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Public-good valuation and intrafamily allocation

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Abstract

I derive the marginal value of a public good in multiperson households, measured alternatively by one household member's willingness to pay (WTP) for the good on behalf of the household, or by the sum of individual WTP values across family members. Households are assumed to allocate their resources using efficient Nash bargains over two goods, one private good for each member, and one common household good. We show that with no altruism among two family members, member 1's WTP on behalf of the household is on average a correct representation of true aggregate household WTP for the public good, and is higher (lower) than this average when member 1 has a higher (lower) marginal value of the public good than member 2. Nonpaternalistic altruism makes each of the two members' WTP on behalf of the household closer to the true aggregate WTP. With paternalistic altruism, attached to consumption of the public good, higher altruism raises aggregate WTP. Higher altruism on the part of both members then moves individual-based WTP closer to true aggregate WTP, while the opposite may occur when only one member is altruistic.

JEL classification: H41, D13, Q26, D64

Key words: Public goods, willingness to pay, contingent valuation, intrafamily allocation

1. Introduction

Over the last 20 years of so, surveys have become an important source of information about economic values of public goods. Contingent valuation (CV), whereby marginal willingness to pay (WTP) for increases in the provision of such goods is elicited in random population samples, has here gained a dominant position in many public-goods contexts, in environmental economics but increasingly also e.g. for health and cultural goods and services.[1] Several problems arise with such methods most of which will be ignored here. This paper focuses on one particular such problem, namely deriving WTP values for multi-person households when only one household member is actually surveyed. One typical way of phrasing a CV question is as follows: "How much are you maximally willing to pay, on behalf of your household, in order to obtain a (small) increase in the quantity of a particular public good?". An issue is whether the individual's WTP answer to such a question can be a correct representation of the entire household, or only of himself or herself. An alternative typical phrasing of CV questions is: "How much are you, personally, maximally willing to pay in order to obtain a (small) increase in the quantity of the public good?". If individuals answer correctly and truthfully to this question, the sum of such personal WTP levels across all family members should reasonably represent the true aggregate WTP of the household for such a change.

A main purpose of this paper is to study the relationship between the sum of "true" answers across all household members to individual questions of the latter type, and answers to questions of the former type when one household member is taken to "represent" the entire household. In particular, we will investigate whether the two

[1] A good review of survey methods using contingent valuation is still Mitchell and Carson (1989). See also Carson, Flores and Meade (2001) for a recent overview of the CV method.

measures may coincide, and if they do not, by how much they deviate and in what direction, and what are causes of such deviations. For this purpose we construct a simple model of household preferences and behavior. Here each household is assumed to consist of two members, each with preferences that are separable in the amounts of three distinct goods: one private good consumed exclusively by the member; one household good consumed jointly by the two members; and one pure public good enjoyed by both and provided outside of the household. The household has a common budget, and the two members decide jointly on their allocation of personal and household goods. We will assume that this allocation is efficient and decided in an efficient asymmetric Nash bargain within the family, with bargaining parameters β and $1-\beta$ for the two members, where $\beta \in (0,1)$. We show that this bargaining solution yields a lower marginal utility of consumption for the common household good than for any of the private goods, and that this disparity is greater for a given member when that member's relative bargaining strength is lower. Intuitively, when the household increases its budget by one money unit, this unit can be spent on either the common good, or on the private goods. In the former case, the amount of the common good increases by one unit. In the second case, member i obtains an increase in private-good consumption equal to $\beta_i < 1$ units (where β_i equals β or $1-\beta$), corresponding to his or her relative bargaining power. For member i to be indifferent between these two ways of spending a money unit, the marginal utility of the private good must equal $1/\beta_i$ times that of the common good.

We study three versions of this basic model, which differ in the degree and types of altruism of the household members toward each other. In the first case there is no altruism. We then show that the aggregate household WTP for the public good can be represented simply by the sum of individual private WTP levels for the public good, in terms of each member's own private good. We argue that member i's WTP for the public good on behalf of the household instead more reasonably ought to be represented by member i's WTP for the public good in terms of the household good. Our main result in this section is that these two measures are identical if and only if the two household members have the same marginal valuation of the public good in terms of the household good. This result is independent of the bargaining parameter $\beta \in (0,1)$, and only depends on efficient bargaining actually taking place. When the two members instead have different valuations of the public good and there is no altruism, the household valuation by one member on behalf of the household will be biased in the direction of that member's marginal public-good valuation. There is however no tendency for systematic bias when taking the sum over household members: household valuation may then be too high or too low, but will "on average" be correct. Thus in a large sample of respondents to such a question, individual household members' valuations will, on average, correctly represent the entire household valuation, only provided that they are truthful.

In section 3 we extend this analysis to the case of pure (nonpaternalistic) altruism among family members, where the general utility level of each of the members enters into the utility function of the other member. Now household members "care about" each other, in a rather general way. This complicates the intrafamily allocation somewhat since the other member's consumption of the private and household good now also enters into the utility function of the first member, and vice versa. We then argue that the sum of individual WTP for the public good must for each member be defined by adding up each member's maximum WTP for the public good in terms of the private good, given that the other member is kept at his or her initial utility level, i.e. pays his or her maximum WTP. We show that this sum is identical to the equivalent sum under no altruism derived in section 2. When comparing this sum to member i's WTP on behalf of the household, we still find (given that $\beta \in (0,1)$ and with "incomplete altruism" as defined below) that these measures are identical if and only if the two members' WTP for the public good in terms of the household good are equal, in the same way as under no altruism. Given that the two household members have approximately the same degree of mutual altruism, their valuations on behalf of the household will now however always differ by less than in the nonaltruistic case, and this effect is greater for higher degrees of altruism. As a consequence, a smaller error will then generally be made when letting one household member value the public good on behalf of the household. On average there is however no change, in the same way as under no altruism.

In our final case, in section 4, altruism is assumed to be paternalistic in the sense that each household member cares about the other member's consumption of the public good, but not about the other member's consumption of other (private or household) goods. In this case the intrafamily allocation of personal and household goods, for a given household budget for such goods, is not affected by altruism. The general level of (individual and household) WTP for increased provision of the public good is now however raised by higher degrees of altruism. When considering the relationship between the sum of individual WTP, and one member's WTP on behalf of the household, this relationship is affected in a similar way as under pure altruism: also now the two measures are more equal, the higher the degree of mutual altruism among the two members.

