilibrium game among members of the set S. Individual utility functions, $u_i[x_i, P]$ have private consumption (x_i) and the public good (P) as arguments. By the Nash hypothesis, each individual takes net contributions from others $(C_{-i} - F)$ and the parameters of the government grant allocation formula (G_ℓ and G,) as given. The quantity (C., $- F + G_\ell + G_m C_{-i}$) can accordingly be modeled as part of each individual's endowment in the budget constraints. Individuals are also constrained from making negative contributions to the public good. Since the price of both goods is fixed at unity by assumption, Marshallian demands for the public good will be functions only of endowments. I denote these functions by:

$$f_i[\mu_i + C_{-i} - F + G_\ell + G_m C_{-i}].$$

Recognizing the "no negative contributions" inequality constraint results in the following expression for an individual's optimal contribution in equilibrium:

$$c_i^* = \max\{0, fi[\mu_i + C_{-i} - F + G_\ell + G_m C_{-i}] - C_{-i} + F - G_\ell - G_m C_{-i}\}.$$

The government honors it's commitment from the first stage after private contributions have been realized.

The discussion in this section has provided a general framework for thinking about fundraising in the context of public good provision. Additional theoretical concerns will be discussed in the context of the empirical specification in Section IV. These include the well established empirical results of warm glow and partial crowd-out. I will also wait until Section IV to consider explicit individual preferences over fundraising expenditures, aggregation of individual contributions, and identification issues related to simultaneity.

Section III: Data

I have been working until now with publicly available data from the IRS Form 990[7]. I presented preliminary results based on these data to the CPB in May. The CPB agreed at that time to give me access to their proprietary data, which I received on July 19th. I have not had time to prepare a detailed description of the CPB data, nor do I have estimation results based on those data at this time. For now I will just give a very general description of the CPB data, beginning with a description of their advantages over the IRS data I had been using.

The CPB's data are more complete than the IRS data, with usable observations from all grant recipients - about 400 stations versus only 52 stations in my own data set. The CPB data also provide richer detail since their annual financial report, unlike the IRS's Form 990, was designed specifically to collect data from public broadcasters. A final advantage is that the CPB actually audits the financial reports they receive. The IRS Form 990 is subject to audit in principle, but such audits are done with almost zero probability in practice, since no tax is due in any case from nonprofit organizations.

While the CPB data are preferable for estimation, the IRS data could still be used to run out-of sample simulations. The cross-section in the IRS data is a sub-set of the cross section in the CPB data, but the time series in the IRS data covers a different period. The years covered by my IRS data are 1990- 1995 with gaps for many stations. The years covered by my the CPB data are 1993, 1995, and 1997. Presenting simulation results based on the IRS data will also permit me to provide station-specific examples. This will not be possible with the CPB data due to confidentiality restrictions.

In addition to station-specific financial data from 1993, 1995, and 1997, I was also provided information on the actual values of G_ℓ and G_m for the years 1993 to 1999. The CPB asked me to reduce my original request, which included data from every year since 1986. Cross-sectional variation turns out to be more important for identification than time series variation due to simultaneity (see Section IV, Part 4). For this reason, I reduced my request to only 3 years, but still asked for data from every station. The years I requested are staggered so that CPB grants can be matched with twice-lagged NFFS (see Section II, Part 3).

[7] The Form 990 data I collected are available on the web at: http://dpls.dacc.wisc.edu/radio/.

The short time series limits the variation of government contributions in my sample. If the data conformed perfectly with the model in Section II, there would only be 3 independent observations on the government's choice variables G_ℓ and G_m. This would not permit statistically significant estimates of crowd-out. One possibility if the data do not match perfectly with the model is to use parameter estimates and residuals from the regression $G_j^t = g_\ell^t + g_m^t C_j^{t-2} + \varepsilon_{Gj}^t$ to compute estimated values of G_ℓ and G_m[8]. This approach would give me two estimated values of G_m (g_m^{95} and g_m^{97}) and roughly 2x400 = 800 estimated values of $G_\ell = g_\ell^t + \varepsilon_{Gj}^t$. The variation in estimated Ge could be sufficient to permit estimation of crowd out. Identification of crowd-out effects could also be facilitated by nonlinear interactions between the government's choice variables and other variables in my econometric specification (See Section IV, Part 3).

In the theoretical model of Section II, a nonprofit organization's expenditures can be neatly divided into two components: fundraising expenditures and service provision (everything else). The line between fundraising and programming expenditures is somewhat blurred in the actual data, however. Part of the problem in the present application is inherent to public broadcasting, where on-air solicitation is a major component of fundraising. In this environment a fraction of the money spent on programming and even capital should be attributed to fundraising. Measuring this h-action is virtually impossible - even for the radio stations' managers - much less an outside researcher.

[8] The indices j and t denote stations and years respectively. Stations are indexed by j = 1, , J, and years are indexed t = 95, 97.

The breakdown of expenditures reported to the CPB is indicated in Table 1.

Table 1: CPB Expenditure Categories

Line Number	Description
	Program Services
1	Programming and Production
2	Broadcasting
3	Program Information and Promotion
	Support Services
4	Management and General
5	Fundraising and Membership Development
6	Underwriting and Grant Solicitation
7	Depreciation and Amortization
	Cost of Capital Assets Purchased or Donated
9a	Land and Buildings
9b	Equipment
9c	All Other

Source: Schedule E of the CPB's Annual Financial Report form.

The breakdown requires some subjective judgement on the part of station managers who fill out the form, and there is undoubtedly some degree of heterogeneity in the accounting definitions used by different stations'. Expenditures reported on lines 5 and 3 almost certainly match the theoretical model's definition of F. Line 6 is more problematic since some money reported under grant solicitation would have been spent to solicit the CPB. CPB grants are fairly standardized, however. Solicitation of the CPB each year requires little more than a few hours' time spent filling out forms. 1 will assume that this accounts for a very small portion of the expenditures reported on line 6. As for the other categories, it is hard to know what portion of these items should be attributed to F. One possibility is to assume that station managers have already made their own assessment of this, and allocated all relevant expenditures to either lines 3, 5, or 6. Alternatively, I could try to obtain data on the number of days devoted each year to pledge drives". This data could be used to construct an instrument for the portion of programming expenditures attributable to fundraising. Suggestions about how to proceed here would be very welcome.

[9] I have met with the people who till out WORT's, WERN's, and WHA's financial reports to the CPB to get some insight into how they arrive at the numbers they report.

[10] The CPB does collect this information each year, but it does so in a survey that is separate from the annual financial report. The person responsible for the non-financial data recently left the CPB, and has yet to be replaced. My initial data request included non-financial data, but the CPB asked me to limit my request to reduce the burden imposed on their staff.

Section IV: Empirical Specification

The function to be estimated is what Steinberg (1986b) has called a "donative revenue function" (DRF). The DRF relates aggregate contributions received from private individuals (C) to fundraising expenditures by a nonprofit firm (F). Factors like government contributions and the cost of solicitation shift the DRF in (C, F)-space. Identification of this function provides information on the effectiveness of fundraising, the revealed objectives of noncommercial radio stations, and the degree of crowd-out associated with different sources of revenue, including government contributions. If the aggregate DRF can be related to individual contribution functions, estimation will also provide insight into the way individual preferences, constraints, and other exogenous factors interact to determine individual contributions to a public good.

This section is presented in five parts. The first part derives an individual contribution function from the theoretical framework of Section II. I begin by specifying a utility function that allows different components of the public good to receive different weight". This generality accommodates the well established empirical results of warm glow (Andreoni, 1993, Kingma, 1989) and partial crowd-out (Steinberg, 199 l and 1997). It also permits individuals to have explicit preferences over fundraising expenditures. In this way, fundraising expenditures will affect utility in two distinct ways. The first is by providing information as described in Section II. The second is by appearing as an argument in the utility function. The second part of this section addresses the issue of cross-sectional variation in solicitation costs. Part 3 derives the aggregate DRF by adding up individual contribution functions. Empirically useful aggregation results depend on several assumptions, which are laid out and discussed explicitly. In Part 4, I note that simultaneity issues inherent to the problem of fundraising make identification of DRFs from time series data implausible. I propose to use cross-sectional variation in fundraising goals to identify DRFs that are common to stations of a similar class. The fifth and final part of this section specifies the stochastic component of my empirical model.

