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An empirical test of neutrality and the crowding-out hypothesis *

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Abstract. This paper tests Warr's neutrality hypothesis that the voluntary provision of a public good is independent of the distribution of income. Specifically, I test the null hypothesis of neutrality against the alternative that total contributions to a public good will be larger the less equally income is distributed. To test this hypothesis, a new data set is constructed by merging data on total voluntary contributions to individual public radio stations with 1990 Census data on the income distribution in each station's listening area. I find that voluntary contributions increase as income inequality rises.

Introduction

In his seminal contribution to the literature on the voluntary provision of public goods, Warr (1983) showed that: "When a single public good is provided at positive levels by private individuals, its provision is unaffected by a redistribution of income. This holds regardless of differences in individual preferences and despite differences in marginal propensities to contribute to the public good." Warr's result generalizes to a host of other neutrality results. For example, Warr (1982) and Roberts (1984) showed that if the government were to contribute to a privately provided public good, and if its contributions were financed through a lump sum tax, total contributions to the good would remain the same. Public contributions would simply crowd-out private contributions dollar for dollar. More recently, Bernheim (1986) demonstrated that Warr's neutrality result may also hold for more general types of government support such as the tax deductibility of charitable contributions and government contributions to a privately provided public good financed through distortionary taxation. Although the issues of income redistribution and government crowd-out have, for the most part, been addressed separately, they

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are theoretically equivalent. Andreoni (1988) noted that: "While Warr proves the redistribution result directly, it also follows simply from the crowding out result. This is because any redistribution can be reconstructed as a series of neutral tax increases and tax decreases. Hence, crowding out and the neutrality of income distribution can be considered together."

Fundamental to all neutrality results is the assumption that corner constraints do not bind. For example, Warr assumed that all individuals contribute to the public good. When corner constraints are binding, when some individuals do not contribute, Bergstrom, Blume and Varian (1986) demonstrated that the amount supplied voluntarily will tend to be smaller the more equally income is distributed. Since only a small portion of the population is likely to contribute to any one public good, the assumption that corner constraints not bind may appear to limit the applicability of neutrality results. It turns out, however, that neutrality continues to hold in a number of interesting cases. Bergstrom et al. (1986) showed that redistributions within the set of contributors or the set of noncontributors have no effect on the provision of a public good. Neutrality results, therefore, may hold even when a portion of the population does not contribute. Furthermore, in cases where a number of public goods are voluntarily provided, Bernheim (1986) demonstrated that even transfers between a contributor to a particular public good and a noncontributor to that good have no effect as long as everyone contributes to at least one of the public goods and sufficient linkages exist between contributors to different goods. For example, suppose you contribute to public radio and I contribute to the American Cancer Society. As long as a third individual contributes to both goods, an income transfer from me to you can be neutralized; after the transfer total contributions to both goods remains unchanged. In any empirical situation, therefore, it would seem difficult to determine whether sufficient linkages exist for neutrality to hold. Nevertheless, it seems plausible that they do exist, making the existence of neutrality a reasonable empirical question.

Empirical tests of the neutrality hypothesis have concentrated on the effect government contributions have on private contributions. While Roberts (1984) did find evidence of dollar for dollar crowd-out, Abrams and Schmitz (1978, 1984), Clotfelter (1985), Shiff (1985) and Kingma (1989) found only partial crowd-out. What has been largely overlooked in the empirical literature is the effect income redistributions have on voluntary contributions.[1] If income redistributions do affect voluntary contributions, then exogenous variation in the distribution of income across localities should provide a direct means of testing Warr's neutrality hypothesis for a locally supplied public good.

This paper tests the neutrality hypothesis directly by focusing on the relationship between income distribution and voluntary contributions to public

radio. Specifically, I test the null hypothesis of neutrality against the alternative that total contributions to public radio will be larger the less equally income is distributed. To test this hypothesis, a unique data set is constructed by merging data on total voluntary contributions to individual public radio stations with 1990 Census data on the income distribution in each station's listening area.

Public radio provides an ideal framework within which to test the neutrality hypothesis for several reasons. First, public radio is a pure public good; any number of individuals can tune in and listen to public radio broadcasts without affecting the utility other individuals receive from listening. Furthermore, public radio is a local public good since its usage is restricted to individuals living within the broadcasting range of the station. As a consequence, differences across localities in the distribution of income provides the exogenous variation needed to test the neutrality hypothesis.