This paper extends the current literature by explicitly considering implications of intrafamily allocation for public-good valuation. Although ignored by many family economists (such as Becker's (1991) landmark work), some previous contributions on intrafamily allocation have considered efficient bargaining among family members.[2] The contribution most closely related to the current one is probably Quiggin (1998), who addresses the issue of household versus individual public-good valuation in a model of only two goods, where purely private goods are traded off against the public goods.[3] Under such assumptions he finds that high degrees of altruism are necessary to make individual and household valuations similar. Here, by contrast, altruism plays no essential role in reaching such a conclusion, only provided that the public goods can be traded off, alternatively, against private and household goods.

Some implications of the analysis, and suggestions for future related research, are discussed in the final section 5.

2. The basic model with no altruism

Consider a model where families consist of two persons (spouses); generalizations can be made to larger families incorporating children. The two members have a common household (and for our purposes exogenous) budget B, which is shared among three types of expenses. First, each household member i = 1,2 has a purely private or personal consumption $C_{i.}$. Secondly, the family members jointly consume a household good in the amount H. These two types of goods all have prices equal to unity. Thirdly, the family pays to support a public good P.[4] Assume at the outset that the household is simply charged a fixed amount T in taxes which is used for financing

[2] See Bergstrom (1997) for a survey. See also Browning and Chiappori (1998) and Aura (2002) for recent empirical evidence in favor of the household bargaining model.
[3] Quiggin states that one interpretation of the "public" good is as a good consumed exclusively within the household. He however does not clarify the implications of this assumption for the equilibrium allocation of the "public" good in such a case, which is the main issue here.
[4] Note that our "public good" may also be a private good whose cost is not charged to users. Typical examples of the latter are many educational, health and cultural (e.g. library) services.

P, and where T is viewed as a lump-sum family expense. The family budget constraint can then be expressed as[5]

$$(1) \qquad B = C_1 + C_2 + H + T.$$

The two household members bargain over the split of $R = B - T$ among C_1, C_2 and H, in an asymmetric Nash bargain with relative bargaining strengths β and $1-\beta$ to household members 1 and 2 respectively. The symmetric Nash bargain here prescribes $\beta = ½$ which is an important special case. At the outset we however assume other possibilities concerning relative bargaining strengths within the family.[6] In this section we assume no altruism, i.e., no element of other individuals' utilities nor consumption enters into the utility function of a given family member. Member i has a utility function which is strongly separable in its three arguments, of the form

$$(2) \qquad U_i = u_i(C_i) + v_i(H) + z_i(P), \; i = 1,2,$$

[5] Asymmetric information about household members' individual income contributions may complicate the intrahousehold allocation problem relative to our exposition. We will argue that asymmetric information is likely not to be a serious problem in households where members interact daily. In particular, it may be difficult for one member to maintain a high consumption level without the other member discovering this.

[6] We are here not considering the possibility that the family may split up, as in the case of divorce of two spouses, or the possibility that a noncooperative equilibrium with no family break-up yields a higher reservation utility for the two spouses. The divorce option is considered in related analyses by Manser and Brown (1974) and McElroy and Horney (1981), and the "inside" noncooperative breakdown option by Lundberg and Pollak (1993); see Bergstrom (1997) for an overview. For our analysis, the threat point is essentially immaterial as long as there is no breakdown of cooperation. We will argue that when household goods are essential and command a large share of the common budget, the divorce option will often be unattractive even for spouses with low bargaining power. The reason is that low bargaining power is likely to go together with low relative income when living as a single. Then the positive utility effect of high household-good consumption within a common household can overwhelm any negative effects of relatively low private-good consumption.

where the u_i, v_i and z_i functions can all be viewed as standard von Neumann-Morgenstern utility functions.[7] They are all increasing and strictly concave and fulfil standard Inada conditions, i.e., f' > 0, f'' < 0 and lim (A→0) f' = ∞, lim (A→∞) f' = 0, for f = u, v and z, and A = C_i, H and P, respectively.

The Nash product for the bargain can be expressed as

$$(3) \qquad NP(1) = [u_1(C_1) + v_1(H)]^{\beta}[u_2(C_2) + v_2(H)]^{1-\beta}.$$

The standard Nash bargaining solution implies that NP(1) is maximized with respect to the C_i and H, subject to the household budget constraint. We may form the following Lagrangian:

$$(4) \qquad L(1) = NP(1) - \lambda(C_1 + C_2 + H - R).$$

Maximizing (4) with respect to the C_i and H now yields the following set of first-order conditions:

$$(5) \qquad \frac{\partial L(1)}{\partial C_1} = \beta N_1^{\beta-1} N_2^{1-\beta} u_1'(C_1) - \lambda = 0$$

$$(6) \qquad \frac{\partial L(1)}{\partial C_2} = (1-\beta) N_1^{\beta} N_2^{-\beta} u_2'(C_2) - \lambda = 0$$

$$(7) \qquad \frac{\partial L(1)}{\partial H} = \beta N_1^{\beta-1} N_2^{1-\beta} v_1'(H) + (1-\beta) N_1^{\beta} N_2^{-\beta} v_2'(H) - \lambda = 0,$$

[7] A generalization to the case of nonseparable preferences is developed in appendix B.

where the N_i are the Nash maximands (i.e., the expressions inside the respective square brackets in (3)). Eliminating λ permits us to derive the following conditions:

$$\text{(8)-(9)} \qquad \frac{1}{1+n} u_1'(C_1) = \frac{n}{1+n} u_2'(C_2) = v'(H).$$

We here use the notation $n = [(1-\beta)/\beta](N_1/N_2)$. n may in the following be viewed as a "primitive" of the bargaining solution; when $n \to 0$, (in the limit) only member 1 has bargaining power; when n = 1, both members have the same "effective bargaining power" (resulting in particular when utility functions are identical and $\beta = ½$); and when $n \to \infty$, only member 2 has bargaining power. Here and in the following we set $v_1'(H) = v_2'(H) = v'(H)$, for any equilibrium value of H.[8] (8)-(9) provide expressions for the marginal rates of substitution between the respective private goods C_i, and the family good H, given an efficient Nash bargaining solution of the type prescribed. It is the familiar public-good solution prescribing the marginal value of the household ("public") good to equal the weighted sum of marginal values of the private goods.[9] Generally, when $\beta \in (0,1)$ (and thus n > 0), $u_i'(C_i)$ exceed $v_i'(H)$ at an efficient Nash bargaining solution. This can be understood by considering the effects on the utility level of household member 1, when R increases by one (small) unit. This unit can be used either on the household good, H, or on private goods, C_i. In the latter case household member 1 however only receives a fraction β of this income to be spent on

[8] This is not a restrictive assumption, at least not locally in the vicinity of the preferred solution. Since the utility functions utilized here fulfil standard von Neumann-Morgenstern criteria, of being invariant to an increasing linear transformation, this transformation may without loss of generality be chosen to equalize absolute and marginal utilities of common household consumption at this point.
[9] See e.g. Starrett (1988) for a presentation. Our solution here of course also coincides with the analysis of Coase (1960), and our model assumes that the "Coase theorem" holds for intrafamily allocations. We will claim that if the Coase theorem is to hold approximately anywhere, it is likely to hold for

increased personal consumption. At the optimal solution, the consumption value of this increased personal consumption must equal the consumption value of the unit increase in H, which in turn implies that the marginal utility of additional personal consumption must be higher than that of common consumption.