Section IV, part 1: Utility Specification and Individual Contribution Functions

The utility function (1) provides the starting point for my empirical specification.

$$u[x_i, c_i, C_{-i}, G, F] = (1-\rho)\ln[x_i] + \rho\ln[1 + \alpha c_i + \beta C_{-i} + \gamma G + \eta F] \tag{1}$$

Note that the utility function discussed in Section II is the following special case of the left-hand side of (1): $u[x_i, P] = u[x_i, c_i + C_{-i} + G - F]$. The specific form chosen for the right-hand side of (1) is a quasi-homothetic variation on Cobb-Douglas utility. A linear Engel curve, or income expansion path (IEP), is the

[11] Equal weighting is included as a special case of the specification.

most important restriction imposed by the assumption of quasi-homothetic preferences. The implications of this restriction are discussed below.

The additive argument of the second term, $1 + \alpha c_i + \beta C_{-i} + \gamma G + \eta F$, is interpreted as follows. The coefficients a, $\beta, \gamma,$ and η permit different components of the public good to receive different weight in the utility function. Equal weight, as in the standard model of Section II, is included as the special case a = $\beta = \gamma = 1, \eta = -1$. The degree of crowd-out associated with contributions from other individuals and the government will depend on β and γ respectively. Explicit preferences over fundraising expenditures will be reflected in η. Adding 1 to the four components and their coefficients normalizes the public good's contribution to utility. Under this normalization, sub-utility from the public good will be exactly zero when the level of the public good is zero ($c_i = C_{-i} = G = F = 0$).

The parameter ρ reflects an individual's taste for the public good relative to the private good'*. A value of $\rho = 0$, for example, implies that the individual derives no utility at all from the public good. For this reason, ρ can be conveniently tied to the informational aspect of fundraising. The value of ρ is assumed to be latent (ρ=0) until an individual has been solicited. Prior to solicitation, an individual's utility function is just $u[x] = \ln[x]$. Upon being solicited, the individual's latent preference for the public good is realized, and (1) becomes the relevant utility function[13]. Note that ρ may still be zero, even after an individual has been solicited, i.e. some people may have preferences such that they derive no utility from the public good, even if they have perfect information about it.

The notation in (1) does not recognize the dependence of G on C. Assuming private contributor's take this dependence into account implies the substitution $G = G_\ell + G_m(c_i + C_{-i})$, which yields:

$$(1') \qquad u[x_i, c_i, C_{-i}, \mathbf{G}, F] = (1-\rho)\ln[x_i] + \rho\ln[1 + (\alpha+\gamma G_m)c_i + (\beta+\gamma G_m)C_{-i} + \gamma G_\ell + \eta F]$$

This utility function can be maximized subject to the standard problem's budget and inequality constraints, which I now restate as (1 a) and (lb) for convenience:

$$(1a) \qquad x_i + c_i = \mu_i$$

$$(1b) \qquad c_i \geq 0$$

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[12] The value of ρ can be restricted, without loss of generality, to the interval [0, 1]. This follows directly from the invariance of utility to monotonic transformations.

[13] The discontinuity of utility with respect to solicitation can be incorporated formally in the expression of the utility function. To do so, interact ρ with an indicator function, I[.], as follows:

$$u[x_i, c_i, C_{-i}, G, F] = (1 - \{I[i \in \boldsymbol{S}]\rho\})\ln[x_i] + \{I[i \in \boldsymbol{S}]\rho\}\ln[1 + \alpha c_i + \beta C_{-i} + \gamma G + \eta F].$$

The expression ($i \in \boldsymbol{S}$) is true if individual i belongs to the set of solicited individuals. This explicit notation is quite cumbersome, and will not be used in what follows. This should not result in confusion since attention is restricted to the set $\boldsymbol{S}$ in most of the analysis.

The resulting optimal contribution is given by:

(2) $$c_i = \max\{0, \rho\mu_i - [(1\text{-}\rho)/(\alpha+\gamma G_m)][1+ (\beta+\gamma G_m)C_{-i} + \gamma G_\ell + \eta F]\}$$

The income expansion path (IEP) implied by (2) is depicted by the solid kinked line in Figure 2. The dashed straight line in Figure 2 is an unconstrained IEP with slope ρ, and intercept $-[(1\text{-}\rho)/(\alpha+\gamma G_m)][1 + (\beta+\gamma G_m)C_{-i} + \gamma G_\ell + \eta F]$. The horizontal intercept of the unconstrained IEP represents a minimum income threshold, $\underline{\mu}$, below which the inequality constraint will bind, and the contribution will be zero. The individual will contribute a fixed proportion (p) of all income above the threshold to the public good. Changes in the contributions of others (C_{-i}), fundraising expenditures (F), and/or the government's grant allocation formula (GP and G,) shift the unconstrained IEP up or down without changing its slope. The solid kinked line recognizes the inequality constraint (lb).

I conclude this part of the section with a consideration of restrictions imposed by my utility specification. The IEP depicted in Figure 2 features two significant generalizations over homothetic preferences (e.g. Cobb-Douglas utility). The first is that the unconstrained IEP is not restricted to pass through the origin. This feature derives from the Stone-Geary-like additive argument of the public good term in (1). The second generalization with respect to homothetic preferences is the kink in the IEP at $\mu_i = \underline{\mu}$. The kink results from the inequality constraint (1 b). The income threshold $\underline{\mu}$ seems entirely plausible in the present application. It implies that contributions to public radio do not begin until a certain comfort level of private consumption has been attained. Less plausible is the constant share of additional income devoted to the public good after the threshold has been exceeded. Nonlinearity of the IEP above the threshold would be desirable.

A popular form of demand that implies this kind of nonlinearity expresses the budget share devoted to a good as a linear function of log-income[14]:

(3) $$s_i = \phi + \lambda \ln \mu_i.$$

In the present application, s_i represents the share of agent i's budget contributed to the public good. The nonlinear income expansion path implied by (3) will be either concave or convex to the horizontal axis depending on the sign of λ[15].

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[14] The use of this form in demand analysis dates back to Working (1943). Deaton and Muellbauer's (1980b) "almost ideal demand system" is an extension of this functional form.

[15] See Figure 1.12 of Deaton and Muellbauer (1980a).

To facilitate comparison of my contribution function (2) with equation (3), I divide (2) by the endowment μ_i. This yields (2'), which also has the budget share devoted to contributions on the left-hand side[16]:

(2') $s_i = \rho - \theta/\mu_i$.

The parameter ρ in (2') is the same ρ that appears in the individual contribution function (2) and the direct utility function (1). The parameter θ is defined for convenience as shorthand for the term $-[(1-\rho)/(\alpha+\gamma G_m)][1 + (\beta+\gamma G_m)C_{-i} + \gamma G_\ell + \eta F]$. As such it is functionally related to ρ, and only constant for a given set of values for C-i, G, and F.

For a given set of values for C_{-i}, F, G_m, and G_ℓ, I now compare the properties of (3) and (2'). I will assume that λ is strictly positive, while the quantity $[-\theta]$ is strictly negative[17]. A graph depicting an example of each curve is given in Figure 3. The income share, s_i, approaches $-\infty$ as income approaches zero from the right in both (3) and (2'). Given the constraint that $s_i \in [0, 1]$, this implies that $s_i = 0$ for some initial range of income in both cases. The implications of the two specifications do differ subtly as income approaches positive infinity, however. In the case of equation (2'), the share of income devoted to contributions approaches an asymptote at $s_i = \rho$. While the share implied by equation (3) grows very slowly when income is high, it has no upper bound other than the constraint at $s_i = 1$. An ever increasing share devoted to contributions is an undesirable property of (3), although the budget shares implied by the two specifications are unlikely to differ significantly over any empirically relevant range of incomes. I conclude that the nonlinear IEP implied by (3) does not offer as much generality as one might expect, and that the functional form of (2) is not dominated by the alternative form (3) on theoretical grounds.

Section IV, Part 2: Cross-sectional Variation in Solicitation Costs

Fundraising expenditures in the theoretical model of Section II are defined as $F = n\kappa$. Empirical implementation of the model requires matching data on fundraising expenditures with the theoretical concept. This task is not straightforward because fundraising expenditures are measured imperfectly in the data, and because solicitation costs are probably not constant across stations. The first problem was addressed in Section III. I now turn to the second problem.

A constant marginal cost of solicitation, κ, was assumed in Section II for simplicity. For a given radio station, the marginal cost of a solicitation may be nearly constant, but it is likely to vary significantly across stations. As noted in Section III, on-air pledge drives are an important component of fundraising at

[16] The obvious constraint that $s_i \in [0, 1]$ applies to both *(3)* and (2'). With this in mind, I do not carry the max function notation when writing (2').