Corners and neutrality

Neutrality can be illustrated using a simple example. Consider a locality composed of just two individuals, identical in every relevant respect. Both individuals possess identical preferences defined over a composite commodity, x, and the total provision of a public good, G. Both x and G are assumed to be normal goods. Let M_0 denotes each individual's identical, exogenously determined, income and g_i denote individuals i's personal contribution to the public good. The total provision of the public good is therefore, $G = g_1 + g_2$. The individual's choice problem is then:

$$\begin{array}{lll} \text{Max} & U = U(x_i, G) & i = 1, 2 \\ x_i, g_i & & \\ \text{s.t.} & x_i + g_i = M_0 & \\ & g_i \geq 0 & \end{array} \tag{1}$$

By replacing i's contribution to the public good, g_i, with $G - g_{-i}$, where g_{-i} denotes the contribution made by the other individual, (1) can be re-written as:

$$\begin{array}{lll} \text{Max} & U(x_i, G) & i = 1, 2 \\ x_i, G & & \\ \text{s.t.} & x_i + G = M_0 + g_{-i} & \\ & G \geq g_{-i} & \end{array} \tag{2}$$

A Nash equilibrium is the set of contributions, $\{g_1^*, g_2^*\}$, such that g_1^* maximizes 1's utility given g_2^* and g_2^* maximizes 2's utility given g_1^*.[2] Figure 1 illustrates such an equilibrium. Each individual's equilibrium contribution is

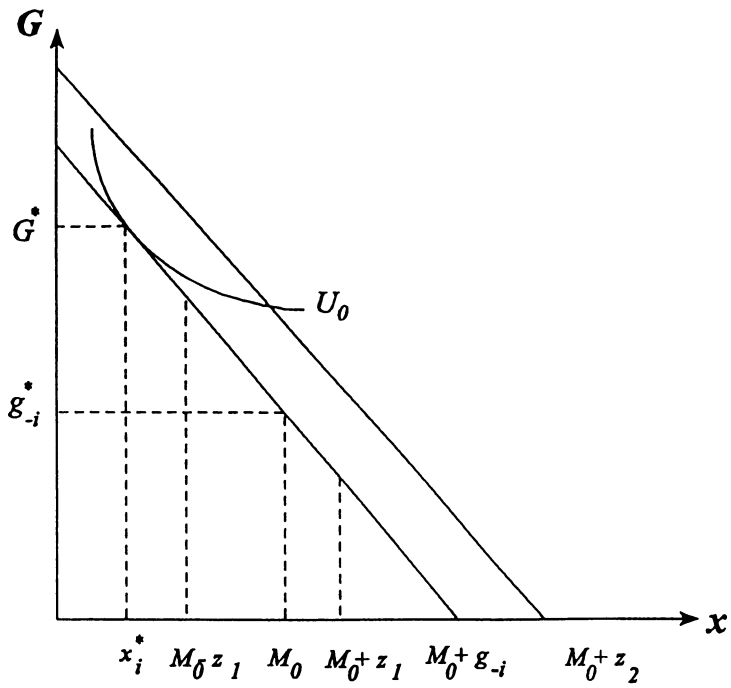

Figure 1. Neutral and non-neutral income transfers

$g_i^* = M_0 - x_i^*$, where x_i^* denotes individuals i's equilibrium consumption of the private commodity. In this case $g_1^* = g_2^*$ and hence the equilibrium provision of the public good is simply, $G^* = 2g_i^*$.

Now consider a redistribution of income which involves transferring z_1 dollars in income, where $z_1 < g_i^*$, from individual 1 to individual 2. Now $M_1 = M_0 - z_1$ and $M_2 = M_0 + z_1$. A new Nash equilibrium can be constructed from the original in which the total provision of the public good and each individual's consumption of the private commodity remains unaltered. To see this, suppose that after this redistribution individual 2 increases his contribution by exactly z_1 and individual 1 reduces his contribution by exactly z_1. Then for each individual, the amount $M_0 + g_{-i}$ remains the same and so the budget constraint does not change. After the redistribution, individual 1 is restricted to the segment of the budget line lying above his new income level $M_0 - z_1$. However, since his old consumption bundle is still available he will still choose it. Similarly, the income transfer to individual 2 extends his feasible choice set along the budget line to $M_0 + z_1$. Note, however, that there is still no better bundle available to individual 2 than his original choice. This establishes the neutrality result: when corner constraints do not bind,

the voluntary provision of a public good is independent of the distribution of income.