As β tends to one, the solution tends to the "dictatorial" solution where person 1 alone decides on the common budget. In this case (with no altruistic motivations) only person 1 enjoys private consumption in the limit, and the rate of substitution between C_1 and H is unity.[10] (In the opposite case, where β tends to zero, only person 2 enjoys personal consumption in the limit, and the rate of substitution between C_2 and H tends to unity.)

An important special case is $\beta = ½$ and identical utility functions, i.e. $u_1(C) \equiv u_2(C)$, and $v_1(H) \equiv v_2(H)$. Then n = 1, i.e., the two family members have the same bargaining power, Then $N_1 = N_2$, and

$$(10) \qquad \tfrac{1}{2}\, u_1'(C_1) = \tfrac{1}{2}\, u_2'(C_2) = v'(H) \,.$$

In this particular case, the marginal utilities of private consumption equal twice the marginal utilities of common household consumption, for both members.

Consider now facing household member 1 with the following question: "What is the highest payment you are willing to make, on behalf of your household, in return for a unit increase in the public good P; i.e., what, in your view, is <u>your household's maximum willingness to pay</u> for such an increase in the public good?".

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intrafamily allocations where the setting is explicitly cooperative and individual interact almost continuously.

[10] Note that for limit solutions of $C_i = 0$ to make sense, we must allow for the household good H to contain all elements necessary for basic survival, such as basic food consumption.

It seems clear that (for "small" overall changes in H and P) this is the same as asking how many units of the household good H member i is willing to forsake in order to obtain one extra unit of P. We find

$$(11) \qquad WTP_i(H) = -\frac{dH}{dP}(U_i = const.) = \frac{z_i'(P)}{v'(H)}, i = 1,2,$$

where $WTP_i(H)$ denotes such a value, i.e., household member i's maximum willingness to pay for the public good, in terms of reduced numbers of consumed units of the household good.

We next wish to derive the maximum willingness to pay for the public good in terms of the private good, for household member i alone, and for the two members taken together. Denote this private value for person i by $WTP_i(C)$, and the aggregate for the two household members, by $WTP(C) = WTP_1(C) + WTP_2(C)$. Neither of these values will generally be identical to $WTP_i(H)$.

Finding a private value $WTP_i(C)$ for person i implies that this person gives a correct answer to the following question: "How much are you willing to give up, in terms your own personal consumption, in order to obtain a unit increase in the public good?". The latter can be expressed as

$$(12) \qquad WTP_i(C) = -\frac{dC_i}{dP}(U_i = const.) = \frac{z_i'(P)}{u_i'(C_i)}, i = 1,2.$$

Using (8)-(9) we now immediately find that, since $u_i'(C) > v'(H)$ for both i, $WTP_i(C) < WTP_i(H)$. The aggregate private WTP for the public good is now simply the sum over i of the $WTP_i(C)$, i.e.,

(13) $$WTP(C) = \frac{z_1'(P)}{u_1'(C_1)} + \frac{z_2'(P)}{u_2(C_2)}.$$

We here wish to find a relationship between the individual member's WTP for the public good on behalf of the household, and the sum of purely private WTP levels for the members taken together. This amounts to comparing the expressions (11) and (13), noting that (8)-(9) must be obeyed (and considering the expressions for N_1 and N_2, from (3)). We may then write WTP(C) as follows:

(13a) $$WTP(C) = \frac{z_1'(P) + nz_2'(P)}{(1+n)v'(H)},$$

where the two terms in the numerator constitute the individual WTP of the two members. We are here also interested in the ratio of $WTP_1(H)$ to WTP(C), denoted R(1) and given by

(14) $$R(1) = \frac{WTP_1(H)}{WTP(C)} = \frac{(1+n)z_1(P)}{z_1(P) + nz_2(P)}.$$

From (14) we immediately the following first main result.

<u>Proposition 1:</u> *Assume efficient household bargaining over a common budget for two household members with bargaining strengths β and 1-β, and no altruism. Then WTP for a public good, as expressed by household member 1 on behalf of the household, is greater (smaller) than the sum of the two household members' private WTP of the*

good, if and only if member 1's marginal valuation of the public good in terms of the common household good is higher (lower) than that of member 2.

When $\beta \in (0,1)$ and thus $n > 0$, and $R(1) > (<) 1$ if and only if $z_1'(P) > (<) z_2'(P)$. Consequently, if and only if the two family members have the same marginal value of the public good, any one of them will express household WTP correctly.[11] Perhaps surprisingly, this result holds irrespective both of altruism and of relative bargaining powers of the two family members. It only depends on efficient bargaining within the household actually taking place. Our claim is that WTP(C) in this case is an appropriate measure of WTP for the public good, as an aggregate over the members.

Note that $WTP_1(H) = WTP(C)$ regardless of $z_i'(P)$, when $n \to 0$ in the limit, i.e., only the household member who is making the valuation has bargaining power within the household. This may be called the limit case of pure paternalism in the absence of altruism. The other family member is then allowed no private consumption in the limit, and will consequently have a very high marginal value of personal consumption. His or her marginal value of the public good in terms of the personal good is then (close to) zero. Member 1 can then be said to be dictatorial in determining the value of the public good. In general, how WTP(C) is distributed between the two individuals depends on n. When person 1 has a high bargaining power (n is small), from (8)-(9) his or her marginal value of private consumption is close to that of common household consumption, implying that $u_1'(C_1)$ is low and $WTP_1(C)$ high relative to corresponding values for person 2, and vice versa when β is low.

[11] More appropriately expressed, the ratio of marginal values of the public good in terms of the household good must be equal; remember that we here have defined relative preferences such that the marginal value of the household good is the same for both.

Our result shows that aggregating up individual WTP values stated on behalf of the household, across household members, will inevitably lead to double counting even in the absence of altruism. This is in contrast to results from other related work, such as Jones-Lee (1992), Johansson (1994) and Quiggin (1998), where altruistic preferences within the household are generally necessary for such possible double counting.