[17] The assumption that $\lambda > 0$ amounts to assuming contributions to the public good are a luxury, where luxuries are defined as goods whose budget share increases with income. It follows that private consumption (the only other good) would be a necessity. Assuming $[-\theta] < 0$ is analogous.

public radio stations. This suggests that solicitation might be less costly for powerful stations in densely populated areas than for low-watt stations in rural areas. To allow for this, I will specify each station's κ as a (presumably decreasing) function of POP, where POP is an estimate of the station's potential audience". If this were a linear function, I would have $\kappa = \kappa_0 + \kappa_1(POP)$. The parameter κ_0 would represent a component of solicitation costs common to all stations (e.g. the price of postage stamps). The term $\kappa_1(POP)$ would allow costs to vary across stations depending on the size of their potential audience". The expected signs of the parameters in this case would be $\kappa_0 > 0$, and $\kappa_1 < 0$. A nonliner alternative would be $\kappa = \kappa_0 + \kappa_1/POP$, which has a lower bound at κ_0. An estimate of $\kappa_0 > 0$, would be sufficient to rule out negative solicitation cost estimates when POP is very large. (The implication of infinite costs when $POP=0$ is essentially irrelevant from an empirical standpoint.)

Section IV, Part 3: Aggregation of Individual Contribution Functions

Data from repeated observation of an individual's contribution given different values of μ_i, C_{-i}, F, G_ℓ, and G_m could be used to identify their individual contribution function (2). The necessary assumption that the individual's vector of parameters (pi, $\alpha_i, \beta_i, \gamma_i, \eta_i$)[20] is constant across observations would be plausible in most applications. Micro data sets with individual variation in variables like the ones listed above do not exist, however. Indeed it is difficult to imagine how such data could be collected, except perhaps from an appropriately designed experiment.

The data described in Section III provide repeated observations at the firm level, rather than at the level of individual contributors. Aggregate contributions to a nonprofit firm are, by definition, simply the sum of all individual contributions. In this part of Section IV, I will derive an aggregate DRF by summing across individual contribution functions (2). The empirical usefulness of this aggregation depends on several assumptions, which will be noted explicitly.

The first thing to note is that the individual contribution functions (2) are linear in income. This follows directly from the specification of quasi-homothetic preferences in Section IV, part 1. The desirable aggregation properties of quasi-homothetic preferences are well known from the work of Gorman (196 1, 1976).

Before summing across individuals, I make the additional assumption that all contributors to the public good have the same vector of parameters (p, a, β, γ, and η). This is clearly a strong assumption. I am essentially assuming a two-type economy. One type has preferences such that, given sufficient income, they will contribute to the public good if solicited. The other type would not contribute, no matter how

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[18] Estimates of POP are available on the CPB's web site at http://www.cpb.org/stations/radio/la2k/

[19] A station's output power and the population density of its listening area are plausibly modeled as exogenous. A station cannot change its output power without FCC approval.

[20] Individual preference parameters were not indexed in Part 1, because the discussion in Part 1 was presented in terms of a single individual's utility and demand functions.

high their income[21]. I will refer to people with the first type of preferences as "potential contributors." The assumption of identical preferences among potential contributors is most plausible when the group represents a small subset of the population. The number of contributors to each station is included in my data from the CPB. I will report the summation across all 400 stations in future drafts of my paper. Even without allowing for double counting of people who contribute to more than one station, it is probably a very small fraction of the U.S. population. An implication of the assumption is that individual contributions will be a monotonically increasing function of μ_i.

The assumption of common preferences would seem to make the fundraiser's problem trivial - she should solicit all the potential contributors with income above a certain threshold[22]. Imperfect information and an element of randomness in contributions could make the problem more interesting (and more realistic), but even the deterministic case is not as simple as initial intuition might suggest. The complication is analogous to the choice of output quantity faced by a non-price-discriminating monopolist in a static environment. The fundraiser faces a trade-off between adding revenue from an additional contributor, and losing revenue from all other contributors due to their aversion to fundraising expenditures. If individuals have such aversion, it will be reflected in the parameter η. Because of these countervailing effects, aggregate contributions will be a nonlinear function of fundraising expenditures.

To derive this nonlinear function, sum across individuals:

$$C = \rho\Sigma_i\mu_i - n[(1-\rho)/(\alpha+\gamma Gm)][1 + \gamma G_\ell + \eta F] - (n-1)[(1-\rho)(\beta+\gamma G_m)/(\alpha+\gamma G_m)]C.$$

Now define M to be the mean income of all contributors, and note that $\Sigma_i\mu_i = nM$. Solving for C and simplifying yields:

$$C = \{[(\alpha + \gamma G_m)\rho nM - n(1-\rho)] / [(\alpha+\gamma Gm) + (1-\rho)(n-1)(\beta+\gamma Gm)]\} * (1 + \gamma G_\ell + \eta F).$$

Recall that $F = n\kappa$, where κ is the marginal cost of a solicitation. Using this relationship to substitute for n results in:

$$C = \{[(\alpha+\gamma G_m)\rho FM - (1-\rho)F] / [\kappa(\alpha+\gamma G_m) + (1-\rho)(F-\kappa)(\beta+\gamma G_m)]\} * (1 + \gamma G_\ell + \eta F).$$

---

[21] I do not need to assume identical preferences for the second type. The economy can include individuals with many different combinations of (ρ, a, β, γ, and η) such that they would never contribute to the public good.

[22] The threshold is $\underline{\mu}$ from Figure 2. Below this level of income, constraint (1 b) will bind, and the contribution will be zero.

I now note that $F \cong (F-\kappa)$, i.e. the magnitude of κ relative to F is minute. (After I have empircal estimates of κ, I can compare them to observed F at this point.) Replacing $(F-\kappa)$ with F in the preceding expression, leaves only one κ in the formula. Making the substitution $\kappa = \kappa_0 + \kappa_1/POP$ (see Section IV, Part 2) yields the following deterministic DRF:

$$C = \{[(\rho-1) + \rho(\alpha+\gamma G_m)M] / [(\kappa_0 + \kappa_1/POP)(\alpha+\gamma G_m) + (1-\rho)(\beta+\gamma G_m)F]\} * (F + \gamma G_\ell F + \eta F^2) \tag{4}$$

Equation (4) expresses aggregate contributions as a function of the parameter vector (p, a, $\beta, \gamma, \eta, \kappa_0, \kappa_1$) and the variables M, F, G_m, G_ℓ, and POP. The expression is linear in income, M. Its extreme nonlinearity in F, G_ℓ, and G_m implies that endogenous fundraising decisions by the nonprofit manager will be a function of the government's choice variables.

The dependence of fundraising decisions on government subsidization has important implications for the measurement of crowd-out. As pointed out by Steinberg (1991), crowd-out should be measured net of endogenous fundraising responses to government subsidization. As an example, he considers a case in which government contributions are reduced by $2,000, and private contributions are observed to increase by exactly the same amount. Ignoring fundraising expenditures, this could be taken as evidence that government contributions had been crowding-out private contributions dollar for dollar. If, however, an additional $1,000 had been spent to raise the additional private contributions, net crowd-out would only be $0.50 to the dollar. The distinction could have important policy implications.

It has been common in previous studies to model government contributions as an exogenous variable, which appears in the DRF as an additive linear term[23]. Such specifications have the form C = h(F) + gG[24]. Equation (4) does not belong to this class of DRF, because G's dependence on private contributions was recognized in its derivation. The standard approach implicitly assumes that fundraisers do not adjust their behavior in response to changes in government subsidization. To see this, substitute the expression C = h(F) + gG into the fundraiser's objective function[25]:

$$P = [h(F) + gG] - F + G.$$

[23] Crowd-out is measured as the coefficient on exogenous government contributions in a linear specification of the DRF by Weisbrod and Dominguez (1986), Kingma (1989), Khanna, Posnet and Sandler (1995), Okten, Kagla and Weisbrod (1998), Segal and Weisbrod (1998), and virtually all the studies surveyed in Steinberg (1991 and 1997). (I **need to look at these** studies **again to make sure.)** Payne (1998) allows for joint determination of government and private contributions, but does not model fundraising decisions.

[24] I suppress the DRF's dependence on marginal solicitation costs and POP in this example.

[25] The fundraiser's optimization problem is summarized in the second stage of Figure 1, and discussed in Section II, Part 2).

The derivative of this expression with respect to fundraising expenditures is $h'(F) - 1$, implying that the fundraiser should choose F such that $h'(F) = 1$[26]. The fimdraiser's decision rule does not depend in any way on government contributions in this framework.

Equation (4), while less tractable than previously studied specifications, allows for potentially important interaction between fundraising expenditures, private contributions, and government contributions.