Now consider an income redistribution in which $z_2 > g_i^*$ is transferred from individual 1 to individual 2. This transfer increases income inequality. After the income redistribution individual 1 can no longer reduce his contribution by the full amount of the transfer since the constraint $g_1^* \geq 0$ is now binding. Suppose he merely reduces his contribution to zero. Then the budget constraint of individual 2 will shift right by the amount $z_2 - g_1^*$. This is illustrated in Figure 1 by the parallel shift in individual 2's budget constraint. Given the assumption that G is normal, the income redistribution causes the level of voluntary provision to increase. Thus, when corners bind, transfers which increase income inequality cause voluntary contributions to increase.[3] This example also reveals the type of income inequality comparison for which the theory applies: *Given any two localities, A and B, if the income distribution in locality A can be obtained through a series of binary equalizing income transfers in locality B then the level of voluntary provision of a public good will tend to be larger in B than it is in A.* Of course, if sufficient linkages of the Bernheim type exist, or the income distribution in locality A can be obtained through a series of transfers *within* the set of contributors or noncontributors, the level of voluntary provision will be independent of the distribution of income.[4]

Measuring income inequality

In his classic article, *The Inequalities of Income* (1920), Dalton argued that any income inequality comparison should be based on a simple principle: if we take $\$z$ away from a richer person and transfer it to a poorer person and this transfer is not so great as to change the relative income ranking of the two individuals then inequality is strictly reduced. This principle, known as the Pigou-Dalton principle of transfers, provides a method of comparing the income distributions of two localities with the same population size and same mean income. If the distribution of income in locality A can be reached through a series of equalizing income transfers in locality B, then according to the principle of transfers income is less equally distributed in B than in A. It is readily apparent that the principle of transfers is based on exactly the same type of income inequality comparison as the theory outlined above. A necessary condition, however, for ranking distributions by the principle of transfers, and hence for applying the theory, is that one distribution be obtained from the other through a series of binary equalizing transfers. The question is, Under what conditions can one distribution be obtained from another through a series of such transfers?

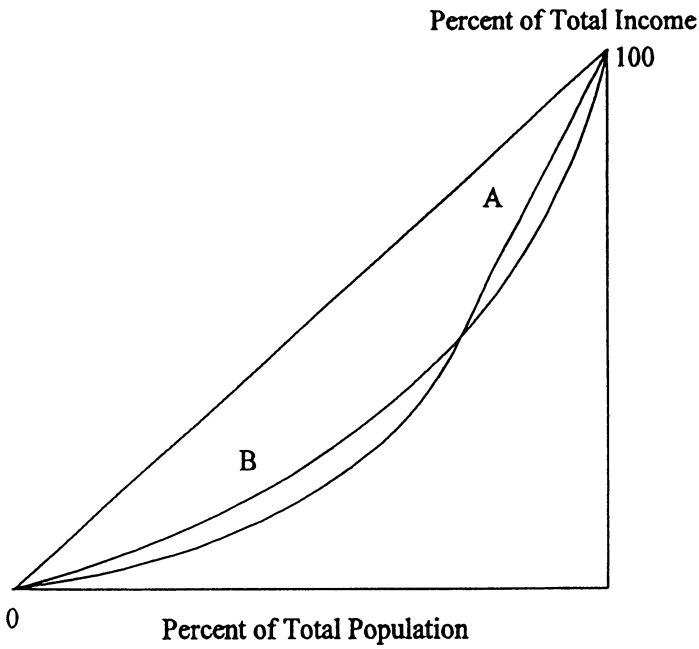

Figure 2. Lorenz curve crossings and incomplete orderings

It turns out that the principle of transfers has a straightforward interpretation in terms of Lorenz curves which provides an answer to the question posed above.[5] The statement that the distribution of income in locality A can be reached through a series of binary equalizing transfers in B is equivalent to the statement that the Lorenz curve of A lies above the Lorenz curve of B. A necessary and sufficient condition for ranking two distributions by the principle of transfers is, therefore, that the Lorenz curves of the two distributions do not cross. When Lorenz curves do intersect the principle of transfers does not provide a complete ordering. This is illustrated in Figure 2 where income is more equally distributed near the top in locality A and more equally distributed near the bottom in B. To obtain the distribution in A from B would now require a series of progressive and *regressive* transfers and hence the two distributions can not be ranked according to the principle of transfers.

Applied to measures of inequality, the principle of transfers requires any mean preserving equalizing income transfer to lower the value of an inequality index. When the Lorenz curves of two distributions intersect, however, it is always possible to find two indexes which will rank the distributions in an opposing manner. For example, consider Figure 2 once again. An inequality index which places more weight on inequality among upper incomes would

lead to the conclusion that income is more equally distributed in A than it was in B. On the other hand, an index which places more weight on inequality among lower incomes would lead to the conclusion that income was more equally distributed in B.

When Lorenz curves cross, the income inequality ordering upon which the theory is based is an incomplete ordering. Hence, the alternative hypothesis, that voluntary contributions will tend to be larger the less equally income is distributed, is silent because the income inequality comparison upon which the hypothesis is based leads to an ambiguous ranking of distributions. To test the theory empirically, therefore, some method of "filling in the gaps" – of completing the ordering – must be employed. My approach is to use a number of different indexes which are sensitive to income inequality over different ranges of a distribution.

