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A Theoretical Model Predicting the WTA-WTP Disparity: Public Policy Implications

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Abstract

A robust finding in economics is that decision-makers often exhibit a much smaller dollar willingness to pay (WTP) for an item than the minimum amount that they claim to be willing to accept (WTA) to part with it. The spread between these two numbers is particularly large for public goods, raising serious public policy concerns regarding which number, if either, is appropriate for valuing such goods. A number of explanations for this phenomenon have been advanced, each perhaps of relevance in particular settings, with little consensus being achieved as to whether any explanation satisfactorily resolves the problem. A traditional utility maximizing model is presented here that predicts that WTA will exceed WTP, quite plausibly by a substantial amount. Moreover, WTA, and not WTP, as the latter is traditionally measured, is seen to be appropriate for use in public policy decisions about increases in the supply of public goods. The central argument stems from a failure to properly value public goods by traditional methods. Since individuals cannot individually purchase public goods by generating income, they will under-generate any income that would have been devoted to public goods. The marginal WTP observed for such goods will, as a consequence, be understated in economic and survey data relative to true values. Moreover, the striking disparity between WTA and WTP for public goods provides support for the practical importance of economists' failure to properly value public goods.

JEL classification: C91, D12, D81

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1. Introduction

Subjects in experimental analyses of economic behavior frequently display a large discrepancy between the dollar value they are willing to accept in order to sell an item (WTA) and the dollar value they are willing to pay to purchase it (WTP) (see Kahneman et al. 1990). In an important recent review, Horowitz and McConnell (2002a), hereafter HM, survey forty-five studies reporting on a wide variety of goods and document quite large WTA/WTP ratios.¹

The observed gap is sometimes believed to be the result of unsound experiments.² However, HM find that WTA/WTP ratios either are not affected or are actually higher for 1) real versus hypothetical experiments, 2) incentive compatible elicitation, and 3) the general public, rather than student subjects. The high WTA/WTP ratios are not so readily dismissed.

One general explanation relates to the nature of the goods examined, with Hanemann (1991) pointing out (Harless 1989 providing empirical support) that goods lacking good substitutes in consumption may have divergent WTA and WTP values even if income effects are modest. Although this may explain responses for some goods, it does not explain several existing experimental results.³ Moreover, in yet another recent paper, Horowitz and McConnell (2002b) argue that a result from Sugden (1999) implies that WTA/WTP ratios of the magnitudes observed "are not consistent with neoclassical preferences."

Of critical interest here is the principle HM result that, "on average, the less the good is like an 'ordinary market good,' the higher is the ratio." They find the highest WTA/WTP ratios for public and

¹ It would seem that the WTA-WTP gap is a somewhat better formulation (the ratio could be small, but the gap large, in terms of the dollars that would be used in, say, a cost-benefit analysis). However, HM's findings are very likely to be robust to this alternative formulation.

²The presence of this large gap is one of the reasons that many economists are suspicious of survey results in "constructed markets," hence the rational explanation for this disparity presented here might have far-reaching policy implications.

³ For example, studies by Knetsch (1995) and Bateman et al. (1997) demonstrate a WTA-WTP disparity employing experimental designs eliminating the income and substitution effects that drive Hanemann's explanation.

non-market goods, with ordinary private goods and various forms of money having ratios progressively closer to unity. The model presented below predicts the seemingly anomalous large spread between WTA and WTP, hence the large ratios, for public goods.⁴ It should be emphasized, however, that the argument presented here also applies for *new* private goods, as well as public goods.⁵

The WTA-WTP gap may well have a number of potential explanations in particular market and experimental settings. The gap is explained in Section 2, for the important class of public goods, with a variant of a simple traditional utility maximization model. In the model individuals desiring public goods are seen to generate too little income, since generating income would not allow greater consumption of the collectively determined public good. Thus, such individuals appear to have lower than their true marginal values for public goods. Section 3 clarifies the WTA-WTP implications flowing from this (mis)valuation process graphically, while Section 4 concludes the paper, emphasizing the implications for public policy.