Section IV, Part 4: Simultaneity and Identification Issues

Any strategy for estimating the parameters of equation (4) will require a data set with variation in the quantities C, M, POP, F, G_ℓ, and G_m. Joint determination of these variables effectively limits the variation in a data set. Equation (4) accounts for interdependence between government and private contributions by making C a function of G_ℓ and G_m instead of assuming G to be exogenous. The model of Section II implies that G_ℓ, G_m, and F will also be jointly determined. My strategy for identification of equation (4) in the face of this simultaneity problem depends on two assumptions. The first is that similar classes of radio stations operate in comparable fimdraising environments, and thus face the same DRF. The second is that fundraising objectives are heterogeneous in the sample.

Estimation of a DRF like (4) is analogous in many ways to estimation of a sales-advertising function. Schmalensee (1972) lays out the theoretical basis for managers to rationally make advertising budgets a fixed proportion of sales. He also provides both anecdotal and empirical evidence that advertising budgets are in fact set this way. One of his main conclusions is the negative result that advertising's effect on demand is essentially unidentified in many contexts due to this "reverse causality."

A similar simultaneity problem is inherent to the model of Section II. Consider a fundraiser facing the problem of choosing F subject to the deterministic DRF $C(F, G_\ell, G_,)$ [27]. Assume that she observes both the parameters of the DRF and the data (C, Ge and G,) without error, but that the econometrician observes

[26] I am assuming an interior solution to the problem. 1 am also assuming that h( ) is concave, with a unique value of F such that $h'(F) = 1$. The form of equation (4) does not guarantee concavity or an interior solution. I will not impose these restrictions in estimation. Unrestricted estimates using IRS data were consistent with these assumptions. (See Figures 7, 8, and 9).

[27] I assume constant income, M, and potential audience, POP, in this part of the section.

only the data. Assume also that the government matches net contributions $[C(F, G_\ell, G,) - F]$ rather than gross contributions $[C(F, G_\ell, G_m)]$[28]. If her goal is to maximize net revenue, her objective function will be of the form:

$$P = C(F, G_\ell, G,) - F + G_\ell + G_m[C(F, G_\ell, G_m) - F]$$

Maximizing this expression with respect to F requires choosing F such that $\partial C/\partial F = 1$[29]. If the parameters of the DRF are time invariant, all variation in F will be due to changes in G_ℓ and G_m. Identification of both fundraising effects (the shape of the DRF) and crowd-out effects (shifts in the curve) from time series variation in G_ℓ and G_m would not be possible without additional assumptions. The situation is depicted in Figure 4. The DRF in Figure 4 is drawn for a given value of the vector (G_ℓ, G_m)[30]. Net revenue is maximized at $F=F^*$. This is seen graphically as the point that maximizes the distance between the DRF and the 45-degree line. The slope of the DRF will be one at this point. The stars in Figure 4 correspond to optimally chosen (C, F)-pairs in five consecutive years. Observing only the five data points, an econometrician is unable to infer the shape and position of the DRF without additional assumptions.

Cross-sectional data offer a solution to this problem, but only under certain conditions. Consider the case of several stations, each facing a different DRF (i.e. different values of ρ, a $\beta, \gamma, \eta, \kappa_0$, and κ_1). This situation is depicted in Figure 5. Time series data from each station will be concentrated around station-specific optima as described in the previous paragraph. These station-specific “clouds” of data will bear no systematic relationship to each other, so cross-sectional data will provide no additional identifying power in this case. Alternatively, assume several stations can be found that face the same DRF (i.e. identical values of $\rho, \alpha\, \beta, \gamma, \eta, \kappa_0$, and κ_1). Cross-sectional variation in G_ℓ may be greater than time series variation, but identification of both crowd-out and fundraising effects from this single source of variation would still not be possible without additional assumptions[31]. In the extreme case with G_ℓ equal for all stations in a given year, cross-sectional data provide no additional information since each station’s time series will be identical in the deterministic case.

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[28] In fact the CPB matches gross contributions. My alternative assumption simplifies the expression for the fundraiser’s decision rule in what follows. I will compare the incentive effects of these alternatives when I run policy simulations in future drafts of my paper.

[29] I am making the same assumptions discussed in footnote 26

[30] These could be the mean values of G_ℓ and G_m over the relevant time period, for example.

[31] G_m is the same for all stations in a given year by assumption

Cross-sectional observations on stations facing a common DRF will have identifying power, however, if fundraising objectives are heterogeneous across stations[32]. To see this, consider the case depicted in Figure 6. Time series observations from three different stations are depicted by the symbols -,*, and + respectively. To keep the graph uncluttered, I assume the stations have similar ranges of M, and POP, and receive similar lump sum grants G_ℓ each year. This allows me to draw a single DRF for all three stations in (C, F)-space, but would not be necessary for analytical identification of the DRF. The station represented by stars has the objective of maximizing net revenue. The manager at that station chooses F^*, which sets $\partial C/\partial F = 1$. The variation of the stars around the optimal point results, as in Figure 4, from variation in G_ℓ and G_m over time. The station represented by plus signs pursues an alternative objective, namely that of gross revenue or total budget maximization. The manager at this station will choose $F = F^+$, which sets $\partial C/\partial F = 0$. Such an objective could be motivated by management incentives to feather their own nests, or by institutional "spend it or lose it" budgeting practices (Steinberg 1986a). The station represented by minus signs is choosing F^-, which sets $\partial C/\partial F > 1$. Such an objective is irrational from a purely economic point of view since additional fundraising expenditures would more than pay for themselves. Nevertheless, "satisficing" or other irrational objectives could reflect institutional constraints like fixed fundraising budgets or credit constraints[33]. In terms of the model in Section II, heterogeneous fundraising objectives imply that C, -F, and G do not receive equal weight in every station's objective function (see Figure 1).

In summary, heterogeneous objectives in the sample provide an independent source of variation in F. This overcomes the simultaneity problem implied by joint determination of G_ℓ, G_m and F in the model of Section II.

Section IV, Part 5: Stochastic Component of the Specification and Estimation Strategy

The first four parts of this section have derived a functional form and laid out the assumptions necessary for identification. This final section specifies the stochastic component of my empirical model and the estimation procedure I plan to use.

{Note for the summer seminar: Actually, this section discusses one option: nonlinear least squares with an additive disturbance. I have been trying to think about alternative ways to specify the stochastic component in my empirical model. I haven't worked anything out in time to include it in this draft of my paper. I may or may not have something to present in Wednesday the 28th.}

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[32] Rao and Miller (1975) have exploited similar cross-sectional variation in decision rules to estimate advertising-sales functions.

[33] Comments from the staff at the CPB indicate that fixed fundraising budgets are common in public radio, especially at stations run by larger institutions like universities.

To summarize previous results, the object of estimation is equation (4). Given this specification, the parameters to be estimated are p, a, $\beta, \gamma, \eta, \kappa_1$, and κ_0. Data from a panel of radio stations will provide both time series and cross-sectional observations on the variables C, F, M, POP, G_ℓ and G,.

The parameters of (4) could be estimated by nonlinear least squares under the assumption that C is also determined in part by an additive term summarizing the effect of unobservable factors. Denote this term by ε_j^t. The subscript indexes radio stations, j = 1, ... , J. The superscript indexes time periods, which in my sample are t = 93, 95, 97[34]. As usual, I assume that the expected value of ε_j^t is zero for all stations in all time periods. The dependence of G_ℓ and G_m on past values of C implies that ε_j^t will be autocorrelated. Cross-sectional heteroskedasticity is also common in data from a cross-section of firms. Statistical test results were consistent with the presence of both autocorrelation and cross-sectional heteroskedasticity in my old data set. Assuming the same is true in my new data set, I will need to make appropriate departures from classical assumptions about the variance-covariance matrix of ε_j^t.

My first assumption is that unobservable factors are uncorrelated between stations:

$$\mathrm{Corr}[\varepsilon_{jt}\varepsilon_{ks}'] = 0 \text{ if } j \neq k,\ t = 93, 95, 97,\ s = 93, 95, 97.$$

[34] Values of G_ℓ and G_m are available for 1999 as well.

To model heteroskedacity across stations and autocorrelation over time for each station, I write the variance-covariance matrix for a given station's unobservables as follows:

$$E[\varepsilon_j \varepsilon_j'] = \sigma^2_j \Omega,$$

where σ^2_j is the station-specific variance term, and Ω is a (3x3) autocorrelation matrix, assumed to be the same for all stations[36]. The overall (3J x 3J) variance-covariance matrix is then:

$$E[\varepsilon\varepsilon'] = \begin{bmatrix} \sigma_1^2\Omega & 0 & 0 & . & . & . & 0 \\ 0 & \sigma_2^2\Omega & 0 & . & . & . & 0 \\ . & & & & & & \\ . & & & & & & \\ . & & & & & & \\ 0 & 0 & . & . & . & & \sigma_J^2\Omega \end{bmatrix}$$

Station specificity of the σ^2_j terms allows for cross-sectional heteroskedasticity.