A generalization to several (m) household members is straightforward, at least in the symmetric case where each member has the same bargaining parameter 1/m. The household good would then be shared among the n members. The sum of purely private WTP will also then equal WTP in terms of the household good for each household member as long as members' marginal valuations of the pure public good are identical.

Above we have assumed that preferences are separable in C, H and P. The appendix considers a generalization to cases with nonseparable preferences. The household bargaining solution will then generally depend on the supply of P. I find that private consumption of member 1 increases with P when P is complementary to C, and decreases when P is complementary to H, for that individual only (with opposite effects when the respective goods are alternative). Member 1's WTP for an increase in P is always higher than in the analysis above, when private consumption is also increased. Aggregate WTP for the two members is however not affected, and neither is individual WTP when the degree of complementarity is the same for the two members. Thus on the whole, little is changed qualitatively by such an extension.

3. Pure intrahousehold altruism

Consider a generalization of the above model to a case of "pure" (nonpaternalistic) altruism within the family only.[12] Each household member now attaches utility to the general utility level enjoyed by the other member, such that the total utility of household member 1 can be expressed as follows:

$$U_1 = u_1(C_1) + v_1(H) + z_1(P) + \alpha_1 [u_2(C_2) + v_2(H) + z_2(P)], \tag{15}$$

and a corresponding expression (with footscripts switched) for household member 2. Here α_i is a relative weight attached by member i to the other family member, relative to the weight attached to oneself. We assume that $\alpha_i \in (0,1)$, i = 1,2, implying, plausibly, that each individual attaches more weight to his or her own utility than to the utility of the other member (the case of $\alpha_i = 1$ for any i can be said to represent complete altruism, which we rule out except as a possible limit case below). We open up for $\alpha_1 \neq \alpha_2$, i.e., different degrees of altruism expressed by each member toward the other member. The budget constraint is the same as previously, while the Nash product here arises as

$$\begin{aligned} NP(2) = &\left[u_1(C_1) + v_1(H) + \alpha_1(u_2(C_2) + v_2(H))\right]^{\beta} \\ &\left[u_2(C_2) + v_2(H) + \alpha_2(u_1(C_1) + v_1(H))\right]^{1-\beta} \end{aligned} \tag{16}$$

[12] We in the following consider only intrafamily altruism. As justified e.g. by Jones-Lee (1992) and Becker (1991), this is likely to be the dominating type of altruism for a majority of individuals.

Forming the Lagrangean L(2), in similar way as L(1), for this case, and maximizing L(2) with respect to the C_i and H under the budget constraint now yields the following three first-order conditions

(17) $$\frac{\partial L(2)}{\partial C_1} = \left[\beta N_1^{\beta-1} N_2^{1-\beta} + \alpha_2(1-\beta)N_1^{\beta} N_2^{-\beta}\right]u_1'(C_1) - \lambda = 0$$

(18) $$\frac{\partial L(2)}{\partial C_2} = \left[(1-\beta)N_1^{\beta} N_2^{-\beta} + \alpha_1 \beta N_1^{\beta-1} N_2^{1-\beta}\right]u_2'(C_2) - \lambda = 0$$

(19) $$\frac{\partial L(2)}{\partial H} = \beta N_1^{\beta-1} N_2^{1-\beta}\left[v_1'(H) + \alpha_1 v_2'(H)\right] + (1-\beta)N_1^{\beta} N_2^{-\beta}\left[v_2'(H) + \alpha_2 v_1'(H)\right] - \lambda = 0.$$

Also here λ can be eliminated to yield the following two conditions, given that v_1'(H) = v_2'(H) = v'(H), as before:

(20)-(21) $$(1+\alpha_2 n)u_1'(C_1) = (\alpha_1 + n)u_2'(C_2) = \left[1 + \alpha_1 + n(1+\alpha_2)\right]v'(H).$$

We see that the new parameters α_i affect the intrafamily allocation, relative to the conditions (8)-(9) under no altruism. Consider first a reference case with symmetric bargaining and equal degrees of altruism, i.e., n = 1, $\alpha_1 = \alpha_2$, and identical utility functions for the two household members. Then u_i'(C_i) = 2v'(H) for i = 1,2, which is the same as with no altruism. The allocation of resources within the household is then unaffected by pure intrafamily altruism.

In other cases the allocation is now however affected. To derive more general implications for the respective household member's WTP for the public good, note first that a unit change in the public good P now has total utility effect z_1'(P) +

$\alpha_1 z_2'(P)$ for household member 1, and correspondingly (with opposite parameters) for member 2. Differentiating (15) with respect to H and P now yields household member 1's WTP on behalf of the household, for increased P, as

$$(22) \qquad WTP_1(H) = -\frac{dH}{dP} = \frac{1}{1+\alpha_1}\frac{z_1'(P)+\alpha_1 z_2'(P)}{v'(H)}.$$

To find the corresponding private valuations, note that altruism between members with respect to consumption of personal goods complicates the argument somewhat. It now makes a difference exactly how the valuation question is posed to the respondent. We have at least three possibilities, as follows:

1. What is your private maximum WTP for an extra unit of the public good, in terms of reduced consumption of your own private consumption good, given that you only, and not the other family member, is to pay to obtain this good?
2. What is your private WTP for an extra unit of the public good, in terms of reduced consumption of your own private consumption good, when also the other family member pays his or her own private maximum WTP to obtain the good?
3. What is your private WTP to obtain one extra unit of the public good, in terms of reduced consumption of your own private consumption good, when also the other family member pays the same amount, i.e., your private maximum WTP to obtain the good?

Given that WTP for the public good is elicited from one family member, and only this member is to pay, the first interpretation appears as the most reasonable. In this case, maximum WTP for the public good for household member 1, denoted $WTP_1(C)$, can be found differentiating (15) with respect to C_1 and Z (and holding C_2 and H constant), yielding

$$WTP_1(C) = -\frac{dC_1}{dP} = \frac{z_1'(P) + \alpha_1 z_2'(P)}{u_1'(C_1)}. \tag{23}$$

Aggregate household WTP is now found aggregating up these separate values. Calling this aggregate $WTP^1(C)$, we have

$$WTP^1(C) = \frac{z_1'(P) + \alpha_1 z_2'(P)}{u_1'(C_1)} + \frac{z_2'(P) + \alpha_2 z_1'(P)}{u_2'(C_2)}. \tag{24}$$

$WTP_1(C)$ is generally greater in (23) than in the corresponding expression with no altruism, (12). The difference is that in (23), household member 1 takes his or her altruistic preference for member 2's consumption of the public good into consideration, thus increasing the value of that good.

