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IMPURE ALTRUISM AND DONATIONS TO PUBLIC GOODS: A THEORY OF WARM-GLOW GIVING*

James Andreoni

> It appears to be a matter of fact, that the circumstance of utility, in all subjects, is a source of praise and approbation: ... it is inseparable from all the other social virtues, humanity, generosity, charity, affability, levity, mercy and moderation.
>
> David Hume, *An Inquiry Concerning the Principles of Morals*

> Feel good about yourself – Give blood!
>
> *Advertisement, The American Red Cross*

When people make donations to privately provided public goods, such as charity, there may be many factors influencing their decisions other than altruism. As Olson (1965) noted, 'people are sometimes motivated by a desire to win prestige, respect, friendship, and other social and psychological objectives' (p. 60) or as Becker (1974) observed, 'apparent "charitable" behavior can also be motivated by a desire to avoid scorn of others or to receive social acclaim' (p. 1083). Clearly social pressure, guilt, sympathy, or simply a desire for a 'warm glow' may play important roles in the decisions of agents. While such warm-glow giving has been acknowledged in the literature,[1] the most common approach has been to assume that preferences depend only on private consumption and the total supply of the public good and not on individual donations *per se*.

Recent research reveals, however, that this 'pure altruism' model lacks predictive power. First, Warr (1982) and Roberts (1984) demonstrate theoretically that government grants should crowd out voluntary gifts dollar-for-dollar,[2] a finding that has been extended to subsidies by Bernheim (1986) and Andreoni (1988). However, empirical studies by Abrams and Schmitz (1978, 1984) and Clotfelter (1985) show that crowding out is quite small. Second, Warr (1983) and Bergstrom *et al.* (1986) show theoretically that the total supply of the public good is independent of the distribution of income, while an empirical study by Hochman and Rodgers (1973) shows that giving to local charities is highly sensitive to the distribution of income within the

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[1] See also Arrow (1975), Sen (1977), Collard (1978), Roberts (1984, 1987), Lucas and Stark (1985), Sugden (1982, 1984), Margolis (1982), and Posnett and Sandler (1986). Some models have considered 'mixed motives' for contributing. These include Cornes and Sandler (1984, 1986) and Steinberg (1987).

[2] Earlier related insights are found in Becker (1974).

community. Third, Andreoni (1988) generalises the theory to show that in large economies virtually no one gives to the public good, hence making the Red Cross, the Salvation Army, and American Public Broadcasting logical impossibilities.[3]

Andreoni (1989) introduces a generalisation of the standard public goods model that includes 'impurely altruistic' motives. This earlier paper presents an intuitive development of impure altruism, and discusses potential applications. In contrast, the purpose of this paper is to formalise the applications to charitable giving, considering a variety of assumptions, and to develop a wide set of implications. In particular, sections I, II, and III discuss the contradictions mentioned above, solve for the sufficient conditions for neutrality to hold, and examine the optimal tax treatment of charitable giving. The overall conclusion is that the 'pure altruism' model is extremely special, and its predictions are not easily generalised. On the other hand, the impure altruism model is consistent with observed patterns of giving. In section IV the model is calibrated to measure the effects of possible policies. This section illustrates that the predicted effects of policy are sometimes reversed when impure altruism is considered. This emphasises a potential need to develop empirical models of charitable giving that account for warm-glow giving and the interdependence of preferences.

I. IMPURE ALTRUISM AND NEUTRAL REDISTRIBUTIONS OF INCOME

For simplicity, consider an economy with only one private good and one public good. Assume that the private good can be converted into the public good by a linear technology so that each can be expressed in units of dollars. Individuals are endowed with wealth, w_i, that they can allocate between consumption of the private good, x_i, and their gift to the public good, g_i. Assume for now that the public good receives no government support. Let n be the total number of individuals, and let $G = \sum_{i=1}^{n} g_i$ be the total amount of the public good. The utility functions can then be written

$$U_i = U_i(x_i, G, g_i), \quad i = 1, \ldots, n \tag{1}$$

where U_i is assumed to be strictly quasi-concave. Notice that g_i enters the function twice, once as part of the public good, G, and again as a private good. This is meant to capture the fact that an individual's own gift has properties of a private good that are independent of its properties as a public good. Implicit in (1) are both of the special cases that we will consider. In particular, when $U_i = U_i(x_i, G)$ the individual cares nothing for the private gift *per se*, hence can be thought of as *purely altruistic*. Likewise, when $U_i = U_i(x_i, g_i)$ the individual is motivated to give only by warm-glow, hence is *purely egoistic*. When both G and g are arguments, the person is *impurely altruistic*.

