THE SIMPLE ANALYTICS OF THE WTA-WTP DISPARITY

FOR PUBLIC GOODS*

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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 more 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 likelihood that economists' systematically undervalue public goods.

I. Introduction

As discussed by Kahneman et al. (1990), 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). In a recent review, Horowitz and McConnell (2002a) surveyed forty-five studies reporting on a variety of goods and documented quite large WTA/WTP ratios.[1]

The observed gap is sometimes believed to be the result of unsound experiments.[2] However, Horowitz and McConnell found 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, although Plott and Zeiler (1997) argue that the ratios stem from incorrect interpretation of the evidence (these authors, however, employ private good experiments in their critique which is seen to be critical below).

How can we understand such large WTA/WTP ratios? The WTA-WTP gap may well have a number of potential explanations in particular market and experimental settings. One utility-based explanation relates to the nature of the goods examined, with Hanemann (1991) pointing out that goods lacking good substitutes in consumption may have divergent WTA and WTP values even if income effects are modest. Harless (1989) provides empirical support for Hanemann's argument. Although this may explain responses for some goods, it does not explain several existing experimental results.[3] Moreover, 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."

Other potential explanations are not grounded in traditional economic theory. Kahneman et al. and others (see Thaler 1980, Tversky and Kahneman 1991, Huck et al. 1997, with Mackenzie 1997

arguing that alternative explanations are plausible) have explained the WTA-WTP gap in models employing an "endowment effect." Boyce, et al. (1992) offer an explanation of the WTA-WTP gap (or endowment effect) involving 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. In addition, 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 (essentially, if it is worth more to others, perhaps it *should* be worth more to me).

Of critical interest here is a principle result of Horowitz and McConnell 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 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. Moreover, the argument presented here also applies for new or unfamiliar private goods and any non-individually incrementable collectively-provided goods.[4]

The WTA-WTP gap is informally explained in Section II, for public goods for which the gap is largest, with a variant of a simple traditional utility maximization model. Individuals desiring public goods will generate too little income, since generating income does not allow increments to the consumption of the collectively determined public good. Thus, individuals will appear to have lower than their true marginal values for public goods. Section III clarifies the WTA-WTP implications flowing from this (mis)valuation process graphically, while Section IV concludes the paper, emphasizing that policy-makers are currently underproviding environmental and other public goods.

II. 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 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 marginal WTP times the quantity of the public good, a Pareto superior amount of both public and private goods would appear to be forthcoming. In practice, demand revelation problems led Samuelson to be pessimistic about arriving at optimal public good levels because of the well-known "free rider" problem in output markets.[5]

However, the traditional understanding of Samuelson's condition for social optimality has two flaws that have gone unrecognized until quite recently. One flaw, addressed formally in Flores and Graves 2008, is that income is treated as given in benefit-cost analysis, when it is in fact endogenous. Optimally chosen leisure would generally decrease, with increasing labor supply leading to more income generation at higher levels of public good provision. Flores and Graves show that WTP with endogenous income is greater than WTP with fixed income, while WTA with fixed income is larger than WTA with endogenous income generation. This partially explains the large WTA/WTP ratios found by Horowitz and McConnell.

However, the second flaw, a different point relating to income generation, is likely to be more critical (see Graves 2009, in press). 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 post-tax 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. Even if the *output* market demand revelation problem were solved (which will generally be presumed in what follows), individuals still lack an incentive to properly generate income in *input* markets. Hence, the income that *would* have been generated, if we could buy public goods like we can private goods, is not generated. In other words, even in a perfect public good output demand revelation setting, we remain in a 2nd best world, because people will fail to optimally generate any 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. Thus, passionate environmentalists, with few demands for ordinary goods, effectively "drop out," exhibiting little willingness to pay for *anything*, despite having high marginal values for public goods they cannot individually acquire. Even with homogeneous preferences, however, marginal WTP for public goods will appear to be lower than it really is to those—public decision-makers and economists in their employ—attempting to ascertain the marginal values for such goods.