When the presumption instead is that all members of society, including the other household members, must be required to pay in order to obtain more of the public good, alternatives 2 and 3 are more relevant. Measure 2 can be derived from the following set of simultaneous equations:

$$u_1'(C_1)dC_1 + \alpha_1 u_2'(C_2)dC_2 = -(z_1'(P) + \alpha_1 z_2'(P))dP \tag{25}$$

$$u_2'(C_2)dC_2 + \alpha_2 u_1'(C_1)dC_1 = -(z_2'(P) + \alpha_2 z_1'(P))dP. \tag{26}$$

Solving (25)-(26) simultaneously for dC_1 and dC_2 in terms of dP now yields the solutions (12) for each of the two household members, as in the case of purely selfish preferences. The aggregate household WTP in this case, denoted $WTP^2(C)$, is then given by (13a). Clearly, $WTP^1(C) > WTP^2(C)$.[13] Intuitively, the only difference between $WTP^1(C)$ and $WTP^2(C)$ is that member 1 takes into consideration that member 2 also must pay to get more of the public good under $WTP^2(C)$, but not under $WTP^1(C)$. When the other member pays, the utility of the first member is reduced, due to altruistic concerns about the other member's reduced personal consumption.

I view $WTP^2(C)$ as the correct measure of aggregate household WTP for a unit increase in the public good, since it involves simultaneous changes in C_1 and C_2 for the two household members so as to leave both utilities constant. The third measure, while hardly theoretically correct, is often in practice elicited in CV studies, but will not be discussed further here.[14] A immediate implication, from comparing $WTP^2(C)$ and WTP(C), is the following:

Proposition 2: *Assume that the analysis in section 2 applies except that household members may exhibit pure altruism as defined. Aggregate WTP for the public good is then invariant to a change in the degree of pure altruism*.

Pure altruism here does not affect the household's "true" marginal value of the public good in terms of private goods, defined by both members being kept at their utility levels when public-good provision changes. By contrast, the sum of purely individual WTP levels ($WTP^1(C)$) exceeds this true WTP value, simply since the

[13] This conclusion is identical to Result 1 in Quiggin (1998).
[14] There are at least two reasons why this third measure is often elicited in practice. First, the interviewer will generally not, and often not even the respondent, be aware of the actual maximum WTP of other household members nor other members of society. An approximation is then for the interviewer to assume that these values are the same when designing the questionnaire. Secondly, the simultaneous issues of simplicity of design and of strategic responses may make it preferable for the interviewer to frame the question as a voting scheme for or against a particular financing method, whereby each individual is to pay either a certain amount, or a certain tax as fraction of income. In both

latter must take into account the utility effect of reduced income for the opposite household member, when all members are kept to their original utility levels.

I next compare individual WTP on behalf of the household (in terms of the household good), to the "true" household WTP measure, $WTP^2(C) = WTP_{12}(C) + WTP_{22}(C)$. Using (20)-(21), the individual valuations $WTP_{12}(C)$, $WTP_{22}(C)$, and $WTP^2(C)$, can be found as

(27)
$$WTP_{12}(C) = \frac{(1+\alpha_2 n)z_1'(P)}{1+\alpha_1+n(1+\alpha_2)}\frac{1}{v\ '(H)}$$

(28)
$$WTP_{22}(C) = \frac{(\alpha_1+n)z_2'(P)}{1+\alpha_1+n(1+\alpha_2)}\frac{1}{v\ '(H)}$$

(29)
$$WTP^2(C) = \frac{(1+\alpha_2 n)z_1'(P)+(\alpha_1+n)z_2'(P)}{1+\alpha_1+n(1+\alpha_2)}\frac{1}{v\ '(H)}.$$

The ratio of $WTP_1(H)$ to $WTP^2(C)$, denoted R(2), is

(30)
$$R(2) = \frac{WTP_1(H)}{WTP^2(C)} = \frac{1+\alpha_1+n(1+\alpha_2)}{1+\alpha_1}\frac{z_1'(P)+\alpha_1 z_2'(P)}{(1+\alpha_2 n)z_1'(P)+(\alpha_1+n)z_2'(P)}.$$

We are here able to demonstrate the following result:

<u>Proposition 3:</u> *Assume that marginal valuations of the public good differ. Then one individual's expressed marginal WTP for the public good, on behalf of the household,*

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these cases the chosen questioning format may be one where the individual is asked to vote for or *is closer to the correct aggregate marginal household WTP, the greater the degree of pure altruism, by either one or both of the members*.

For a proof, see the appendix. This result holds for a partial change in altruism by either of the members (i.e. when either α_1 or α_2 changes partially, or when $\alpha_1 = \alpha_2 = \alpha$ and thus both parameters change simultaneously). Altruism here in all cases contributes to a sort of "averaging" of marginal valuations across household members, when such valuations are expressed by one of them. A condition is that individual 1 must know individual 2's preferences for the public good, and appropriately take these known preferences into consideration in the elicitation procedure.

When both or either of $\alpha_i \in (0,1)$, R(2) = 1 if and only if z_1'(P) = z_2'(P), in the same way as under no altruism in section 2 above. Comparing R(2) to R(1) reveals that the ratio of WTP_1(H) to WTP(C) is closer to unity in the current case, which is clear also from Proposition 4. In the special limit case of "complete altruism", $\alpha_1 = \alpha_2 \to 1$, R(2) $\to$ 1 regardless of z_1'(P) and z_2'(P). In this case the individual value of the public good is simply the average value for the two household members, which is the correct value measure in this case, irrespective also of n and thus the bargaining parameters β and 1-β.

These results differ fundamentally from results found in related papers by Jones-Lee (1992) and Quiggin (1998). In these papers, altruism within the family is claimed to increase individual expressed WTP for public goods. Here we show that this is not the case under pure altruism. Individual expressed WTP can increase or decrease, depending on whether the other individual's marginal WTP for the public good is lower or higher than that of the individual surveyed, but is "on average" unaltered.

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against a scheme whereby all are required to pay the same given amount.