[3] All of these inconsistencies are partially addressed by recognising that neutrality breaks down if redistribution and taxation involve non-contributors, as shown by Bergstrom *et al.* (1986). However, Sugden (1982) shows that even if the taxes and redistributions are non-neutral, the Nash assumption implies that they will be almost neutral. Hence, all of these theoretical statements are always at least approximately true.

In contrast to the impure altruism model, an important alternative approach is to consider moral or group-interested behaviour. This has been done by Sen (1977), Collard (1978), Laffont (1985), Margolis (1982), and Sugden (1982; 1984). Sugden (1984), for instance, shows that the anomalous predictions from public goods approach to philanthropy are avoided if we acknowledge that people may adhere to 'moral constraints' or a 'principle of reciprocity'. A second alternative to impure altruism is the mixed public-private good approach of Cornes and Sandler (1984, 1986), and Steinberg (1987). It is also clear in the work of these authors that neutrality will not hold.[4]

To continue with the analysis of the impure altruism model, make the simplifying assumption that all individuals give a positive amount to the public good. While an interior equilibrium is necessary for most of the results to follow, it does not severely restrict the implications of the model. The comparative statics results which involve corner solutions carry over exactly from the pure altruism case. Considering boundary solutions here, therefore, will not add to the insights of Bergstrom *et al.* (1986).

Next, write the gifts of everyone except person i as $G_{-i} = \sum_{j \neq i} g_j$. Then individual donations functions can be found by solving

$$\max_{x_i, g_i, G} U_i(x_i, G, g_i)$$
$$\text{s.t. } x_i + g_i = w_i$$
$$G_{-i} + g_i = G.$$

Under the Nash assumption G_{-i} is treated exogenously. Hence, by substituting $g_i = G - G_{-i}$ into the above and in turn substituting the budget constraint into the utility function, the maximisation problem is equivalent to

$$\max_{G} U_i(w_i + G_{-i} - G, G, G - G_{-i}).$$

Differentiating with respect to G and solving yields a donations function that takes as arguments the exogenous parts of the maximand:

$$G = f_i(w_i + G_{-i}, G_{-i}),$$

or equivalently $$g_i = f_i(w_i + G_{-i}, G_{-i}) - G_{-i}.$$

The first argument in f_i comes from the public goods dimension of the utility function. Hence, call the derivative of f_i with respect to this argument f_{ia} for i's marginal propensity to donate for altruistic reasons. Obviously, if both charity and the private good are normal, then $0 < f_{ia} < 1$. The second argument of f_i comes from the private goods dimension of the utility function. Call the derivative with respect to this argument f_{ie} for i's marginal propensity to donate for egoistic reasons. The sign of f_{ie} can be seen by considering the following thought experiment. Suppose we reduce G_{-i} by one dollar, but we simultaneously increase w_i by one dollar so that the value of the first argument

[4] In fact, the impure altruism model can be seen as a special case of the Cornes and Sandler model, while the Steinberg model is a special case of impure altruism.

of $f_i(\ )$ remains unchanged. Assuming that both warm glow and the private good are normal, then some of the new dollar of wealth w_i will go towards increasing consumption of each. As a result G will fall, hence $f_{ie} > 0$. Under these conditions a Nash equilibrium will exist. If we also assume that $0 < f_{ia} + f_{ie} \leqslant 1$, then it can be shown that the Nash equilibrium is also unique and stable.[5]

Separating the propensities to donate into egoistic and altruistic components now allows for a method of indexing the altruism of agents. Notice that if a person is a pure altruist then the second argument of the donations function will be missing. As a result, w_i and G_{-i} will be perfect substitutes in the individual's donations function. This implies that $df_i/dw_i = df_i/dG_{-i}$. If, on the other hand, the person is purely egoistic, then utility functions are no longer interdependent, so $\partial f_i/\partial G_{-i} = 1$ and $f_{ia} + f_{ie} = 1$. For the intermediate case of impure altruism, $\partial f_i/\partial w_i < \partial f_i/\partial G_{-i} < 1$. Hence, define the coefficient

$$\alpha_i = \frac{\partial f_i/\partial w_i}{\partial f_i/\partial G_{-i}} = \frac{f_{ia}}{f_{ia} + f_{ie}},$$

where $0 < \alpha_i \leqslant 1$. One can see that this *altruism coefficient* serves to index altruism. For instance, for pure altruists, $f_{ie} = 0$, hence $\alpha_i = 1$. For pure egoists, $f_{ia} + f_{ie} = 1$, hence $\alpha_i = f_{ia}$. For impure altruists, on the other hand, $f_{ie} > 0$ and hence $f_{ia} < \alpha_i < 1$. The lower the relative value of f_{ie}, the nearer α_i is to 1, hence the more i can be thought of as behaving as a pure altruist. The comparison also extends across individuals. If $\alpha_j > \alpha_k$ then j can be considered more altruistic than k. We can now use this model to examine the generality of the pure altruism model.