A parsimonious model of autocorrelation is an AR(1) in which the parameter $[\upsilon \in (0, 1)]$ is the same for all stations”. In this model,

$$\varepsilon_j^t \cdot \upsilon\varepsilon_j^{t-1} + u_j^t,$$

$$\mathrm{Var}[\varepsilon_{jt}] = \sigma_j^2 = \sigma^2_{uj}/(1 - \upsilon^2), \text{ and}$$

$$\Omega_j = \Omega = \begin{bmatrix} 1 & \upsilon & \upsilon^2 \\ \upsilon & 1 & \upsilon \\ \upsilon^2 & \upsilon & 1 \end{bmatrix} \forall j = 1, \ldots, J$$

The advantages of this stochastic specification are that it relies on standard econometric theory and is relatively easy to implement[38]. The disadvantage is that ε_j^t is tacked onto equation (4) in a rather ad hoc

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[36] The dimension of the auto-correlation matrix is (3x3) because there are 3 time periods in my sample.

[37] Contributions enter the government's grant determination formula with a two-year lag. This implies that the autocorrelation process should also have a two-year lag. My data set includes observations only from the odd-numbered years 1993, 1995, and 1997. In the context of my data set, an AR(1) process is appropriate.

fashion. There are several points in the model of Section 2 that are likely to be characterized by imperfect or asymmetric information. These may be more natural places for the introduction of stochastic elements.

I have only begun considering alternatives to the additive term, ε_j^t, and will not discuss them in this draft of the paper. It is possible that I may have some ideas to present on Wednesday the 28th.

Section V: Estimation Results

I do not yet have results based on the CPB data, but I can present some preliminary results based on the IRS data. I will use 3 graphs to summarize my old results. To avoid confusion, I will not present any tabular estimation results since my old specification was not the same as equation (4). The results discussed in this section are presented only to give a general idea of how the data can be expected to conform to the empirical model developed in Section IV.

Figure 7 plots private contributions against fundraising expenditures for 38 National Public Radio affiliates. There are a total of 104 observations plotted in Figure 7. Observations indicated by a triangle are "large stations." Observations indicated by circles are "small" stations. The distinction is made based on the size of a station's potential listening audience. There are 39 triangles and 65 circles in Figure 7. The absence of circles above a certain level of fundraising expenditures suggests that large and small stations are not operating in comparable fundraising environments. The two curves in Figure 7 are least squares fits of a quadratic DRF specification to the two sub-sets of the data. The optimal level of fundraising implied by the two curves is very different. The greater dispersion of observations in the upper right comer of the graph is evidence of heteroskedasticity.

Figure 8 provides some detail on the small stations. This sub-sample was again divided into "relatively small" and "relatively large" stations. Unlike Figure 7, the separation between circles and triangles is not distinct in Figure 8. I interpret this as an indication that the stations represented in Figure 8 (unlike those in Figure 7) can plausibly be assumed to operate in similar fundraising environments (i.e. to face the same DRF). The two curves in Figure 8 are evaluated at different levels of government spending (the .25 and .75 quantiles of the empirical distribution). The slight difference between the curves could be interpreted to mean that the magnitude of crowd-out (or crowd-in) is small. (The coefficients on government spending terms were not statistically significant. The coefficients on fundraising terms were statistically significant at the 10% level.)

Figure 9 is restricted to large NPR affiliates. As with the small NPR affiliates, there was not a sharp division between the set of "relatively large" and "relatively small" stations. The ID numbers used to mark observations in Figure 9 reveal where observations from individual stations lie relative to each other. With one possible exception (station 83) each station's data tends to be clustered together. This is consistent with the discussion of simultaneity in Section IV, Part 4. A similar pattern was observed for

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[37] Nonlinear least squares is discussed by Greene (1993) in Chapter 11. Cross-sectional heteroskedasticity and autocorrelation in panel data sets are discussed in Greene (1993), Chapter 16.

small stations. Coefficients on both fundraising and government spending terms were statistically significant for this group, but the economic significance of crowd-out was negligible.

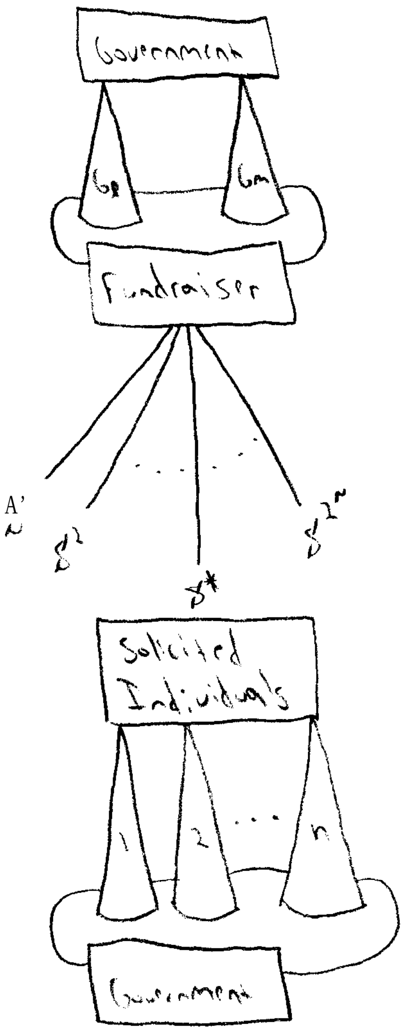
Figures 8 and 9 are consistent with the assumption of heterogeneous fundraising goals across stations. The potential gains to additional fundraising would seem to be substantial for stations in the lower left-hand comers of the two graphs, although some caution is advised in drawing such conclusions from these rough estimates. An econometric caveat to the estimates presented in this section is that government contributions were taken as exogenous, i.e. the CPB's grant determination formula in the fourth stage of Figure 1 was not acknowledged. Payne's (1998) estimates of crowd-out were very sensitive to alternative assumptions about the endogeneity of government contributions. An institutional caveat has to do with my criteria for pooling observations in Figures 8 and 9. My data allow me to distinguish between "large" and "small" stations, but the only measure of programming format I have is the very crude binary indicator of NPR affiliation. It is quite possible that something other than my measures of size and NPR affiliation separates the apparent underachievers from the apparent optimizers in Figures 8 and 9. If so, it might not be appropriate to expect the underachievers to replicate the optimizers' fundraising success.

I am more comfortable interpreting my results as an indication of where the CPB or other researchers more familiar with the noncommercial broadcasting industry might want to pick up where my economic analysis leaves off. If (and only if) they conclude that stations in, say, Figure 9 really are facing comparable fundraising opportunities, then it might be advisable to encourage them all to adopt station 122's fundraising practices. The estimated gains in revenue are in some cases an order of magnitude greater than current levels of CPB funding.

Section **VI:** Conclusions

I have presented a theoretical framework in which fundraising at nonprofit firms can be studied. The sequential game in Section II generalizes a standard model of contributions to a public good for this purpose. Endogenous government contributions are also part of the framework. I have specified the model for estimation, and collected data from the CPB. These data are well suited for estimation of my model since public radio is one of the best real world approximations of a textbook public good. Preliminary estimates based on similar data from the IRS indicate that public radio fundraising conforms well with the model, and that salient empirical results can be expected.

Figure 1: Summary of the Theoretical Framework



Stage 1: Government

Announce lump sum grant G_ℓ and matching grant rate G,.

Stage 2: Fundraiser

$$\max_{S \subseteq \{1, 2, \ldots, N\}} \quad P = C - F + G$$

$$\text{s.t.} \quad C = \Sigma_{(i \in S^*)} c_i^*$$
$$F = n\kappa$$
$$G = G_\ell + G_m C$$

Stage 3: Solicited Individuals

$$\max_{xi,\, P} \quad ui[x_i, P]$$

$$\text{s.t.} \quad x_i + P = \mu_i + C_{-i} - F + G$$
$$P \geq C_{-i} - F + G$$
$$G = G_\ell + G_m(c_i + C_{-i})$$

$$\Rightarrow \quad c_i^* = \max\{0, f_i[\mu_i + C_{-i} - F + G_\ell + G_m C_{-i}] - C_{-i} + F - G_\ell - G_m C_{-i}\}$$

Stage 4: Government

Provide government contribution $G = G_\ell + G_m C$

Notation

Ge:	Lump sum government contribution to the public good.
G,:	Rate at which government matches private contributions.
$\{1, 2, 3, \ldots, N\}$:	The set indexing each member of the population.
P:	Level of the public good, measured in dollars.
c:	Aggregate private contributions to the public good, measured in dollars.
c_i^*:	Utility maximizing contribution of individual i.
C_{-i}:	Total contributions by all agents other than agent i.
F:	Total fundraising expenditures.
s*:	Net revenue maximizing choice of the subset of the population to be solicited.
n :	Cardinality of the set S*
κ:	Exogenously determined constant marginal cost of a solicitation.
x_i:	Individual i's consumption of the private good, measured in dollars.
μ_i:	Individual i's exogenous endowment of money.
f_i[ ]:	Individual i's Marshallian demand for the public good.