4. Paternalistic altruism with respect to the public good

We now consider "paternalistic" altruism, where the utility of each member depends on the other member's consumption of the public good but no other goods. This can be relevant in many contexts. For instance, when the public good is a cultural or educational good, members may care about each other's "cultivation" or education level, as in the case of public libraries contributing to greater reading skills and other intellectual abilities. When P is health or environmental services, members may care about each others' health status and longevity, affected by the good supply. This may reflect the idea that the underlying motivation for the "altruistic" member is at least in part selfish.[15] Now the utility of member 1 can be expressed as

$$(31) \qquad U_1 = u_1(C_1) + v_1(H) + z_1(P) + \alpha_1 z_2(P),$$

and with footscripts switched for the other member.[16] The intrafamily allocation of resources is unaltered by such altruism given that payments for the public good do not change. Thus (5)-(7) and (8)-(9) still hold to describe this allocation. Member 1's WTP on behalf of the household is now given by

[15] We are ignoring possible selfishly motivated altruism related to either personal or household goods. For the household good, such an effect could be present if increased consumption of certain common household items develops preferences that are more similar among family members, or improves the other person's health status or longevity (as could be the case with a better dwelling, located in a safer and cleaner place, or better prepared common meals). For purely private goods one might picture opposite paternalism where one member prefers the other member to consume less of particular goods (as when the other member overeats, drinks or smokes, or spends parts of his or her spare time on a preferred, possibly hazardous, activity, such as motor cycling or parachuting).

[16] Note that (29) implies that it is the other member's utility of public-good consumption (and thus not the consumption level itself) which enters the first member's utility function. This is a simplification

(32) $$WTP_1(H) = -\frac{dH}{dP}(U_1 = const.) = \frac{z_1'(P) + \alpha_1 z_2(P)}{v\ '(H)},$$

and correspondingly (with opposite subscripts) for member 2. The aggregate household WTP, taking the sum of purely individual payments (in terms of the respective private goods), is now given by (22), as under pure altruism in section 3. This permits us to draw the following conclusion:

Proposition 4: *Assume that each household member has mutual but incomplete paternalistic altruism with respect to the opposite member's consumption of the public good. Then household WTP for the public good is increased, in terms of both the household and the private goods, and more so for higher degrees of altruism.*

This follows from the fact that $WTP_1(H)$ now is greater than in previous cases, and that $WTP^1(C) > WTP(C)$. The ratio $WTP_1(H)$ to $WTP^1(C)$, denoted R(3), given by

(33) $$R(3) = \frac{WTP_1(H)}{WTP^1(C)} = \frac{(1+n)(z_1'(P) + \alpha_1 z_2'(P))}{z_1'(P) + \alpha_1 z_2'(P) + n(z_2'(P) + \alpha_2 z_1'(P))}.$$

We now see from (33), that the ratio of member 1's WTP for the public good on behalf of the household, to true aggregate household WTP, equals unity in a special case where

(34) $$(1-\alpha_1)z_2'(P) = (1-\alpha_2)z_1'(P).$$

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which can perhaps best be motivated if the utility level $v_i(P)$ represents member i's actual use of the public good, such as his or her use of public-library or health services.

We also demonstrate the following properties of this solution, in appendix A:

a) Whenever $\alpha_1 = \alpha_2 = \alpha$, an increase in α moves R(3) closer to unity whenever $z_1'(P) \neq z_2'(P)$.

b) Whenever $\alpha_1 > 0$, and $\alpha_2 = 0$, R(3) increases uniformly in α_1.

c) Whenever $\alpha_2 > 0$, $\alpha_1 = 0$, R(3) is reduced uniformly in α_2.

A proportional increase in the degree of mutual altruism moves the value ratio R(3) closer to unity, as under pure altruism in the previous section. Here, however, when only the member conducting the valuation on behalf of the household is altruistic, increased altruism always increases that member's valuation on behalf of the household, relative to true aggregate valuation. The opposite happens when the other member only is altruistic, and altruism increases. These cases are intuitively obvious. In case c), increased altruism does not at all change member 1's valuation on behalf of the household, but it increases true aggregate valuation. Thus R(3) must drop.

5. Conclusions

We have studied implications of efficient intrahousehold bargaining and altruism for valuation of public goods, measured by the maximum willingness to pay (WTP) to obtain an extra unit of a given public good. Our main result is that WTP of a household member on behalf of the entire household is then always "on average" equal to the sum of purely private individual WTP levels. This result is independent of altruism among family members as defined in the paper, and otherwise of the shape of the household members' utility functions, as long as these satisfy standard VNM assumptions and are defined over three goods, a purely private good, a common household good, and a pure public good. In the efficient solution, household members have lower marginal values of the common household good, used for tradeoff against the public good "on behalf of the household", than of purely private goods, used in the purely private tradeoffs. The two measures are identical for a given household where one member is surveyed, only when the two members' marginal valuations of the public good (in terms of the household good) are identical. When marginal valuations differ, and preferences are separable in the three goods, member 1's WTP on behalf of the household exceeds (is lower than) the sum of private WTP levels when member 1 has the higher (lower) marginal value of the public good. This result is modified somewhat under preference nonseparability, as the level of supply of the public good then generally affects the intrahousehold bargaining solution, in different ways for different types of nonseparability, implying that individual (but not aggregate) household WTP may differ in more complex ways.

Two cases of altruism, one with pure (nonpaternalistic) altruism, and one with "paternalistic" altruism (with respect to consumption of the public good only), are subsequently considered. Only in the second of these cases is the general valuation of the public good increased by altruism. This corresponds to previous results in the literature, e.g by. Bergstrom (1982), Jones-Lee (1992) and Johansson (1994) in the context of statistical-life valuation. Our novel and important result is that, on average, any one member's WTP on behalf of the household still always equals the sum of purely private WTP levels. In both cases of altruism, however, any one member's valuation on behalf of the household is closer to the sum of individual valuations, the greater the degree of mutual altruism.

Our results have important implications for how to interpret answers to questions about WTP for public goods from CV or similar surveys. Whenever such values are elicited correctly and truthfully, and households generally behave as single welfaremaximizing units as we assume, letting WTP values expressed by an individual household members represent an entire household consisting of several members generally does not pose serious problems of benefit valuation. Such WTP values are always on average correct. Individual valuations are however more correct representations of household valuation the more altruism matters. But on average the degree of altruism here is immaterial.

My results also indicate that care should be taken when attempting to elicit purely private WTP values from individuals belonging to multi-person households. Such purely private values should ideally be assessed in terms of individual-specific consumption goods, which may pose challenges in terms of question framing.