PROPOSITION 1. *The change in total giving resulting from a transfer between any two people, say persons 1 and 2, such that* $dw_1 = -dw_2 = dw$, *is*

$$\frac{dG}{dw} = c(\alpha_1 - \alpha_2), \tag{2}$$

where $0 \leqslant c \leqslant 1$. *Hence, the income transfer will increase (decrease, or not change) the total provision of the public good if and only if the income gainer is more altruistic than (less altruistic than, or equally as altruistic as) the income loser.*

The proof of this and all subsequent propositions can be found in the appendix.

This proposition shows that pure altruism is indeed sufficient for neutrality: if $\alpha_1 = \alpha_2 = 1$ then $dG/dw = 0$, as in Warr (1983). In general, however, this proposition indicates that redistributions of income will not be neutral, but will increase total giving if they transfer money to the more altruistic. The main reason for this difference between pure and impure altruism is that the pure altruism model assumes that people are indifferent between consuming their own gift or the gift of someone else. Hence, people are indifferent between the

[5] This assumption simply requires that gifts and private consumption both be normal with respect to what Becker (1974) calls 'social income', $w_i + G_{-i}$. See Andreoni (1987).

status quo and an alternative that gives them one less dollar of w and one less dollar of g while someone else gets one more dollar of w and one more dollar of g, or vice versa. In equilibrium, therefore, people respond to a transfer of income with an equal change in g. Impure altruism, however, assumes that people are not indifferent between these alternatives: all else equal, they prefer the bundle with the most warm glow. Hence, people are unwilling to perfectly substitute g to offset a transfer. The degree to which they are willing to make this substitution is reflected in the altruism coefficient; more altruistic people are more willing to substitute. Hence, when we take a dollar from someone with low altruism, he is unwilling to reduce g, while when we give the dollar to one with high altruism, he is very willing to increase g. The net effect is an increase in total giving.

We can note from (2) that pure altruism is only one of the cases in which the equilibrium G will be independent of redistributions of income. This holds whenever $\alpha_1 = \alpha_2$. More generally, we can express the sufficient condition for G to be independent of redistributions as:

PROPOSITION 2. *The total provision of the public good is independent of the distribution of income if and only if each Nash supply function can be written in the form* $g_i = f_i^*(\alpha w_i + G_{-i}) - G_{-i}$, *where* $0 \leqslant \alpha \leqslant 1$, f_i^* *is an increasing function for all* i, *and* α *is identical across all* i.

The class of functions specified in Proposition 2 will be sufficient for the equilibrium G to be independent of redistributions of income. However, if we require that both x_i and G be independent of redistributions, then pure altruism also becomes a necessary condition. To see this, totally differentiate the donations function f^* in Proposition 2, assuming neutrality: $f^{*\prime}(\alpha dw_i + dG_{-i}) = 0$. Substituting $dg_i + dG_{-i} = 0$ and rearranging we find that $dg_i/dw_i = \alpha$. But full neutrality requires that $dx_i/dw_i = 0$ and $dg_i/dw_i = 1$. Hence, $\alpha = 1$ is also necessary for complete neutrality.

II. IMPURE ALTRUISM WITH SUBSIDIES AND DIRECT GRANTS

This section extends the results of the previous section to public goods that are provided both publicly and privately. In particular, assume that the government subsidises private giving at a rate s_i, and pays for this subsidy by levying lump sum taxes, τ_i. Also, assume that the government is not wasteful, so that all net tax receipts are donated to the public good. These assumptions will allow separate consideration of the government's role in encouraging voluntary giving through subsidies to giving, and its part in providing direct grants to the charity by raising τ_i.

Let $T = \sum_{i=1}^n \tau_i - s_i g_i$ be the government's net tax receipts, and let $Y = G + T$ be the joint supply of the public good. As before, impure altruism implies that preferences are $U_i = U_i(x_i, Y, g_i)$. Let $y_i = g_i(1 - s_i) + \tau_i$ represent i's total contribution to the public good, including both tax and voluntary components. Then i's budget constraint can be written $x_i + y_i = w_i$. Furthermore, since $Y = \sum_{i=1}^n y_i$, we can define $Y_{-i} = Y - y_i$, and write the budget constraint as

$x_i + Y = w_i + Y_{-i}$. As before, the Nash assumption implies that the consumer's optimisation problem over (x_i, g_i) is, after the appropriate substitutions, formally equivalent to

$$\max_Y U_i\left(w_i + Y_{-i} - Y, Y, \frac{Y - Y_{-i} - \tau_i}{1 - s_i}\right).$$