Atkinson (1970) and Schwartz and Winship (1980) have demonstrated that the following index, which satisfies the principle of transfers, provides a flexible means of addressing the sensitivity issue discussed above:

$$I = 1 - \left[\Sigma \left(\frac{y_i}{\mu}\right)^{1-\epsilon} f(y_i)\right]^{\frac{1}{1-\epsilon}} \qquad \epsilon > 0$$

$$I = \left[\Sigma \left(\frac{y_i}{\mu}\right)^{1-\epsilon} f(y_i)\right]^{\frac{1}{1-\epsilon}} - 1 \qquad -1 < \epsilon < 0, \tag{3}$$

where μ denotes mean income, y_i is the income of the i'th income group and $f(y_i)$ is the portion of the population in the i'th income group. The parameter ϵ allows the researcher to choose how sensitive the index is to transfers between individuals in different ranges of the income distribution. As ϵ increases, the index becomes more sensitive to (places more weight on) income transfers among lower income individuals and less sensitive to transfers among upper income individuals. In all, six inequality indexes, based on equation (3) and values of ϵ equal to –.5, –.1, .1, .5, 1, and 2 were calculated using the 25 household income categories in the 1990 Census.[6]

This family of indexes has two additional desirable characteristics. First, it is mean independent, providing a means of separating the effect of changing total income from the effect of dispersing that income. It is also invariant to proportionate differences in population size. If the population in locality A can be formed by merging n identical populations from locality B, it has the same measure of income inequality as B.

The focus of this study is on the effect income inequality has on voluntary contributions, however, other variables will affect voluntary contributions as well. For example, as noted in the introduction, the effect government contributions, funded through lump sum taxation, have on private contributions is

theoretically equivalent to the effect of income redistributions. To illustrate this point, suppose the government contributes a dollar to public radio and finances its contribution by taxing me, a voluntary contributor, one dollar. Theoretically, the government's tax financed contribution can be viewed as an income redistribution in which a dollar is transferred from one contributor, me, to another, the government. Therefore, as long as I was originally contributing at least a dollar to public radio, theory predicts that the government's contribution will crowd-out private contributions dollar for dollar. Similarly, if I originally was not contributing to public radio or the government taxed me by an amount greater than my original contribution, theory predicts the government's contribution will only partially crowd-out private contributions. In this paper, Warr's neutrality hypothesis and the crowd-out hypothesis are, therefore, addressed in tandem by simultaneously controlling for the effects of differences across localities in the distribution of income and the level of government support.

The population of a locality can also affect contributions to public radio. Andreoni (1988) showed that as the number of individuals in a locality grows infinitely large, total contributions to a public good increase to a finite value.[7] This result implies that as a locality's population grows, total voluntary contributions to public radio should increase at a decreasing rate. Thus, there should exist a positive but concave relationship between total contributions and population size across localities.

Finally, because contributions to public radio are tax deductible, the price of contributing a dollar is equal to one minus the individual's marginal tax rate.[8] Since this per unit subsidy to contributors affects the relative price of contributing, it will, in general, affect contributions to public radio.[9] Because tax rates differ across states, individuals who have identical incomes but live in different states are likely to have different marginal tax rates and thus different prices for their personal donations. Interstate variation in tax rates is therefore expected to have real effects on the level of voluntary contributions.

The data

Data on total voluntary contributions to public radio stations were provided by the Corporation for Public Broadcasting (CPB) and consists of a 1986 cross section of observations on listener supported stations located throughout the United States. The sample consists of all public radio stations supported by the CPB. Furthermore, because almost all public radio stations which are affiliated with National Public Radio (NPR) are also supported by the CPB, the sample contains virtually the entire universe of NPR affiliated stations operating in the United States.

Public radio stations obtain voluntary contributions primarily through annual membership drives. Additional private funding is also obtained through auctions and donations made by 'friendship' groups affiliated with individual stations. Total voluntary contributions are defined as the sum of these three sources of private support. On average, voluntary contributions accounted for approximately 27% of the funding received by stations in1986. Besides helping to cover basic operating costs voluntary contributions received by a station directly affect the quality of services the station provides. For example, additional private support may enable a station to purchase popular programs produced by NPR, American Public Radio (APR) or the Cable News Network (CNN). Thus, there exists a direct link between private contributions received and the quality of this public good.