2. A Failure to Value Public Goods Properly

The traditional method of determining the proper relative amounts of public goods (see Samuelson 1954) involves aggregating the marginal willingness to pay of all households benefiting from the good and equating that value to the marginal cost of its production. The aggregated marginal WTP is the vertically summed individual marginal WTP's of, in principle, all of those affected by provision of the public good. Were one able additionally to impose a lump sum tax on each affected household in an amount equal to its MWTP times the quantity of the public good, a Pareto superior amount of both

⁴ Other authors have discussed the modeling of the WTA-WTP gap in models not grounded in utility theory, but rather employing an "endowment effect" (see Thaler 1980, Tversky and Kahneman 1991, Huck et al. 1997, with Mackenzie 1997 arguing that alternative explanations are plausible). One interesting approach is that of include Boyce, et al. (1992) who offer an explanation of the WTA-WTP gap (or endowment effect) that involves the moral responsibility that accompanies ownership in some settings. The WTA was found to be much larger for the sale of a Norfolk pine seedling if the seller believed the plant was going to be destroyed after the sale by the buyer versus neutral beliefs. Also Mueser, Dow, and Graves (2001) provide a rationale for the gap involving value uncertainty, with WTA offers conveying important information that is not revealed by WTP.

⁵ See Romer (1993) on the importance of new goods for the welfare costs of trade restrictions. Graves (2002)

public and private goods would appear to be forthcoming. In practice, demand revelation problems led Samuelson to be pessimistic about arriving at such an optimal public good level because of the wellknown "free rider" problem (for potential solutions to such problems, see Clarke 1971 and Groves and Ledyard 1977).

However, the Samuelson condition for social optimality has a flaw that has gone unrecognized until quite recently (see Flores and Graves 2002 and Graves 2001, the former providing the more technical presentation). The income level, taken as given in the argument leading up to the marginal conditions, is of critical importance, for at the heart of economics is the presumption that we work to get the things we want. Apart from philanthropy or theft, we can only consume the goods and services that we desire through the supply of our labor and other inputs into the production process. The proper supply of work effort will occur for ordinary private goods; we work up to the point where the marginal value of goods is equal to the marginal value of the foregone leisure associated with their acquisition.⁶

To the extent that we value public goods, however, we also realize that getting extra income to buy them will accomplish nothing, for they are determined collectively and our private decision to generate income to buy them will have a negligible impact on that decision. There is no ordinary market in which we can buy, say, reduced global CO_2 levels or endangered species preservation, and even if the output market demand revelation problem were solved, we still lack individual incentive to properly generate income. This follows from the fact that the supply of labor to get the public good is costly, yet yields no benefits to the supplier. Hence, the income that *would* have been generated if we could buy public goods like we can private goods does not get generated. In other words, even in a

describes the important relative role of technological advance for existing versus new goods to endogenous growth.

⁶Indeed, the point is more general in that any decision involving additional income (e.g. schooling or training) involves the implicit comparison of marginal benefits of expected future goods gained to the costs of the training. The focus here, for simplicity only, is on short-run work-leisure decisions.

perfect public good *output* demand revelation setting, we remain in a 2nd best world, because people will fail to optimally generate the income that would have gone toward public good purchases.

Perhaps ironically, in a world of heterogeneous preferences, the more important public goods are, relative to private goods, in one's preferences, the lower will be the observed income. And, as a consequence, marginal WTP for public goods will *appear* lower than it really is to those (public policy decision-makers and economists in their employ) attempting to ascertain the marginal values for such goods. Consumers desiring private goods will generate the income to buy the many things they desire. Those rational individuals, however, who care a lot about the environment or any other public good will generate very little income because they are unable to get what they want, on the margin, regardless of income generated. Hence such individuals will substitute toward leisure (and ordinary goods) which they *can* affect, until the marginal value of leisure is equated to their (fairly low) marginal valuations of ordinary private goods.⁷

3. Visualizing the Public Goods Misevaluation and the WTA-WTP Gap

The preceding discussion presumes a three good world, comprised of ordinary private goods (AOG, Marshallian income), public goods (G), and leisure (L). Two-dimensional graphs are, however, generally much easier to draw and understand than are three-dimensional graphs. But, in the present context one must be cautious. In the usual economic principles presentation of production possibility frontiers, leisure is implicitly optimized out of the problem when looking at the optimal quantities of two goods (see Figure 1). That is, when we draw the production possibilities curve, it is predicated on optimal quantities of leisure, hence work effort. If the labor force of a nation were forced to work twenty-five percent more, its citizens would select a larger amount of both goods in general, but that

⁷They may also pursue less remunerative occupations (e.g. working with environmental groups and the like) that offer an alternative means of impacting provision of public goods. Note that decision-makers *will* generate the income to purchase private good substitutes for the public goods they desire, suburbanization being of particular importance (see Graves 2002).

would make them worse off, as seen at U*(too much work) in Figure 1. Similarly, if the labor force is required to work twenty-five percent less, the citizens would select smaller amounts of both goods, as seen at U*(too little work) in Figure 1. We are only able to argue that the correct amounts of the two goods are being produced and consumed if we have the optimal levels of leisure, at U** in Figure 1— all other potential production possibility frontiers result in combinations of the two goods that are sub-optimal.