The analysis here points to possible extensions that can be interesting for future analysis. First, further research is required to determine the relevance of the unitary, bargaining and conflict views on household allocation.[17] Secondly, many goods are likely not to be purely private or household goods but instead lie on a more diffuse continuum between these extremes. Thirdly, children have not been modeled explicitly here. Children should here perhaps be interpreted as individuals with low bargaining power, and being subject to considerable altruism (by parents), and otherwise sharing the common household budget. The analysis under either of the two altruism variants considered may then apply. Fourthly, altruism outside of the household may play important roles. Finally, when applying CV or similar techniques, a number of other methodological weaknesses, whose seriousness may depend on the type of WTP question posed, will also be of concern in practice. I intend to address such issues in future research.

[17] For a recent study emphasizing the conflict view, see Anderson and Baland (2002).

Appendix A: Derivations of changes in R(2) and R(3)

I here consider how R(2) and R(3) change as the degree of altruism changes, each in three separate cases, namely a) $\alpha_1 = \alpha_2 = \alpha$ and α changes; b) $\alpha_1 > 0$ and $\alpha_2 = 0$ and α_1 alone changes ; and $\alpha_1 = 0$ and $\alpha_2 > 0$ and α_2 alone changes. Consider first R(2). $dR(2)/d\alpha > 0$ if and only if

(A1) $$[z_1'(P)]^2 < [z_2'(P)]^2 ,$$

which implies that when both members become more altruistic, R(2) increases when $z_2'(P) > z_1'(P)$. In this case R(2) < 1 at the outset, implying that R(2) moves closer to one. Conversely, when R(2) > 1 at the outset, R(2) decreases and also in this case moves closer to 1.

Consider next case b. Then $dR(2)/d\alpha_1 >$ if and only if

(A2) $$(z_1'(P))^2 < \frac{(2\alpha_1 + n)z_1'(P) + \alpha_1(\alpha_1 + n)z_2'(P)}{2\alpha_1 + n + \alpha_1(\alpha_1 + n)} z_2'(P).$$

(A2) holds whenever $z_1'(P) < z_2'(P)$. Thus when member 1 has a higher value of the public good than member 2, a more altruistic member 1 implies that R(2) is always reduced. Since R(2) > 1 at the outset in this case, it implies that R(2) moves in the direction of unity in this case. In the opposite case, $z_1'(P) < z_2'(P)$, R(2) < 1 at the outset, and is increased by greater degree of altruism. Thus more altruism also here leads to convergence toward a solution where the two measures are the same.

Consider next case c. Now again $dR(2)/d\alpha_2 > 0$ if and only if $z_2'(P) > z_1'(P)$, implying that $R(2) < 1$ at the outset. Thus also now we obtain convergence.

Consider next the case of paternalistic altruism, with the corresponding ratio R(3). In case a, an increase in α implies that R(3) increases if and only if

$$\text{(A3)} \qquad \begin{aligned} &(1+\alpha)(1-n)z_1'(P)\left[z_1'(P)-z_2'(P)\right] \\ &< (\alpha+n(1-\alpha)(z_1'(P)+z_2'(P))\left[z_1'(P)-z_2'(P)\right]. \end{aligned}$$

Consider here first the case of $z_1'(P) > z_2'(P)$. Then the condition for (A3) to hold can be expressed as follows:

$$\text{(A4)} \qquad z_1'(P) < -z_2'(P)(\alpha+n(1-\alpha)).$$

Condition (A4) can never hold, thus R(3) can never increase, but must always decrease, with greater altruism given that $z_1'(P) > z_2'(P)$.

Consider next the opposite case, $z_1'(P) < z_2'(P)$. We now find that (A3) holds if and only if

$$\text{(A5)} \qquad -z_1'(P) < z_2'(P)(\alpha+n(1-\alpha)),$$

i.e., always whenever $z_1'(P) < z_2'(P)$, which is just the case considered. Note also that when $z_1'(P) > z_2'(P)$, $R(3) > 1$, while when $z_1'(P) < z_2'(P)$, $R(3) < 1$. This implies that R(3) always moves closer to unity, either in the upward or downward direction, when α is increased.

In case b we here find that $dR(3)/d\alpha_1 > 0$ if and only if

$$\text{(A6)} \qquad nz_2'(P) > 0.$$

(A6) always holds as long as $n > 0$ and $z_2'(P)$, i.e., member 2 has both positive bargaining power and positive valuation of the public good. It is clear that when $z_2'(P) = 0$, paternalistic altruism here does not matter. It is also clear that when $n = 0$, household member 1 is always dictatorial and $R(3) = 1$ always. In other cases, $R(3) > 1$, and $R(3)$ increases in α_1. Intuitively, both $WTP_1(H)$ and $WTP^1(C)$ increase in α_1, but $WTP_1(H)$ by relatively more whenever member 2 has some bargaining power.

Consider finally case c, where $\alpha_1 = 0$ and $\alpha_2 > 0$. Then an increase in the degree of altruism by person 2 now reduces $R(3)$ if and only if

$$\text{(A7)} \qquad nz_1'(P) > 0.$$

Thus generally, $R(3)$ is always reduced in this case. Intuitively, a higher degree of altruism, partially for person 2, now increases $WTP^1(C)$, while $WTP_1(H)$ is unaffected.

Appendix B: More general preference relationship

I will now consider the main implications of more general preference relationships for the two household members, over the goods C, H and P, in the case of no altruism. Assume that

(B1) $U_i = U_i(C_i, H, P), \quad i = 1,2,$

where U_i is a standard (vNM) utility function, assumed strictly concave in C_i, H and P, and may generally differ between the two individuals. The Nash bargaining solution now has the same basic setup as before- The Nash maximands entering into the bargaining solution can here be specified as $N_i = U_i(C_i, H, P) – U_i(0, 0, P)$, i = 1,2, and the solutions corresponding to (8)-(9) are:

(B2)-(B3) $$\frac{1}{1+n}u_{1C}'(C_1,H,P) = \frac{n}{1+n}u_{2C}'(C_2,H,P) = u_H'(C_1,H,P).$$

Again the u_H are normalized to be identical at equilibrium. Simplify also by setting cross second derivatives with respect to C_i and H, u_{iCH}, equal to zero; other cases complicate without yielding further significant insights. The main new issue is how a change in P changes the bargaining solution and thus the equilibrium distribution of consumption between the two spouses. This in turn affects individual WTP for a changed supply of P. In principle such an effect could arise for two different reasons. First, relative inside bargaining positions of the two members could be affected. Secondly, outside options could be affected. Here we focus on the former effect. This implies an assumption (as above) that outside options are not exercised at equilibrium and that the inside utility level is always higher than the outside option level (e.g. from breaking up a marriage).