The first order condition of this problem is

$$-\frac{\partial U_i}{\partial x} + \frac{\partial U_i}{\partial Y} + \frac{\partial U_i}{\partial g}\frac{1}{1 - s_i} = 0.$$

Solving this yields
$$y_i = f_i\left(w_i + Y_{-i}, \frac{Y_{-i} + \tau_i}{1 - s_i}, s_i\right) - Y_{-i}.$$

The first argument again is from the altruism motive, while the second comes from the egoism motive. The third argument, s_i, appears because of the expression multiplying the third partial derivative in the first order condition. It is easy to verify that the derivative of f_i with respect to this argument, call it f_{is}, is positive for impure altruists but zero for pure altruists. As before, define the altruism coefficient as

$$(df/dw)/(df/dY_{-i}), \quad \text{so} \quad \alpha_i = f_{ia}/[f_{ia} + f_{ie}/(1 - s_i)],$$

and also assume that

$$0 < df/dY_{-i} \leqslant 1, \quad \text{so} \quad 0 < f_{ia} + f_{ie}/(1 - s_i) \leqslant 1.$$

We can now determine the comparative statics of this model. First, consider the effects of redistributions. It is clear that by treating τ_i and s_i as parameters the problem becomes formally equivalent to that of the last section. Hence, Propositions 1 and 2 will also hold in the presence of taxation. Next we can analyse the effects of changing taxes and subsidies.

PROPOSITION 3. *Given preferences of the form $U_i = U_i(x_i, Y, g_i)$ and an interior equilibrium, (a) any increase (decrease) in the lump sum tax τ_i will increase (decrease) the total provision of the public good if and only if $\alpha_i \leqslant 1$ for all i, and $\alpha_j < 1$ for some j, that is*

$$dY = c\sum_{i=1}^{n}(1 - \alpha_i)\, d\tau_i,$$

where $0 \leqslant c \leqslant 1$.

(b) any increase (decrease) in the subsidy rate s_i will increase (decrease) the total provision of the public good if and only if $\alpha_i \leqslant 1$ for all i, and $\alpha_j < 1$ for some j, that is

$$dY = c\sum_{i=1}^{n}\left(\alpha_i \frac{f_{is}}{f_{ia}} + (1 - \alpha_i)\frac{Y_{-i} + \tau_i}{1 - s_i}\right) ds_i.$$

The model has now evolved to its fullest generality. It can be seen that the distribution of income as well as government tax policies are crucial in determining the total supply of the public good. Transfers of income to the more altruistic from the less altruistic will increase the equilibrium supply of the public good. Direct grants financed by lump sum taxation will only incompletely crowd out private donations. Finally, subsidies to giving can have the desired effect. Only in the case of pure altruism will the strong forms of neutrality hold.[6] The intuition for these results follows that of the last section: individuals are not indifferent between allocations that offer the same mix of public and private goods. Moreover, people are not indifferent between paying for the public good voluntarily (through private donations) or involuntarily (through taxes). Given the choice, people are assumed to prefer to give directly, that is, they prefer the bundle with the most warm glow.

III. OPTIMAL TAX TREATMENT OF CHARITY

The impure altruism model provides a concise framework for determining whether subsidies or direct grants are more desirable. The model indicates, as in Feldstein (1980) and Roberts (1987), that subsidies dominate. The key to this result is that a dollar spent on subsidies provides a greater stimulus to charity than a dollar of direct grants. To see this, suppose that the government raises the subsidy rate s_i, and finances this by raising taxes τ_i. Totally differentiating the donations function we find

$$dy_i = \left(f_{ia} + \frac{1}{1-s_i} f_{ie} - 1\right) dY_{-i} + \frac{1}{1-s_i} f_{ie}\, d\tau_i + \left[\frac{Y_{-i}+\tau_i}{(1-s_i)^2} f_{ie} + f_{is}\right] ds_i.$$

Again, solving by the method in Proposition 3, we see

$$\begin{aligned} dY &= c \sum_{i=1}^{n} (1-\alpha_i)\, d\tau_i + c \sum_{i=1}^{n} \left(\alpha_i \frac{f_{is}}{f_{ia}} + (1-\alpha_i) \frac{Y_{-i}+\tau_i}{1-s_i}\right) ds_i \\ &= \frac{dY}{d\tau} + \frac{dY}{ds} > \frac{dY}{d\tau}. \end{aligned}$$

Hence, for any given level of taxes collected, the taxes will have a bigger impact on total giving if they are spent on subsidising gifts rather than on direct grants. Notice that, in contrast to Feldstein (1980), this result does not depend on the price elasticity of giving. In this formulation, all that is required is that the altruism coefficient be less than one.