Strictly speaking, the broadcasting radius of a station should determine the geographic boundary of a locality. Unfortunately, the Census does not report the population characteristics of such geographic areas. I have therefore chosen to define localities in terms of metropolitan statistical areas (MSA's). Because the vast majority of public radio stations are located in or near an MSA, the population characteristics of an MSA should provide excellent proxies for the characteristics of the population located within the broadcasting radius of a station. If a station is located more than 50 miles from the nearest MSA, the locality is defined to be the city or town in which the station is located. Furthermore, if a locality contains more than one public radio station, total voluntary contributions are defined as the sum of all contributions made to stations within the locality. For example, since there were three stations operating in the Boston area in 1986, total voluntary contributions in this locality were defined to be the sum of the contributions made to all three stations.

In addition to the data described above, the CPB also provided data on the amount of government support stations in the sample received in 1986. Government support is composed of two categories; federal support, which consists primarily of CPB funding, and state and local support. Federal funding consists of a fixed base grant which is the same for all stations and a matching grant which is based on the share of total non-federal income each station receives. Since this matching grant reduces the effective price of contributing to a public radio station by an equal amount in all localities, matching federal support can be omitted from the empirical analysis. However, even though all stations received the same base grant, non-matching federal aid will differ across localities because some localities contain more than one station. Non-matching federal aid, therefore, must be included in the empirical analysis.

State and local funding consists of the sum of all state and local government support and the funding stations received from universities or colleges. Unfortunately, very little information is available on the nature of state and local funding. Specifically, it is impossible to determine which stations, if any, received matching grants from these sources. The empirical analysis which follows assumes that all state and local support is composed of non-matching grants. If some of this support is in the form of matching grants, estimates of the crowd-out effect will tend to be biased downward.

The price of contributing to public radio depends on an individual's marginal tax rate and, therefore, on an individual's income. Nevertheless, because most contributors to public radio have relatively high incomes, the price of personal donations is defined to be $p = 1 - t$, where t denotes the combined state and federal marginal tax rate for an individual in the top state and federal tax bracket.[10] Note that since an individual's marginal tax rate is a function of how much they contribute, p is endogenous. To overcome this problem, I follow the convention of using the price of the first dollar of personal donations. Furthermore, I make the simplifying assumption that all individuals within a locality are itemizers.

Ten observations were dropped from the initial sample because they represented stations that did not raise funds from the public. Seven stations were prohibited from fundraising because of specific state statutes or local ordinances. For example, some public radio stations owned by state and private universities were prohibited from fundraising by the universities that owned them. Furthermore, two stations in the sample were just getting started in 1986 and hence were not able to organize membership drives at the time. Finally, one station was involved in an unusual joint operational arrangement with a commercial station and was restricted to five hours of broadcasting per day.

Table 1 presents summary statistics for the variables used in this study. Data on the population size, mean income and demographic characteristics of different localities were obtained from the 1990 Census. On average, localities raised $259,488 in voluntary contributions for public radio. The standard deviation of this number, however, indicates that total contributions varied considerably across localities. Population size also varied widely across the sample.

Table 1. Summary statistics

	Mean	Std.Dev.
Total voluntary contributions	259,488	434,703
Government support	312,325	392,986
Mean H.H. Income	36,848	6,437
Price	.476	.020
H.H. Population	266,201	436,290
I ($\epsilon = - - .5$)	.178	.028
I ($\epsilon = 1$)	.322	.037
I ($\epsilon = 2$)	.452	.042
Mean education (18 plus)	12.9	.463
Mean age (18 plus)	42.77	2.92

Number of observations = 183

Results of the regressions

To test the predictions of the theory six models were estimated using the following loglinear specification.[11]

$$\begin{aligned} lnG_j \;=\; & \beta_0 + \beta_1 I_j + \beta_2 ln\, M_j + \beta_3 ln\, P_j + \beta_4 lnPop_j \\ & + \beta_5 ln\, Gov_j + \beta_6 Ed_j + \beta_7 Age_j + Mstat_j + \delta_j + \zeta_j \end{aligned} \quad (4)$$

where j indexes localities, G denotes total contributions to public radio, I is one of the six measures of the distribution of income, M is mean household income, P is the price of personal donations, *Pop* is the number of households, *Gov* is the amount of non-matching government support, *Ed* is average ecducational attainment, *Age* is the average age of the population and ζ is a random disturbance term. Each regression also includes a dummy variable, denoted *Mstat*, which takes the value 1 if a locality contains more than 1 station. *Mstat* is included in the model to control for any effect the presence of multiple stations might have on total contributions which is not captured by the other control variables.[12] Furthermore, since one of the primary missions of the Corporation for Public Broadcasting (CPB) is to provide everyone in the United States with access to public broadcasting information, a number of stations were established and supported by the CPB in sparsely populated areas hundreds of miles from the nearest metropolitan area. Because these stations, which are all located in Alaska or on Indian reservations, tend to provide services which are markedly different from the rest of the stations in the sample the dummy variable, δ, was included as a control for these stations.[13]