Figure 2: An Individual Contributor's Income Expansion Path

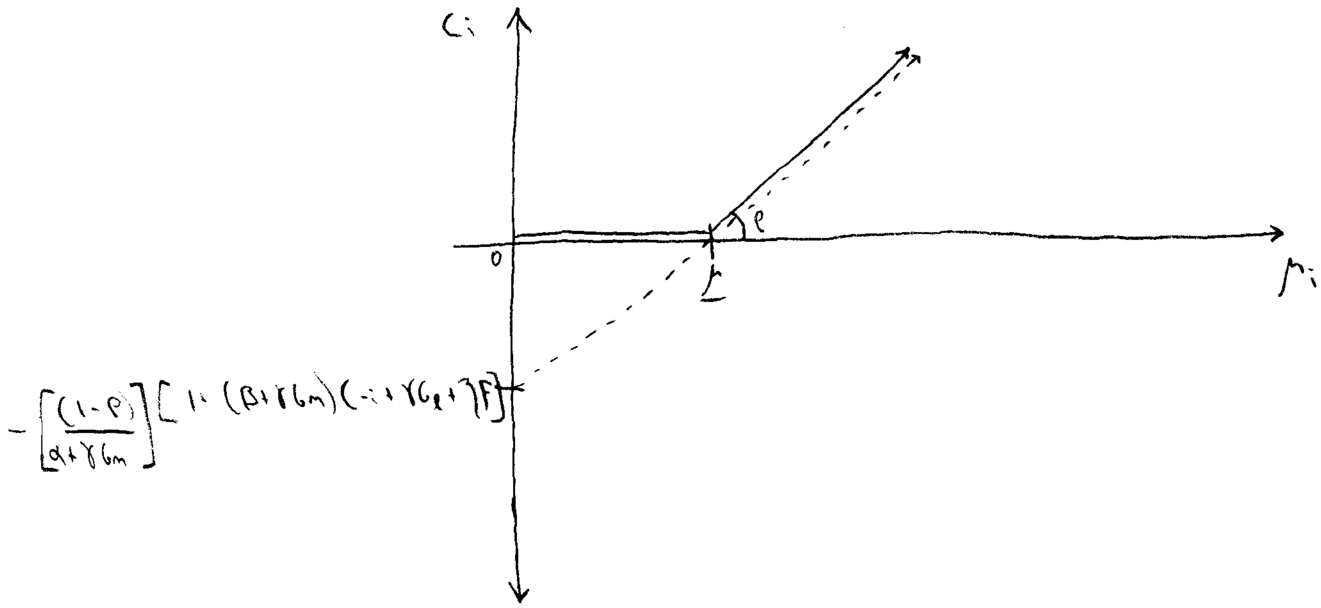


Figure 3: Expenditure Shares implied by Specifications (2') and (3)

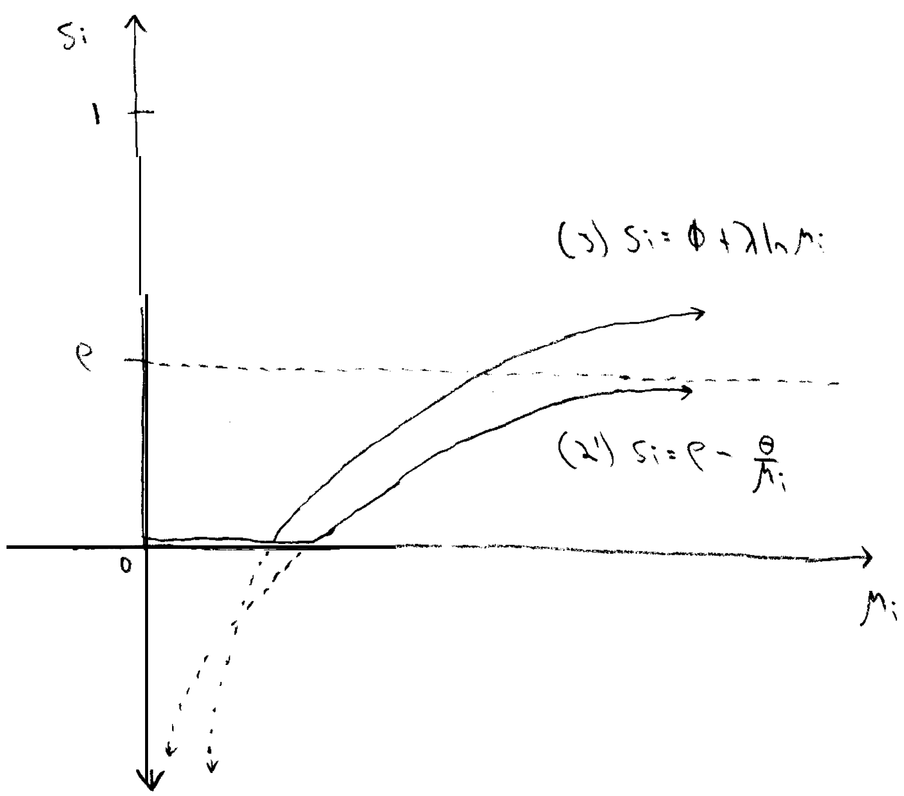


Figure 4: Fundraising-Contribution Pairs for a Net Revenue Maximizing Station Over Time