By examining utility functions we can verify that subsidies Pareto dominate. Substituting in the budget constraint, indirect utility can be written

$$V_i = U_i[w_i - y_i, Y, (y_i - \tau_i)/(1-s_i)].$$

[6] Some forms of neutrality could trivially hold under other, less plausible, assumptions about the warm glow. For instance, people could get a warm glow from their entire gift to the public good, including the taxes they pay, so $U_i = U_i(x_i, Y, y_i)$. But this is exactly the problem encountered in Proposition 1, with Y and y_i replacing G and g_i. So again, redistributions of income will matter. However, taxes and subsidies will not matter: as long as corners are not violated, the choice of y_i can be made independently of its composition of private and public contributions.

Suppose that direct grants are increased so that $dY = 1$ and $dy_i = \Delta_i$. Then by the envelope theorem

$$dV_i|_{\text{grants}} = U_Y(1-\Delta_i) - U_g \frac{d\tau_i}{1-s_i}.$$

Now suppose that τ_i and s_i are increased simultaneously by $(d\hat{\tau}_i, ds_i)$ to reproduce the same changes in giving. From the above we know that $d\hat{\tau}_i \leqslant d\tau_i$. Then

$$\begin{aligned} dV_i|_{\text{subsidy}} &= U_Y(1-\Delta_i) - U_g \frac{d\hat{\tau}_i}{1-s_i} + U_g \frac{g_i}{1-s_i} ds_i \\ &\geqslant dV_i|_{\text{grants}}. \end{aligned}$$

We see that subsidies will always increase utility more than an equivalent increase in direct grants. This follows from the assumption that $U_g > 0$. The intuition for this result is clear: because public giving is an imperfect substitute for private giving, people prefer to make donations directly rather than indirectly. Hence, subsidising altruistic behaviour is more efficient because of the egoistic motive for giving.[7]

IV. THE EMPIRICAL RELEVANCE OF IMPURE ALTRUISM

As seen above, relative degrees of altruism are of primary importance in determining effects of tax and subsidy policies. Unfortunately, the absolute magnitudes of the altruism coefficients cannot be measured with current empirical models. This is because existing empirical studies treat charitable giving as though it were a purely private good; they generally do not attempt to account for impure altruism or the interdependence of preferences.[8] However, this section will demonstrate that we can use existing empirical studies to learn about the relative degrees of altruism across income classes. This will allow us to sign comparative statics experiments, and to speculate on what may be learned from a full-blown empirical study of utility interdependence.

First we must make a functional form assumption. Therefore, assume that preferences can be represented by the Cobb–Douglas utility functions

$$U_i = a \ln x_i + b \ln Y + c \ln g_i, \quad i = 1, \ldots, n,$$

$a, b, c > 0$. It is shown in the appendix that the altruism coefficient for this utility function can be written

$$\alpha_i = \frac{a[g_i(1-s_i)]^2}{a[g_i(1-s_i)]^2 + c[\omega_i - g_i(1-s_i)]^2}, \tag{3}$$

[7] Throughout the above discussion we have assumed that first-best taxation is available to the government or, equivalently, that labour supply is perfectly inelastic. As in Feldstein (1980), this assumption is necessary to make the distinction between the general question of optimal commodity taxes and the specific question of the optimal means by which the government should encourage charity.

[8] One exception is Feldstein and Clotfelter (1976). They attempted to account for interdependence through 'economic proximity' (see their pp. 17–9). While they found coefficients of the correct sign, they were not significant.

where $\omega_i = w_i - \tau_i$ is wealth net of the taxes paid if the individual were to choose $g_i = 0$. ω_i is similar to the definition of income used in econometric studies of giving.[9] We are interested in how α varies over a cross-section of individuals, stratified by ω. If we assume that s can be approximated by a continuous and differentiable function, then this can be answered by taking the derivative of (3) with respect to ω, keeping in mind that both g_i and s_i are functions of ω. As shown in the appendix, taking the derivative and simplifying yields

$$\text{sign}\left(\frac{\partial \alpha}{\partial \omega}\right) = \text{sign}\,[\eta + (1+\epsilon)\,\sigma - 1],$$

where η is the income elasticity of giving, ϵ is the price elasticity of giving, and

$$\sigma = [d(1-s)/d\omega]\,[\omega/(1-s)]$$

is the elasticity of the subsidy schedule. Under the American scheme of tax deductibility, the marginal subsidy rate s_i is simply the marginal tax rate. Since s_i increases with ω, then $\sigma \leqslant 0$. This means that if we have a value for σ, as well as estimates of η and ϵ that are stratified by income class, then we can

Table 1

*Changes in the Altruism Coefficient Based on Price and Income Elasticities Estimated by Income Class**