Reiterating, consumers of private goods will generate the income to buy the many things they desire, and those desires are observed in the market. Rational individuals, however, who care about

environmental or other public goods will have unobserved desires, since they have incentives to free ride in input markets. Such individuals will substitute toward leisure (and ordinary goods) which they *can* affect, until they equate the marginal value of leisure to their (low) marginal valuations of ordinary private goods.[7]

III. Visualizing the Public Goods Misvaluation and the WTA-WTP Gap

Two-dimensional graphs are 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 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 frontier projections in two-space correspond to non-optimal amounts of leisure on the omitted dimension.

The discussion of Section II presumed a three-good world comprised of ordinary private goods (AOG, Marshallian income), public goods (G), and leisure (L). Figure 2 depicts this case. The underlying bowl-shaped indifference curves are not displayed in the figure to minimize clutter (for purposes of reference, imagine three-good Cobb-Douglas preferences). The optimum optimorum of Samuelson is shown at point (AOG**, G**, L**). At this point—and at this point only—the

traditional vertical aggregation of individual marginal WTPs accurately captures the marginal value of increments to the public good, setting that total equal to marginal opportunity cost. At any other leisure level, there will be a different aggregated marginal value. Moreover, a path dependence exists that implies that we will *always* be under-providing the public good, due to the free riding in input markets discussed in Section II.

To clarify further, consider the public good, G in Figure 2, to be broadly defined environmental quality. The initial process of economic development involves provision of the private goods that are critical to survival. As income grows, and the marginal values of ordinary private goods fall relative to environmental quality, there will be political pressure to begin providing environmental quality. Initially, the political institutions to do so will be lacking, and we will be at $G = 0$ in Figure 2, consuming L_0 of leisure and AOG_0 of ordinary private goods. At this corner solution, the level of satisfaction (not shown in the figure) might be relatively low vis-a-vis a consumption bundle with increments to the public good. Consequently, institutions will emerge that allow direct governmental provision of environmental goods (e.g. municipal waste treatment plants) or indirect provision (e.g. required catalytic converters on automobiles). But how much environmental quality should government provide?

As government provision of the good is increased from zero, households *will* generate the income to pay the higher taxes or prices associated with increments to the public good. Hence optimal leisure will fall and the production possibility frontier shifts outward in two-space, but there will be remaining free riding behavior in input markets. Therefore, a best case scenario—solving the demand revelation problem—would result in an apparent optimum at (AOG^*, G^*, L^*), yielding U^* level of satisfaction in Figure 2. At this point, the traditional Samuelsonian optimum would appear to exist,

since the apparent aggregated marginal WTP's would equal marginal opportunity cost. However, we remain at a suboptimal leisure level, because of the input market failure, hence fall short of Samuelson's true optimum optimorum at U**.

The bold arc on the three-dimensional production possibility surface represents, then, the *infinite* number of possible apparent Samuelson optima, each associated with a different level of leisure. With complete free-riding we would be at one end of this arc, while with zero free riding we would be at the other end, at the Samuelson optimum optimorum.

Now consider Figure 3, a projection of Figure 2.[8] Following Figure 2, the outermost 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**, in the omitted dimension). However, *actual* levels of leisure will exceed L** as discussed, with income not being generated for unfulfilled public good provision. Thus, as with the situation at U*(too little work) in Figure 1, we will be on a non-optimal production possibility frontier, interior to the optimal one.

The dashed indifference curve of Figure 2 represents the apparent marginal rate of substitution between AOG and G, with free riding in input markets. Suppose that a public policy decision-maker is contemplating an increase in G, from G* to G* + ΔG, as depicted on the horizontal axis of Figure 3. At (A, G*), one of the apparent Samuelson optima, it will look to economic analysts and policy makers that the marginal value of an increment to the public good is A-B. Those apparent benefits will fall short of the apparent costs along the existing sub-optimal production possibility frontier projection.[9] The true marginal value of the increment ΔG in the public good at G* is A-C, holding utility constant. B-C represents the ungenerated income that would have been spent entirely on the public good, apart from general equilibrium effects.[10] Moreover, the WTA of a return from G* + ΔG to the original G* is

D-B; note that either D-B or A-C are larger than the (improperly) measured WTP of A-B.