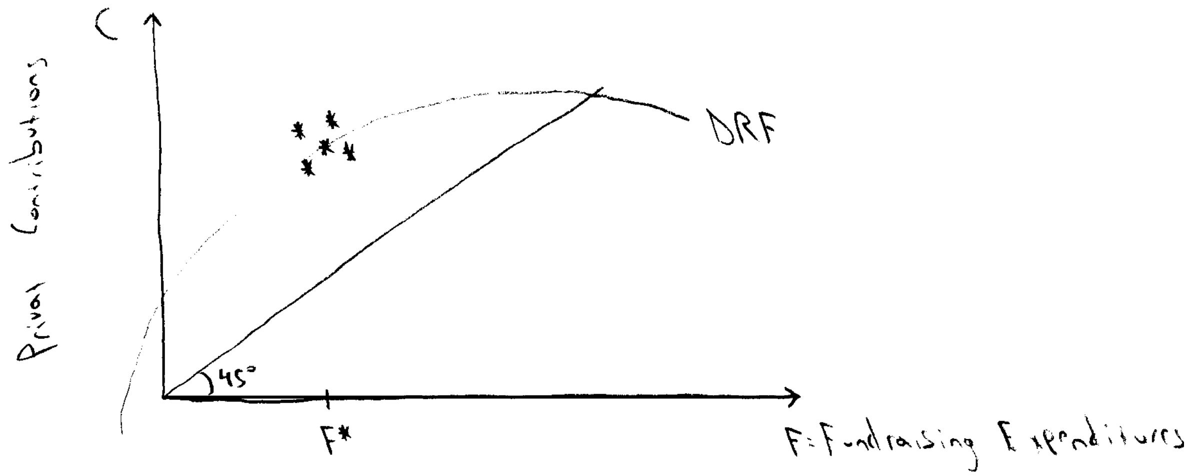


Figure 5: DRFs and Optimal C-F Pairs for Three Stations Facing Different DRFs

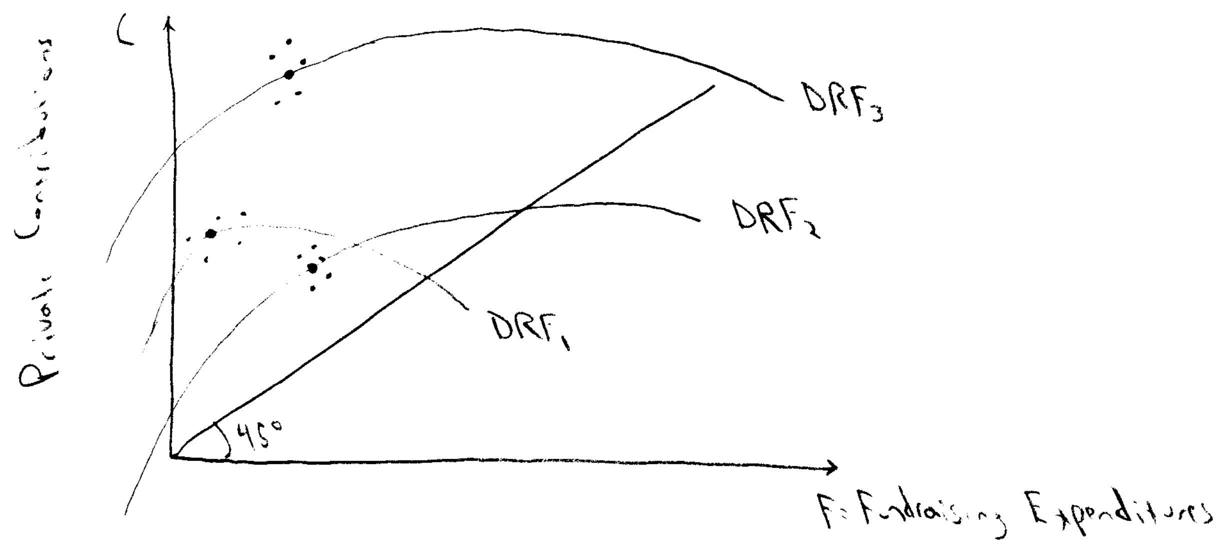


Figure 6: F-C Pairs for Three Stations with Different Objectives Facing the Same DRF

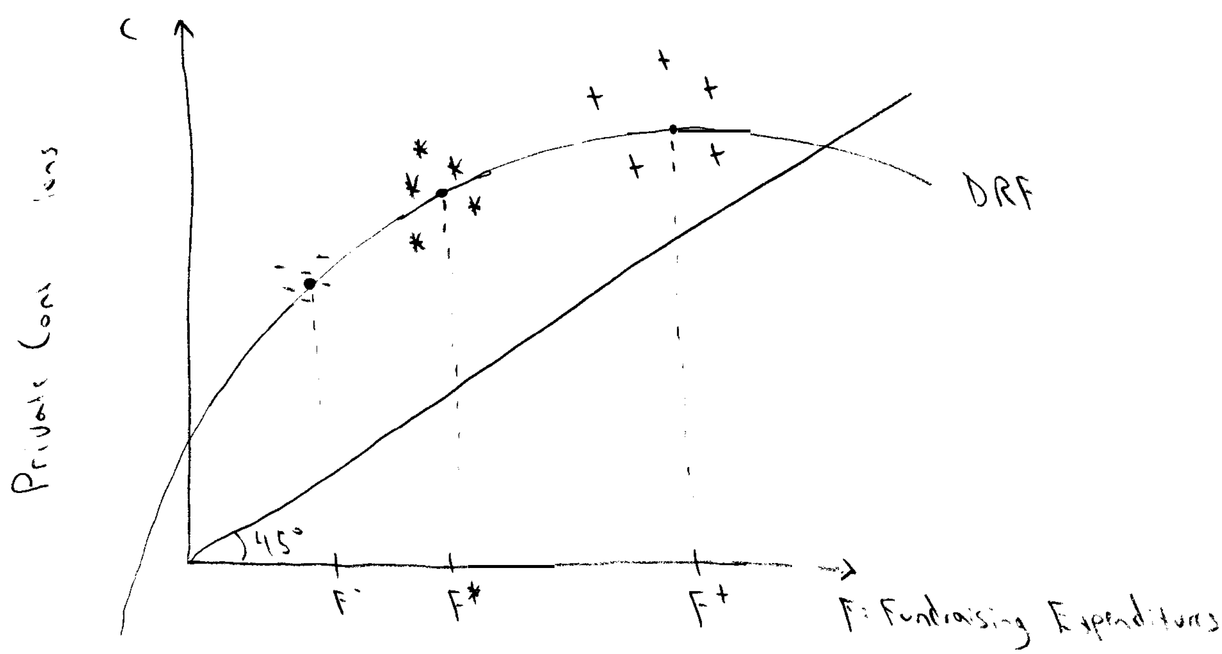


Figure 7:

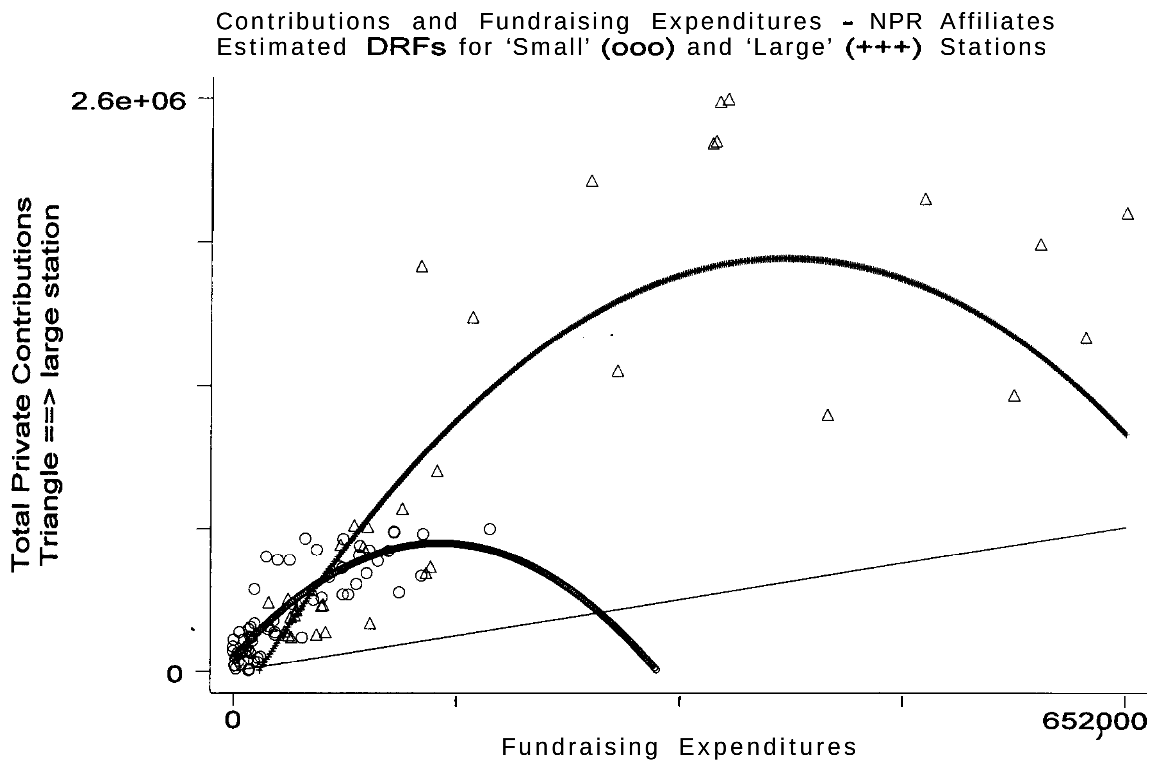


Figure 8:

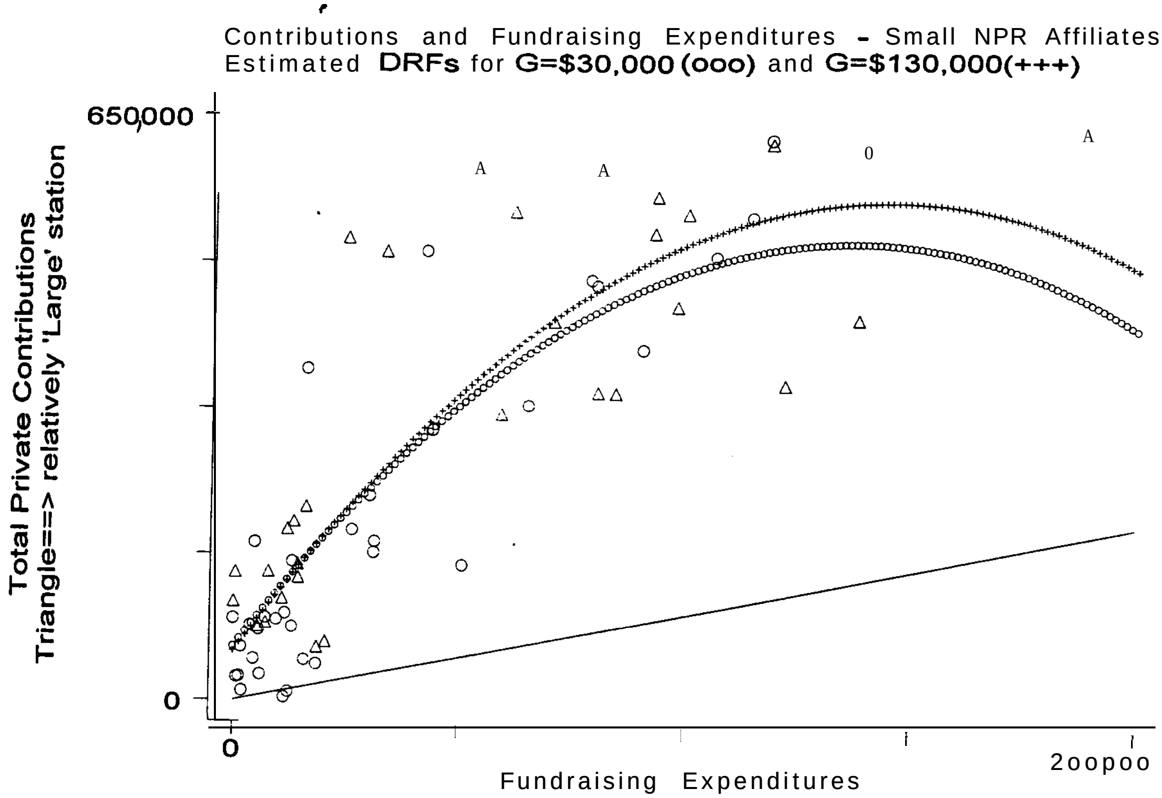
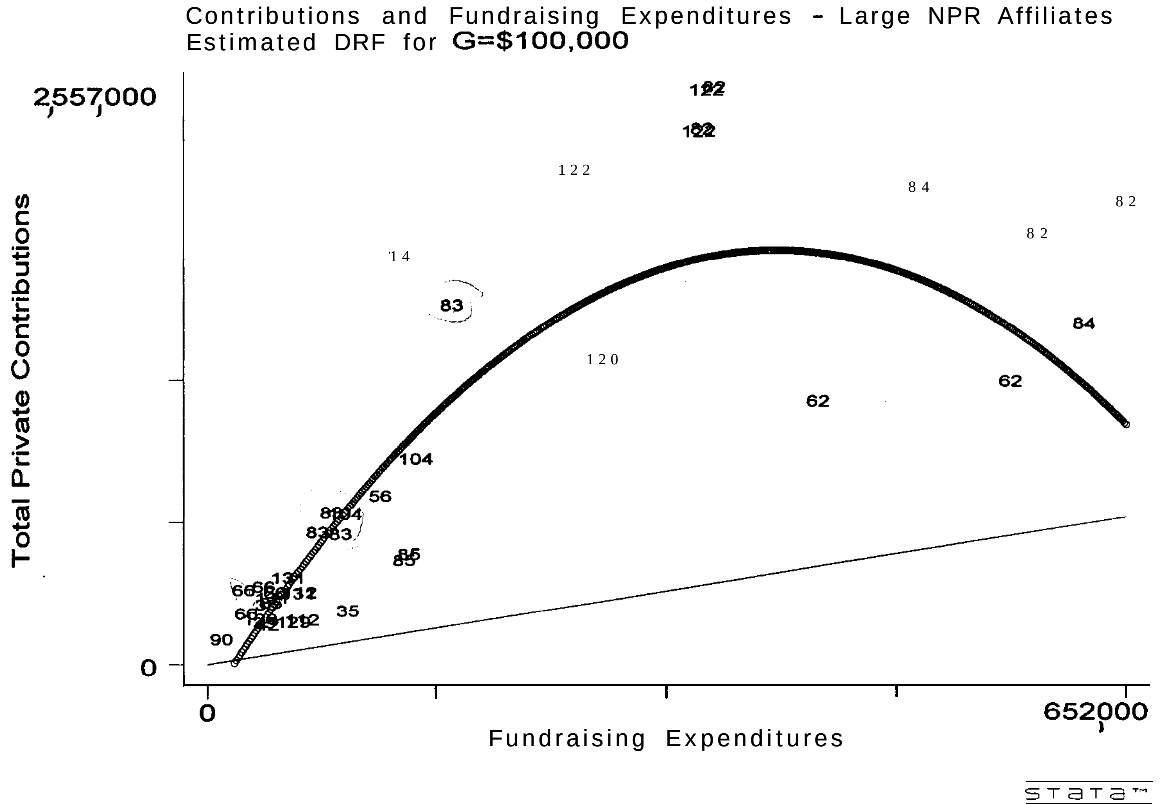


Figure 9:



Contributions and Fundraising Expenditures - Large NPR Affiliates
Estimated DRF for G=$100,000
Total Private Contributions
2,557,000
0
Fundraising Expenditures
0
652,000
stata™

References

Andreoni, James (1993) "An Experimental Test of the Public-Goods Crowding-out Hypothesis," American *Economic Review,* Vol *83, No. 5,* pp. 1317-1327.

Andreoni, James (1997) "Toward a Theory of Charitable Fundraising," *Journal of Political Economics,* Vol. *106, No. 2:* pp. 1186-1213.

Bergstrom, Theodore, Lawrence Blume, and Hal Varian (1986) "On the Private Provision of Public Goods," *Journal of Public Economics,* Vol. 29, pp.25-49.

Council of Economic Advisors (1998) *Economic Report of the President with the Annual Report of the Council of Economic Advisors,* Washington, D.C.: U.S. Government Printing Office.

Deaton, Angus and John Muellbauer (1980a) *Economics and Consumer Behavior, New* York: Cambridge University Press.

________ (1980b) "An Almost Ideal Demand System," *American Economic Review, vol. 70,* pp. 3 12-336.

Gorman, W. M. (1961) "On a Class of Preference Fields," *Metroeconomica*, *vol. 13,* pp. 53-56.

________ (1976) "Tricks with Utility Functions," in M. Artis and R. Nobay (eds.) *Essays in Economic Analysis,* Cambridge: Cambridge University Press.

Greene (1993) *Econometric Analysis,* 2nd edition, New York: Macmillan.

Khanna, Posnet and Sandler(1995) "Charity Donations in the UK: New Evidence Based on Panel Data," *Journal of Public Economics,* Vol. *56,* pp. 257-72.

Kingma, Bruce (1989) "An Accurate Measurement of the Crowd-out Effect, the Income Effect, and the Price Effect for Charitable Contributions," *Journal of Political Economy,* vol. 92.

Leser, C. E. V. (1963) "Forms of Engel Functions," *Econometrica, vol. 3* 1, pp. 694-703.

Okten, Kagla and Burton Weisbrod (1998) "Determinants of Donations in Private Nonprofit Markets," unpublished manuscript, Northwestern University.

Payne, Abigail (1998) "Does the Government Crowd-out Private Donations? New Evidence from a Sample of Nonprofit Firms." *Joural of Public Economics*

Rao, Ambar and Peter Miller (1975) "Advertising/Sales Response Function," Journal of Advertising Research, Vol. 15, No. 2, pp. *7-15.*

Segal, Lewis and Burton Weisbrod (1998) "Interdependence of Commercial and Donative Revenues," in *To Profit or Not to Profit: The Commercialism Transformation of the Nonprofit Sector,* Burton Weisbrod, ed. New York: Cambridge University Press.

Schmalensee, Richard (1972) *The Economics of Advertising,* Amsterdam: North-Holland.

Steinberg, Richard (1986a) "The Revealed Objective Functions of Nonprofit Firms, *Rand Jounal of Economics,* Vol. 17, No. 4, pp. 508 -- 526.

________ (1986b) "Should Donors Care about Fundraising?" in Rose-Ackerman, S. (ed.), *The Economics of Nonprofit Institutions: Studies in Structure and Policy.* Oxford University Press, New York.

________ *(199* 1) "Does Government Spending Crowd-out Donations ? Interpreting the Evidence," Annuls *of Public and Cooperative Economics*, **Vol.** *62, pp. 59* 1-6 *18.*

________ (1997) "Overall Evaluation of Economic Theories," ***Voluntas***, Vol. 8, No. 2, pp. 179-204.

U.S. Department of Commerce (1998) *Statistical Abstract of the United States 1998*, (118th edition) Washington, D.C.

Weisbrod, Burton and Nestor Dominguez (1986) "Demand for Collective Goods in Private Nonprofit Markets: Can Fundraising Expenditures Help Overcome Free-Rider Behavior?' *Journal of Public Economics*, Vol. *30*, pp. 83-95.

Working, H. (1943) "Statistical Laws of Family Expenditure," *Journal of the American Statistical Association*, *vol. 38*, pp. 43-56.