Income class†	Year	Source	Estimated elasticity‡ Price	Estimated elasticity‡ Income	sign of $d\alpha/d\omega$
$4,000–20,000	1962	3	−3·67 (0·45)	0·53 (0·07)	+/−
	1970	3	−0·35 (0·52)	0·80 (0·10)	−
$4,000–10,000	1948–68	2, eqn (6)	−1·80 (0·56)	0·68 (0·06)	−
	1975	1	−0·95 (0·66)	0·39 (0·21)	−
$10,000–20,000	1948–68	2, eqn (7)	−1·04 (0·76)	0·85 (0·23)	−
	1975	1	−1·35 (0·32)	0·62 (0·09)	−
$20,000–100,000	1948–68	2, eqn (8)	−1·13 (0·25)	0·91 (0·17)	−
$20,000–50,000	1962	3	−0·97 (0·26)	0·61 (0·19)	−
	1970	3	−0·85 (0·31)	0·89 (0·16)	−
	1975	1	−1·66 (0·11)	0·36 (0·67)	−
$50,000–100,000	1962	3	−1·10 (0·19)	1·90 (0·20)	+
	1970	3	−1·12 (0·22)	0·87 (0·20)	−
	1975	1	−1·36 (0·14)	0·67 (0·14)	−
$100,000 or more	1948–68	2, eqn (9)	−0·29 (0·11)	1·38 (0·06)	+
	1962	3	−1·29 (0·04)	1·02 (0·04)	+
	1970	3	−1·74 (0·08)	1·03 (0·04)	+
	1975	1	−1·78 (0·12)	1·09 (0·05)	+

* The first five columns are as reported by Clotfelter (1985), p. 67.
Sources: 1, Clotfelter and Steuerle (1981), table 4; 2, Feldstein (1975); 3, Feldstein and Taylor (1976), table 3.
† Source 2 is in 1967 dollars, all others are in current dollars.
‡ Standard errors are in parentheses.

[9] See Clotfelter (1985, pp. 54–5) for a detailed description of the use of this variable in econometric studies.

conjecture about whether, at a particular point, the altruism coefficient is increasing or decreasing.

Table 1 summarises estimates of η and ϵ from recent econometric studies, as reported by Clotfelter (1985, p. 67). The final column indicates the sign of $\partial\alpha/\partial\omega$, which was calculated under the assumption that $0 \geqslant \sigma \geqslant -0.40$. For values of σ outide this range there is no stable pattern to these signs. However, this range is likely to capture any true underlying value.[10] As can be seen, the altruism coefficient falls as income rises until income reaches levels of approximately \$100,000 or more (in pre-1976 dollars), and then the altruism coefficient begins to rise. Conditional on Cobb–Douglas utilities, therefore, we can rank the \$50,000–100,000 income group as the *least* altruistic. This suggests cutting taxes on the highest income group while increasing taxes on the \$50,000–100,000 group may increase private giving. However, cutting taxes to the \$50,000–100,000 group and raising taxes on lower income groups may actually reduce total charity. Moreover, this suggests that if we consider income elasticity alone, then our predictions for tax changes for those under \$100,000 would be exactly the opposite of the prediction from impure altruism. This is because income elasticity rises for incomes up to \$100,000, while altruism falls. According to impure altruism, cutting the taxes on those with the relatively higher α, and hence lower η, will generate the relatively greater increase in giving. This is contrary to what would be predicted without considering impure altruism. We see with these simple experiments that accounting for impure altruism and interdependent preferences may potentially yield conclusions dramatically different from those drawn with more conventional models.

V. CONCLUSION

When people make donations to privately provided public goods, they may not only gain utility from increasing its total supply, but they may also gain utility from the act of giving. However, a simple application of the public goods model ignores this phenomenon. A consequence of this omission is that the theoretical predictions are very extreme and implausible: total provision of the public good is independent of the distribution of income among contributors, government provision completely crowds out private provision, and subsidies are neutral. On the other hand, the impure altruism model leads to predictions that are intuitive and that are consistent with empirical regularities. By assuming that individuals are not indifferent between gifts made by themselves and gifts made by other individuals or the government, we conclude that redistributions to more altruistic people from less altruistic people will increase total provision, that crowding out will be incomplete, and that subsidies can have the desired effect. Furthermore, subsidies Pareto-dominate direct grants in accomplishing policy goals of government. Finally, using Cobb–Douglas

[10] An estimate of σ can be obtained by regressing the log of $(1-s_i)$ on the log of income. As an example, I used income distribution numbers for 1980 generated by McDonald (1984), along with the 1980 federal marginal tax rates. With this method I obtained an elasticity estimate of $\sigma = -0.109$ with a standard error of 0.0013. As can be seen, this is well within the range given.

preferences as the basis for calibrating the model, we find that altruism coefficients decline with income for all but the highest class. The result is that the predicted effects of policy are sometimes reversed when impure altruism is considered. This holds out the possibility that the conventional view of charitable giving may be inaccurate, and indicates the potential importance of developing empirical models that account for impure altruism and the interdependence of preferences.