Now consider Figure 2, a substantially more complicated appearing diagram.⁸ The solid lines represent the production frontier and optimal quantities of ordinary goods, AOG^{**} , and public goods, G^{**} , when we have the optimal levels of leisure (L**, not shown in the diagram). However, *actual* levels of leisure will fall sort of L** due to the fact that rational individuals will not work to generate the income to buy the public goods they want when doing so will not allow them to acquire more. They will free ride in input markets, as discussed earlier. Thus, as with the situation at U*(too little work) in Figure 1, we will be on a non-optimal production possibility frontier, as shown in the extreme case of maximal free riding by the dashed line production possibility frontier in Figure 2.

But, there is a slight twist to the argument. In Figure 1, we have the usual indifference mapping drawn where utility rises until we hit U^{**} at which point utility would fall if people were forced to produce more goods, given tastes and technology. Figure 2 recognizes that there are two sets of indifference mappings, a true set and an apparent set. One mapping ("Regime 1") occurs when there is no free riding in input markets and the true marginal rate of substitution between AOG and G is observed. Representative indifference curves from this set are shown as U_0^{**} , U_1^{**} , and U^{**} . Were citizens forced in Regime 1 to reduce their labor supply, as was discussed in the context of

⁸ I am indebted to Don Fullerton for pointing out that this diagram is in fact more complicated than it seemed to me, hence requiring fuller explanation.

Figure 1, there would be some new, but sub-optimal, tangency of an indifference curve from this set with the corresponding production possibility frontier.⁹

But, economists do not observe either true preferences or the proper production possibility frontier. In a rational world (but one initially without any government public goods provision) we would observe actual production at AOG_{max} and G = 0, that is, where the dashed production possibility frontier intersects the vertical axis in Figure 2. Such a situation would not persist, because the level of utility with true (Regime 1) preferences would be quite low—citizens would clamor for collective action in providing for the public good. Hence, government would begin supplying the public good, but how much should they supply?

This brings us to Regime 2. As government begins supplying the public good, labor supply will be increased to pay the necessary taxes, and utility will increase as resources are reallocated to provide positive amounts of the public good. But, how do we decide when to stop increasing the public good from zero? Samuelson argued that we should continue to supply the public good until aggregated marginal willingness to pay equals the marginal cost of provision. But, this is flawed as discussed earlier, because we continue to have free riding in input markets, apart from labor supply increases required to pay the higher taxes associated with any existing G provision level. Hence income will be too low at the apparent Samuelson optimum. The seemingly optimal level of satisfaction, *as seen by the economic analyst*, is depicted by the dashed indifference curve in Figure 2 labeled U*. This Regime 2 indifference curve understates the true marginal rate of substitution between ordinary goods and the public good. The true marginal rate of substitution (shown along U_0^{**}) between private and public goods is not being observed at G* in Figure 2, because people are working only enough to pay the taxes for the sub-optimal G provision level.

⁹Note that the production possibility frontier associated with forced labor reductions under the regime in which free riding does not occur is not that depicted in Figure 2. Forced labor reductions without free riding would result in balanced reductions in AOG and G, while free riding only results in reductions in the labor that would have been used to

The implications for the WTA-WTP gap may readily be seen with reference to Figure 2. In the figure G* represents the traditionally defined optimum level of public goods provision, at which the *apparent* marginal rate of transformation between "all other goods" (AOG) and the public good, G, just equals the *apparent* marginal rate of substitution between those goods, along U*.¹⁰

Reiterating, the "apparent" qualifiers in the preceding sentence result from the input market failure discussed in Section 2. First, being unable to acquire desired public goods by individually generating income results in an apparent production possibilities frontier that is shifted horizontally to the left of the true production possibility frontier, were that not the case.¹¹ And, having not generated that income to spend on the public good results in the false appearance that G is relatively unimportant vis-à-vis ordinary goods, U* appearing to be flatter than the true marginal rate of substitution between AOG and G.