Consider now the effects of an increase in P on C_1, C_2 and H from changes in the bargaining solutions (B2)-(B3). Since such an increase in P leaves R constant, dH = -

dC_1 -dC_2, from (1). Differentiating (B2)-(B3) with respect to C_1, C_2 and H then yields the following approximate solutions:[18]

(B4) $$\frac{dC_1}{dP} = \frac{1}{D}\left[(u_{1HP} - \frac{1}{1+n}u_{1CP})(\frac{n}{1+n}u_{2CC} + u_{2HH}) - (u_{2HP} - \frac{n}{1+n}u_{2CP})u_{1HH}\right]$$

(B5) $$\frac{dC_2}{dP} = \frac{1}{D}\left[-(u_{1HP} - \frac{1}{1+n}u_{1CP})u_{2HH} + (u_{2HP} - \frac{n}{1+n}u_{2CP})(\frac{1}{1+n}u_{1CC} + u_{1HH})\right]$$

(B6) $$\frac{dH}{dP} = \frac{1}{D}\left[(\frac{1}{1+n}u_{1CP} - u_{1HP})\frac{n}{1+n}u_{2CC} + (\frac{n}{1+n}u_{2CP} - u_{2HP})\frac{1}{1+n}u_{1CC}\right],$$

where

(B7) $$D = \left(\frac{1}{1+n}u_{1CC} + u_{1HH}\right)\left(\frac{n}{1+n}u_{2CC} + u_{2HH}\right) - u_{1HH}u_{2HH}$$

is a positive determinant. While this solution appears rather complicated in general, we may illustrate its main properties by considering two relevant special cases.

<u>Case I: $u_{1CP} \neq 0$, $u_{2CP} = u_{iHP} = 0$, i = 1,2.</u> Here the supply of the public good affects the marginal utility of private consumption for household member 1 but no other marginal utilities. In this case, (B4)-(B6) simplify to

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[18] These solutions are not exact since n, and thus the "effective bargaining parameters" 1/(1+n) and n/(1+n), are also generally affected, while in these calculations I take n to be a constant. The qualitative effects will however be correct. The reason is that the adjustments of the N_i and the respective effective bargaining parameters go in opposite directions. Thus when e.g. member 1's net utility N_i goes up in the new solution, ceteris paribus, his or her relative bargaining strength is reduced somewhat to eliminate part of this increase.

(B8) $$\frac{dC_1}{dP} = \frac{1}{D}\left[-\frac{1}{1+n}u_{1CP}(\frac{n}{1+n}u_{2CC} + u_{2HH})\right]$$

(B9) $$\frac{dC_2}{dP} = \frac{1}{D}\frac{1}{1+n}u_{1CP}u_{2HH}$$

(B10) $$\frac{dH}{dP} = \frac{1}{D}\frac{n}{(1+n)^2}u_{1CP}u_{2CC.}$$

Consider $u_{1CP} > 0$, whereby an increase in the supply of P raises the marginal utility of the private good for member 1 only. This leads to higher private consumption for member 1, and to lower common household consumption and private consumption for person 2. The utility change for member i when P is increased can be expressed as

(B11) $$\frac{dU_i}{dP} = u_{iC}\frac{dC_i}{dP} + u_H\frac{dH}{dP} + u_{iP}, i = 1,2.$$

In the case considered here, the sum of the two first terms is positive for member 1 and negative for member 2. Consequently, member 1 is willing to pay more for the increase in P, than what appears from the analysis in section 2 above.

Intuitively, the increase in marginal utility of private consumption for member 1 makes it efficient for the household to also increase member 1's private consumption (in order to fulfil the efficiency conditions (B2)-(B3)). As a more concrete example, consider the case where spouse 1 only is a potentially eager golfer, and the increase in P is the building of a public golf course nearby, making golf a new option. This raises the marginal utility of private consumption for the golfing spouse, leading the household to allocate more of the common resources to this spouse's golfing hobby. (Thus in this particular case, spouse 1's increase in utility due to a higher P is greater than that of spouse 2 for two separate reasons: first, because the direct utility effect, u_{1P}, is much higher, but also because the indirect effect via the household bargaining solution is positive.) Examples where the marginal utility of private consumption is lowered when P is increased are perhaps easier to find. Assume that spouse 1 has a medical problem that requires private treatment in the absence of a publicly available treatment, and assume that the increase in P implies that such a public treatment becomes available. Then spouse 1's marginal utility of private consumption is lowered, implying that the household is willing allocate less of its common resources to such costs for spouse 1. This implies that the overall utility change, and WTP, for spouse 1 is smaller than that found in section 2 (in the concrete example, though, the total utility effect of the change in P may still be much higher for spouse 1, which after all has the benefit of the treatment; the main overall positive effect for spouse 2 may be that private and household consumption are raised).

Case II: $u_{1HP} \neq 0$, $u_{iCP} = u_{2HP} = 0$, $i = 1,2$. Here an increase in P affects the marginal utility of H, for spouse 1 only. The effects on consumption are now

(B12) $$\frac{dC_1}{dP} = \frac{1}{D} u_{1HP} \left(\frac{n}{1+n} u_{2CC} + u_{2HH} \right)$$

(B13) $$\frac{dC_2}{dP} = -\frac{1}{D} u_{1HP} u_{2HH}$$

(B14) $$\frac{dH}{dP} = -\frac{1}{D}\frac{n}{1+n}u_{1HP}u_{2CC}.$$

Here a positive u_{1HP} reduces C_1, and increases C_2 and H. Overall utility of private and household consumption is now reduced for member 1, and increased for member 2. This is opposite of what was found in case I. Here, when the marginal utility of common household consumption is increased for member 1, the marginal utility of private consumption should also be raised for that individual. This in turn implies that overall private consumption must fall for that individual. (Private consumption will be raised for the other individual, since H is raised and (B2)-(B3) must still hold.)

For a concrete example here, assume that only spouse 1 suffers due to poor air quality, and that the increase in P takes the form of better air quality which reduces spouse 1's utility from having an expensive house location (in an expensive neighborhood with low pollution levels to start with). The Nash bargaining solution then dictates that H be lowered (the couple now moves to a less expensive location), and private consumption for spouse 1 increased (in order to bring the marginal utility of C_1 down, in line with the reduction in the marginal utility of H for spouse 1). Then spouse 1's utility, and thus WTP for the increase in P, are raised by these consumption reallocations. Opposite, consider a case where spouse 1's utility from using a common car for the household increases when P increases (as when P is the opening of a new public park or adult educational facility, which requires this spouse to travel by car for its use). The marginal utility of personal income for spouse 1 should then also increase, and C_1 decrease.

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