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Appendix

Proof of Proposition 1. Let $d\mathbf{w} = (dw_1, dw_2, \ldots, dw_n)$ such that $\Sigma_{i=1}^n dw_i = 0$. Then totally differentiate the Nash supply function for each i:

$$\begin{aligned} dg_i &= f_{ia}(dw_i + dG_{-i}) + f_{ie}\, dG_{-i} - dG_{-i} \\ &= (f_{ia} + f_{ie} - 1)\, dG_{-i} + f_{ia}\, dw_i. \end{aligned}$$

Substitute $dG_{-i} = dG - dg_i$ into each of the above and rearrange to get

$$dg_i = \frac{f_{ia} + f_{ie} - 1}{f_{ia} + f_{ie}} dG + \alpha_i\, dw_i.$$

Summing across all i and solving for dG yields

$$dG = c \sum_{i=1}^{n} \alpha_i\, dw_i, \tag{A 1}$$

where
$$c = \left(1 + \sum_{i=1}^{n} \frac{1 - f_{ia} - f_{ie}}{f_{ia} + f_{ie}}\right)^{-1}.$$

It is easily verified that $0 \leqslant c \leqslant 1$. Without loss of generality, let person 1 be the income gainer and person 2 be the income loser so that $d\mathbf{w} = (dw, -dw, 0, \ldots, 0)$. Then

$$dG = c(\alpha_1 - \alpha_2)\, dw.$$

So sign (dG) = sign $(\alpha_1 - \alpha_2)$. Since 1 is the income gainer, this establishes the result.

Corollary 1.1. *Any redistribution of income will increase (decrease, or not change) the total provision of the public good if and only if the sum of the i altruism coefficients, weighted by the i income changes, is greater than (less than, or equal to) zero.*

Proof. See equation (A 1) above.

Corollary 1.2. *If the Nash equilibrium provision of the public good is independent of a redistribution of income, then the redistribution will not alter the consumption of x_i and g_i for those not directly involved in the transfer.*

Proof. By continuity and monotonicity, $f_i(w_i + G - g_i, G - g_i) = f_i(w_i + G - g_i', G - g_i')$ implies $g_i = g_i'$.

Proof of Proposition 2. Since identical values of the altruism coefficient among all agents is sufficient for neutrality, a supply function of the form given is obviously also sufficient. The remainder of the proof is therefore devoted to the necessary condition. We can begin by noting that Corollaries 1.1 and 1.2 together imply that under neutrality the equilibrium α coefficients must be identical for all i across all allowable distributions of income. This is because any redistribution can be duplicated by a series of redistributions, each of which leaves at least one person's consumption unchanged.

Next, write the generalised supply functions as

$$G = f_i(w_i + G_{-i}, G_{-i}). \tag{A 2}$$

In equilibrium, (A 2) holds for all individuals. Since f_i is monotonic in G_{-i} it has a unique inverse, ϕ_i, which applied to both sides of (A 2) yields

$$\phi_i(G; w_i) = G_{-i}. \tag{A 3}$$

When G is fixed, equation (A 3) simply determines the level of G_{-i} necessary to maintain G as an equilibrium when wealth is w_i. Totally differentiate (A 2), assuming neutrality (i.e. $dG = 0$)

$$0 = f_{ia}\, dw_i + f_{ia}\, dG_{-i} + f_{ie}\, dG_{-i}.$$

Rearrange to find $$\frac{dG_{-i}}{dw_i} = -\frac{f_{ia}}{f_{ia}+f_{ie}} = -\alpha,$$

where $\alpha = \alpha(G)$ is the equilibrium value of α. From (A 3) this in turn implies that $\phi_i(G; w_i)$ is linear in w_i and so

$$\phi_i(G; w_i) = -\alpha w_i + \pi_i(G). \tag{A 4}$$

Substitute (A 3) into (A 4) and rearrange to get

$$\pi_i(G) = \alpha w_i + G_{-i}. \tag{A 5}$$

Since $dG/dG_{-i} > 0$, π_i must be monotonically increasing, therefore π_i has an inverse, f_i^*, that is also an increasing function. Apply this inverse to both sides of (A 5) to get $G = f_i^*(\alpha w_i + G_{-i})$.