Table 2. Parameter estimates – Log linear specification. Coefficient (Standard Error)

Regressor (Coefficient)		Regressor (Coefficient)	
Inequality Index (β_1) ($\epsilon = 1$)	4.81**	Average Education (β_6)	0.818**
	(1.92)		(0.227)
Log Mean Income (β_2)	0.942**	Average Age (β_7)	0.016
	(0.390)		(0.032)
Log Price (β_3)	–3.67**	Mstat	0.678**
	(1.35)		(0.173)
Log Population (β_4)	0.450**	δ	–3.67**
	(0.054)		(0.91)
Log Government Support (β_5)	–0.093**	Constant	–18.17**
	(0.038)		(6.41)

R-square 0.62
Number of observations 183
** Indicates Coefficient is significant at the 5% level or better.

If total contributions to public radio are independent of the distribution of income, as the neutrality hypothesis would suggest, β_1 should equal zero. If corners really matter, however, theory predicts total contributions to public radio will tend to be larger the less equally income is distributed and thus β_1 should be positive and statistically significant. It follows that to test the neutrality hypothesis against the more general alternative set forth by Bergstrom et al., one need only calculate a simple t satistic under the null hypothesis, $\beta_1 = 0$. Similarly, if government contributions crowd-out private contributions, β_5 should be negative and statistically significant. Theory also predicts the coefficients on mean income and household population should be positive. Furthermore, since the theory implies an increasing but concave relationship between total contributions and population size, β_4 should be less than one.

The results obtained for all six model were qualitatively and quantitatively similar. Table 2, therefore, presents only the regression results obtained when the model was estimated using an inequality index calculated by setting $\epsilon = 1$. A complete set of regression results are presented in the appendix. Graphical inspection of the raw data revealed greater variation in total contributions in large localities (as measured by population size) than in small localities. Although taking logs removed most of his heterogeneity, White's covariance estimator was employed to ensure that the estimated standard errors were consistent.[14] Table 2 contains these corrected standard errors.

Table 3. Results for various measures of income inequality

Inequality Index	Coefficient	t-Statistic
I ($\epsilon = - - .5$)	3.32	1.53
I ($\epsilon = - - .1$)	25.86	2.00
I ($\epsilon = .1$)	30.88	2.20
I ($\epsilon = .5$)	8.16	2.43
I ($\epsilon = 1$)	4.81	2.50
I ($\epsilon = 2$)	4.13	2.14

Note: t-statistics based on asymptotic standard errors.

Overall, the results are consistent with the theory. The estimated coefficients on all the regressors are of the correct sign and in most cases significant at the 5% level or better. Table 3 presents estimates of the coefficient on the inequality index, β_1, for all six models. Note that β_1 is always positive indicating that voluntary contributions increase as income inequality rises. Futhermore, β_1 is statistically significant for all values of ϵ greater than –.5. Hence the null hypothesis of neutrality is rejected at the 5% level or better in every case but one. These results, therefore, provide evidence against the null hypothesis of neutrality and evidence in support of the alternative hypothesis that total contributions will be larger the less equally income is distributed.

To test the hypothesis that the inequality indexes were simply picking up variation in total contributions caused by income entering the model in some nonlinear fashion, I added variables generated by raising mean income to the second, third and fourth power as regressors in the loglinear and log-log specification. Based on the t-tests for these regressors, the hypothesis that income entered the model in a nonlinear fashion was rejected.[15]

Note that the significance of β_1 depends on the value of ϵ. In fact a clear pattern emerges from these results. When ϵ equals –.5, no significant relationship exists between the level of voluntary provision and the degree of income inequality in a locality. As the value of ϵ increases towards 1, however, the relationship increases in significance. Furthermore, when ϵ equals 2, the significance of β_1 falls to a level below that obtained for $\epsilon = .1$.[16]

One possible explanation for this pattern is that for some values of ϵ the inequality measure is most sensitive to transfers *between* contributors and noncontributors while for other values of ϵ it is most sensitive to transfers *among* contributors or noncontributors. For example, recall that as ϵ increases the inequality index becomes more sensitive to transfers among lower income

individuals and less sensitive to transfers among upper income individuals. Thus, for a value of ϵ equal to –.5, the index is most sensitive to transfers among the very rich. The finding that β_1 is close to zero when ϵ equals –.5, therefore, suggests that income transfers among the very rich have no effect on total contributions to public radio. Using 1986 survey data on the demographic characteristics of contributors and noncontributors to 63 of the public radio stations present in this sample, Kingma (1989) found the average income of contributors to be $48,074. This would place contributors in the top quartile of the income distribution in a locality. Thus assuming income transfers among the rich represent transfers among contributors this result would tend to support the hypothesis that income transfers confined to the set of contributors have no effect on the voluntary provision of a public good.[17] Furthermore, note that β_1 is most significant when ϵ equals .5 and 1, which corresponds to the cases where the inequality index is most sensitive to transfers around the upper middle and middle portions of the income distribution and least sensitive to transfers among the very rich or very poor. Assuming transfers between contributors and noncontributors are most likely to occur over this range of the income distribution, this result provides further support of the hypothesis that income redistributions do effect the level of voluntary provision when corner constraints are binding.