Suppose that a public policy decision-maker is contemplating an increase in G, from G* to G* +) G, as depicted on the horizontal axis of Figure 2. The apparent WTP for this increment to the public good is A-B. But the true WTP is A-C, holding utility constant.¹² Moreover, the WTA of a return from G* +) G to the original G* is D-B; either D-B or A-C are larger than the improperly measured WTP of A-B.

Two central observations emerge from Figure 2. First, traditionally measured WTP is much lower than the actual WTP; indeed, giving up that small amount of AOG to obtain the incremental quantity of G results in an increase in utility, as seen in the difference between U_0^{**} and U_1^{**} . Hence, the true WTP is much closer to the WTA than the apparent WTP. This explains the large WTA-WTP

finance the public good.

¹⁰ It is likely that G is actually being provided at levels substantially below the Samuelson optimum; this will not materially affect the discussion of the text.

¹¹ One could argue that it is more appropriate to refer to the initial situation as merely being a point within the true production possibility curve, the solid PPF in the figure. But the "apparent" curves (dashed) are what is actually being observed and recognizing that explicitly provides better intuition.

¹² Note that paying for the public good with a tax set equal to marginal willingness to pay will result in the optimal

gaps (or large WTA/WTP ratios) in the literature. The large WTA/WTP ratios for public goods stem from having mis-measured WTP, because input market failures result in income not being generated and spent on public goods.¹³ Second, it is clear from the figure that it is the traditionally defined WTA that is closest to the *true* but unobserved WTP. Thus, the appropriate values to use in policy analysis of public goods provision are the much larger WTA numbers.

4. The WTA-WTP Gap: Conclusion and Public Policy Implications

The model presented here predicts the many empirical findings of a large gap for public goods between WTA and WTP. The analysis does not, of course, disprove the existence of other supplementary explanations for a gap between WTA and WTP. However, the implications of the model are derived from a conventional economic individual optimization framework, combined with market failures of traditional sorts. Those with a predilection for resolving anomalous WTA-WTP behavior within a traditional economic expected utility framework might find the present approach preferable as a starting point, invoking other explanations only as necessary in particular market or experimental settings.

The public policy implications of the findings here are pronounced. Reiterating, Graves 2001 and Flores and Graves 2002 provide an argument, briefly sketched here, that public goods will be under-provided if the traditional mechanism (vertical aggregation of WTP at an initial income level) is used to determine the optimal quantities to supply. It should be emphasized that *small* percentage changes in generated income lead to very large percentage changes in public goods provision, since the

generation of more income, as the value of leisure is re-equated to the marginal values of goods of both types.

¹³ As discussed in Graves 2002, the introduction of attractive *new* (previously unavailable) private goods will also result in an increase in the desired income since the purchase of the new good will increase the marginal utility of the (smaller) optimal quantities of the originally consumed goods. Thus, at the new optimum there will be a small optimal quantity of leisure purchased; households will work more. Note further that, if all technological progress merely involved lower costs for existing goods, one would expect steady decreases over time in work effort, as the marginal value of leisure is equated to every lower marginal values associated with the ever-larger quantities of those goods. That hours of work have stayed relatively constant for a number of decades in the US attests to the importance of new ordinary goods and public goods. In the present context, individuals in experiments (e.g. the Norfolk pines of Boyce et al.) involving ordinary private goods that they had previously not experienced by the subjects would be expected to exhibit higher WTA/WTP

latter is calculated on a much smaller base. For example, suppose that entirely eliminating free riding in input markets would result in a mere one percent increase in generated income to provide higher quality air or water. That one percent represents \$100 billion dollars with a \$10 trillion GDP. But that sum would represent a roughly *twenty-five* percent increase in the roughly \$400 billion currently spent on air and water quality.

Hence, the substantial under-provision of public goods (and work effort to pay for them) is shown here to provide an explanation for the large measured WTA/WTP ratios for public goods. Indeed, WTP, as traditionally measured, is found to be an incorrect proxy for the true marginal value of an increment to a public good. Rather, the WTA as usually measured provides a better proxy for *actual* WTP (allowing for endogenous labor supply) for an increment to the public good. Conversely, the observed large WTA/WTP ratios for such goods in the literature would seem to imply that the public goods mis-valuation discussed in the cited papers is important as a practical matter.

ratios than would be the case for more familiar goods.

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