Two central observations emerge from Figure 3. First, traditionally measured WTP is lower, potentially much lower, than actual WTP. Giving up only A-B of AOG to obtain the incremental quantity ΔG results in an increase in utility, as seen in the difference between U_0^{**} and U_1^{**} (this corresponds to moving down the arc of Figure 2). With normal utility functions, the *true* WTP would be much closer to the WTA than it is to the apparent WTP. This explains the large WTA-WTP 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.[11]

Interestingly, providing increments to the public good would cause the slopes of the dashed line indifference curve family in Figure 3 to become steeper as we move toward the optimum optimorum. That is, the *apparent* marginal rate of substitution between AOG and G (the slope of the dashed line) will get closer and closer to the true marginal rate of substitution as G^{**} is approached from the left. This is because there will be smaller amounts of free riding as households are forced to generate the income to pay the higher taxes or higher prices associated with higher levels of the public good. At G^{**} the apparent and true indifference curves would coincide, and free riding would be eliminated. Hence, at any of the infinite number of apparent Samuelson optima short of the optimum optimorum, the WTA/WTP ratio will be larger than is the case for private goods. Upon arrival at G^{**}, however, the much higher WTA/WTP ratios currently observed in the literature for public goods vis-à-vis private goods would disappear, concomitant with the elimination of input market free riding at that point.

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

The analysis here predicts the many empirical findings of a large gap between WTA and WTP,

or a high WTA/WTP ratio, for public goods. The analysis does not invalidate, of course, the existence

of the other supplementary explanations, mentioned at the outset, 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, invoking other explanations only as necessary

in particular market or experimental settings.

The public policy implications of the findings here are pronounced. Public goods will generally

be under-provided if the traditional mechanism (vertical aggregation of WTP at initial income levels) is

used to value increments. Moreover, it should be emphasized that *small* percentage changes in

generated income lead to very large percentage changes in public goods provision, since the latter is

calculated on a much smaller base. For example, suppose that eliminating free riding in input markets

would result in just a one percent increase in generated income to provide wide-ranging improvements

in environmental quality. That one percent represents $140 billion dollars with a $14 trillion GDP.

Freeman (2002, p. 126) argues that the costs of *all* major environmental laws enacted since Earth Day

in 1970 were $225 billion in 2000, perhaps $280 billion in current dollars. Hence, that $140 billion of

ungenerated income would represent about a *fifty* percent increase in the amount currently spent

annually on environmental quality in the U.S.[12] Rising marginal provision costs would result in

smaller optimal increases in environmental quality, as would general equilibrium considerations (the

marginal value of environmental quality would fall relative to ordinary private goods as more is

acquired)

Input market failures leading to a 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. WTP, as traditionally measured, is an incorrect proxy for the true marginal value of an increment to a public good. Rather, the WTA as usually measured is likely to provide 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 Section II is important as a practical matter.

The very large WTA/WTP ratios for public goods, relative to private goods, suggest that we are far from the true optimum optimorum. There are an infinite number of apparent Samuelson optima, since there is a continuum from complete input market free riding at zero public goods provision to zero free riding at the true optimum. A likely policy implication is, then, that public goods should be incremented until the WTA/WTP ratios fall to those observed for ordinary private goods, falling from perhaps ten or twenty to one currently, to something a bit greater than one. It is likely that following such a procedure might involve substantial changes in how resources are allocated in high-income countries.

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[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 benefit-cost analysis). However, Horowitz and McConnell's findings would certainly be robust to this alternative formulation.

[2] The presence of this large gap is one of the reasons that many economists are suspicious of survey results in "constructed markets." The rational explanation for this disparity presented here supports those lines of experimental work (as do Arrow et al. 1993.

[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.

[4] See Romer (1993) who demonstrates the importance of new goods for the welfare costs of trade restrictions. Graves (2002) describes an important relative role of technological advance for existing versus new goods for endogenous growth models.

[5] For potential solutions to such problems, see Clarke (1971) and Groves and Ledyard (1977). There are, however, many other reasons to expect underprovision in the environmental setting (see Graves 2007 for extensive details).

[6] Indeed, 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.

[7] They may also pursue less remunerative occupations (e.g. working with environmental groups and the like) that offer an alternative means of affecting public good provision. Note that households *will* generate the income to purchase private good substitutes for the public goods they desire, suburbanization being of particular importance; see Graves (2003). Thus, if private good substitutes are both poor and expensive, it is possible that provision of the public good at optimal quantities would not require much, if any, reduction in leisure. The text discussion implicitly presumes independence of the public good from both private goods and leisure.