Proof of Proposition 3. (*a*) Totally differentiate the donations functions and rearrange, as was done in Theorem 1, to arrive at

$$dY = c \sum_{i=1}^{n} (1-\alpha_i)\, d\tau_i,$$

where $$c = \left\{1 + \sum_{i=1}^{n} \frac{1 - f_{ia} - [1/(1-s_i)] f_{ie}}{f_{ia} + [1/(1-s_i)] f_{ie}}\right\}^{-1}.$$

Since $c > 0$, this proves the result.

(*b*) Totally differentiating and rearranging in the same manner yields

$$\begin{aligned} dY &= c \sum_{i=1}^{n} \left\{\frac{f_{is}}{f_{ia} + [1/(1-s_i)] f_{ie}} + (1-\alpha_i)\frac{Y_{-i}+\tau_i}{1-s_i}\right\} ds_i \\ &= c \sum_{i=1}^{n} \left(\alpha_i \frac{f_{is}}{f_{ia}} + (1-\alpha_i)\frac{Y_{-i}+\tau_i}{1-s_i}\right) ds_i. \end{aligned}$$

When $\alpha_i = 1$ for all i we know by the way the donations function is constructed that $f_{is} = 0$ must also hold. In this case $dY = 0$. On the other hand, if there exists an $\alpha_j < 1$, then $f_{je} > 0$ and $f_{js} \geqslant 0$ and so $dY/ds_j > 0$.

The Altruism Coefficient for Cobb–Douglas Utility

The optimisation problem

$$\max_{Y}\, a \ln(w_i + Y_{-i} - Y) + b \ln(Y) + c \ln\left(\frac{Y - Y_{-i} - \tau_i}{1 - s_i}\right)$$

has first order conditions

$$-\frac{a}{S-Y}+\frac{b}{Y}+\frac{c}{Y-Y_{-i}-\tau_i}=0, \tag{A 6}$$

where $S = w_i + Y_{-i}$ is *is* social income. To find the expression for f_{ia} we need to find dY/dS. Totally differentiating (A 6) and solving we find

$$f_{ia}=\frac{dY}{dS}=-\frac{a/(S-Y)^2}{\Delta}$$
$$=-\frac{a/(w_i-y_i)^2}{\Delta},$$

where Δ represents the second order conditions on the optimisation problem.

To find f_{ie} we need to determine how the choice of Y changes as Y_{-i} changes, keeping social wealth constant. Totally differentiating (A 6) while keeping $dS = 0$ we find

$$f_{ie}=\left.\frac{dY}{dY_{-i}}\right|_{dS=0}=-\frac{c/(Y-Y_{-i}-\tau_i)^2}{\Delta}$$
$$=-\frac{c/(y_i-\tau_i)^2}{\Delta}.$$

Putting these together we find

$$\alpha_i=\frac{a(y_i-\tau_i)^2}{a(y_i-\tau_i)^2+c(w_i-y_i)^2}.$$

Finally, substituting $y_i = g_i(1-s_i)+\tau_i$ and $\omega_i = w_i-\tau_i$ we get

$$\alpha_i=\frac{a[g_i(1-s_i)]^2}{a[g_i(1-s_i)]^2+c[\omega_i-g_i(1-s_i)]^2}. \tag{A 7}$$

Next we will determine the derivative of the altruism coefficient. For ease of notation we will suppress the i subscript. Furthermore, let $h = g(1-s)$. Then we can write (A 7) as

$$\alpha=\frac{ah^2}{ah^2+c(\omega-h)^2}.$$

Differentiating this and rearranging yields

$$\frac{d\alpha}{d\omega}=\frac{2ach^2(\omega-h)\,[(dh/d\omega)\,(h/\omega)-1]}{[ah^2+c(\omega-h)^2]^2}.$$

Hence, the sign of $d\alpha/d\omega$ is determined as

$$\operatorname{sign}\frac{\partial\alpha}{\partial\omega}=\operatorname{sign}\left(\frac{dh}{d\omega}\frac{\omega}{h}-1\right). \tag{A 8}$$

Evaluating this we see that

$$\frac{\partial h}{\partial\omega}\frac{\omega}{h}-1=\left[\frac{\partial g}{\partial\omega}(1-s)+\frac{\partial g}{\partial(1-s)}\frac{d(1-s)}{d\omega}(1-s)+g\frac{d(1-s)}{d\omega}\right]\frac{\omega}{g(1-s)}-1$$
$$=\frac{\partial g}{\partial\omega}\frac{\omega}{g}+\left[1+\frac{\partial g}{\partial(1-s)}\frac{1-s}{g}\right]\frac{d(1-s)}{d\omega}\frac{\omega}{1-s}-1$$
$$=\eta+(1+\epsilon)\,\sigma-1.$$

This together with (A 8) yield the result reported in Section IV.

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