The coefficient on government support, β_5, was consistently negative and significant indicating that government contributions crowd-out private contributions. Estimates of β_5 indicate that a 1 percent increase in government support reduces total contributions by approximately .09 percent. Evaluated at the mean values of total contributions and government support, these results indicate that a one dollar increase in government support results in a 7.5 cent decrease in private contributions. The fact that government contributions only partially crowd-out private contributions is consistent with the finding that income transfers have real effects on total contributions. However, as mentioned previously, these estimates should be interpreted with caution since they may significantly understate the degree of government crowd-out if some state and local government support was in the form of matching grants.

Finally, the estimated income and price elasticities were all statistically significant and quantitatively consistent with the estimates obtained in previous studies.[18] Similarly, the estimated population elasticities, β_4, were all positive, significant and less than one indicating that as the population in a locality grows larger, voluntary contributions increase at a decreasing rate.

Concluding remarks

When corner constraints are binding and sufficient overlap between the sets of contributors to different public goods do not exist, neutrality breaks down. This paper has attempted to ascertain just how important corner solutions are and hence whether or not neutrality results can be expected to hold even approximately.

The results suggest that the distribution of income in a locality has a significant effect on voluntary contributions to a public good. Thus, within the specific context of the voluntary provision of public radio, when corner constraints are binding, neutrality does not appear to hold even as an approximation. Empirical support is also found for the hypothesis of Bergstrom et al. (1986) that, if a large portion of the population does not contribute to the provision of a public good, total contributions will tend to be smaller the more equally income is distributed. Thus as these authors note: "... if an economy evolves toward a more equal distribution of income we can expect the amount supplied voluntarily to diminish. This means that the case for government provision in the interest of efficiency would become stronger as the income distribution becomes more equal and might eventually overcome the advantages of private provision."

The results of this study also imply that binding corner constraints may explain why this and other studies have found that government contributions only partially crowd-out private contributions. Furthermore, the fact that Warr's neutrality result appears to hold when income transfers are most likely to be confined to the set of contributors suggests that the crowd-out effect might be substantially larger if the government financed its contributions by taxing only the set of contributors. Some evidence which support this view was recently provided by Andreoni (1993). In an experiment designed specifically to test the crowd-out hypothesis, Andreoni found that when corners were not binding government contributions crowded-out private contributions by 71.5%. It would be interesting to see if the pattern which emerged in the results obtained in this paper could be explained in future empirical research. For example, it would be interesting to examine, perhaps by using survey data on individual contributors and noncontributors to a public good, whether or not Warr's neutrality result does indeed hold for income transfers within the set of contributors or noncontributors.

Notes

1. The one exception is a paper by Hochman and Rodgers (1973). The authors use data on aggregate contributions (contributions to all goods and causes) in 28 cities and the disperson of income in those cities to test the hypothesis that individuals have interdependent utility functions.
2. It can be shown that for a given distribution of income this Nash equilibrium is unique. For a proof of this result see Bergstrom et al. (1992, 1986) or Fraser (1992).
3. Bergstrom, Blume and Varian (1986) demonstrate how this result can be extended to cases involving heterogeneous preferences.
4. For neutrality to hold in the case where transfers are confined to the set of contributors no contributor can lose more income than he was originally contributing.
5. The Lorenz curve graphs the portion of total income received by the bottom X percent of the population. If all individuals within a locality possessed identical incomes, (a case of perfect equality) the Lorenz curve would be a straight line emanating from the origin at a 45 degree angle.
6. The mean of each income interval was assumed to be located at the midpoints in making these calculations except for the open ended interval at the top, for which information on mean income was available. Furthermore, adjustments were made using a Pareto curve for the open ended, top income interval. A detailed description of how these indexes were calculated is available from the author upon request.
7. More recently, Fries, Gulding and Romano (1991) have provided a generalization of Andreoni's theorem which extends this result to large but finite economies.
8. This only holds if all contributors itemize their deductions. The price of personal donations is one if a contributor does not itemize.
9. See Broadway, Pestieu and Wildasin (1989) or Warr (1983) for a discussion of when subsidies will have real effects. Also see Bernheim (1986) for an example of a model in which the overlap between the sets of contributors to different causes renders subsidies to private contributions neutral.
10. Data on state and federal tax rates were obtained from the ACIR publication "Significant Features of Fiscal Federalism."
11. The six models were also estimated using a linear specification of the form:

$$G_j = \beta_0 + \beta_i I_j + \beta_2 M_j + \beta_3 P_j + \beta_4 Pop_j + \beta_5 Pop_j^2 + \beta_6 Gov_j + \beta_7 Ed_j + \beta_8 Age_j + Mstat_j + \delta_j + \zeta_j$$

    where the new regressor, Pop_j^2, denotes the square of household population in locality j. The results obtained using this specification were qualitatively similar to the results obtained using the log-linear specification. Similarly, the models were also estimated using a semi-log specification. Once again, the results obtained were qualitatively similar to those obtained using the log-linear specification. Results are available upon request.
12. The models were also estimated using a set of dummy variables for localities with more than one station. Specifically, since the number of stations located in a locality ranged from one to seven, a total of six separate dummy variables, corresponding to localities with two or more stations, were used. However, a Wald test revealed that there was no statistically significant difference between the parameter estimates obtained when a single dummy variable, *Mstat*, was used or when the six separate dummy variables were used.
13. Estimating the regression equation without δ does not significantly alter the results obtained. These results are available from the author upon request.
14. A number of tests for heteroscedasticity were performed. Based on White's general test, the null hypothesis of homoscedasticity could not be rejected. However, based on a Goldfeld–Quant test, the null of homoscedastiticity was rejected. (The Goldfeld–Quant test was conducted by sorting the sample by population size.)

15. Entering these regressors independently or all together also had no effect on the significance or point estimate of β_1.
16. Estimating the model using additional inequality indexes, based on various values of ϵ, produces similar results. Specifically, estimates obtained using alternative indexes calculated by allowing ϵ to vary between –.5 and 2.5, produces a pattern identical to the one presented in Table 3.
17. Theoretic support for the proposition that individuals contributing to public radio will have relatively high incomes is provided by Bergstrom et al. (1986) and Andreoni (1988). Bergstrom et al. have demonstrated that in the case of identical preferences, all contributors will have higher incomes than noncontributors. Extending this result, Andreoni demonstrates that as the population in a locality grows large, the set of contributors becomes more confined to the very rich.
18. Estimates of the income elasticity of voluntary contributions reported in previous studies range from 0.21 by Lindsey and Steinberg (1990) to 1.31 by Reece and Zeischang (1985). Estimates of the price elasticity of contributions range from –.85 by Reece and Zeischang (1985) to –4.97 Shiff (1985).

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Appendix

Parameter estimates for all six models. Coefficient (Standard Error)

Variable	I ($\epsilon = -.5$)	I ($\epsilon = -.1$)	1 ($\epsilon = .1$)	I ($\epsilon = .5$)	I ($\epsilon = 1$)	I ($\epsilon = 2$)
Inequality Index	3.31 (2.16)	25.86 (12.89)	30.88 (14.09)	8.16 (3.36)	4.81 (1.92)	4.13 (1.93)
Log Mean Income	0.755 (0.379)	0.811 (0.375)	0.836 (0.375)	0.879 (0.377)	0.942 (0.390)	0.730 (0.363)
Log Price	–3.34 (1.38)	–3.46 (1.37)	–3.50 (1.36)	–3.57 (1.35)	–3.67 (1.35)	–3.67 (1.36)
Log Population	0.469 (0.052)	0.461 (0.053)	0.458 (0.053)	0.453 (0.053)	0.450 (0.054)	0.447 (0.057)
Log Government Support	–0.085 (0.038)	–0.087 (0.038)	–0.088 (0.038)	–0.090 (0.038)	–0.093 (0.038)	–0.094 (0.039)
Average Education	0.768 (0.223)	0.774 (0.223)	0.779 (0.222)	0.792 (0.223)	0.818 (0.227)	0.835 (0.230)
Average Age	0.005 (0.030)	0.007 (0.030)	0.008 (0.030)	0.011 (0.031)	0.016 (0.032)	0.018 (0.033)
Mstat	0.686 (0.177)	0.686 (0.176)	0.685 (0.176)	0.682 (0.175)	0.678 (0.173)	0.675 (0.173)
δ	–3.64 (0.935)	–3.65 (0.936)	–3.65 (0.933)	–3.66 (0.923)	–3.67 (0.910)	–3.68 (0.900)
Constant	–14.21 (5.77)	–15.19 (5.83)	15.71 (5.88)	–16.71 (6.05)	–18.17 (6.41)	–16.80 (6.22)
Rsq	0.615	0.617	0.620	0.622	0.624	0.622