[8] I am indebted to Don Fullerton for pointing out that this diagram is in fact more complicated than it first seemed to me, requiring a fuller explanation using the three dimensional figure.

[9] Note that the dashed production possibility frontier in Figure 3 is not that associated with forced labor reductions under a regime in which free riding does not occur, as was the case in Figure 1. 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 finance the public good.

[10] As more of the public good is provided its marginal value, relative to private goods would be expected to fall.

[11] 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 smaller 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. This follows from efforts to equate the marginal value of leisure to the falling marginal values of increased existing goods. That hours of work have stayed relatively constant for a number of decades in the US attests to the importance both of new ordinary goods and of public goods. In the present context, individuals in experiments involving *unfamiliar* ordinary private goods would be expected to exhibit higher

WTA/WTP ratios than would be the case for more familiar goods, as found in the review by Horozitz and McConnell (2002).

[12] Freeman makes a convincing argument that there is great variation among the various environmental programs in net benefits, with some programs economically rational by conventional benefit-cost measures while others have costs far exceeding benefits. The argument of the text suggests that benefits are understated in all cases, but does not reduce the importance of benefit-cost analysis in selecting among potential projects.

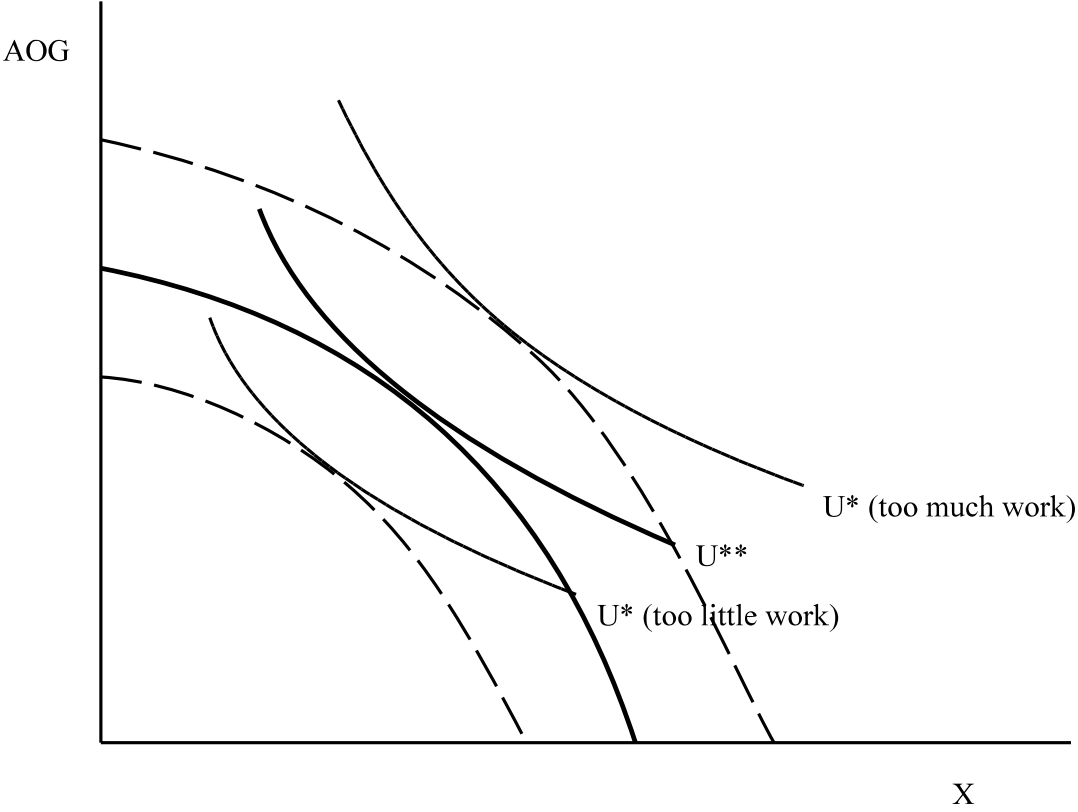# Figure 1. Optimal Goods Consumption Depends on Leisure Being Optimal

AOG

U* (too much work)

U**

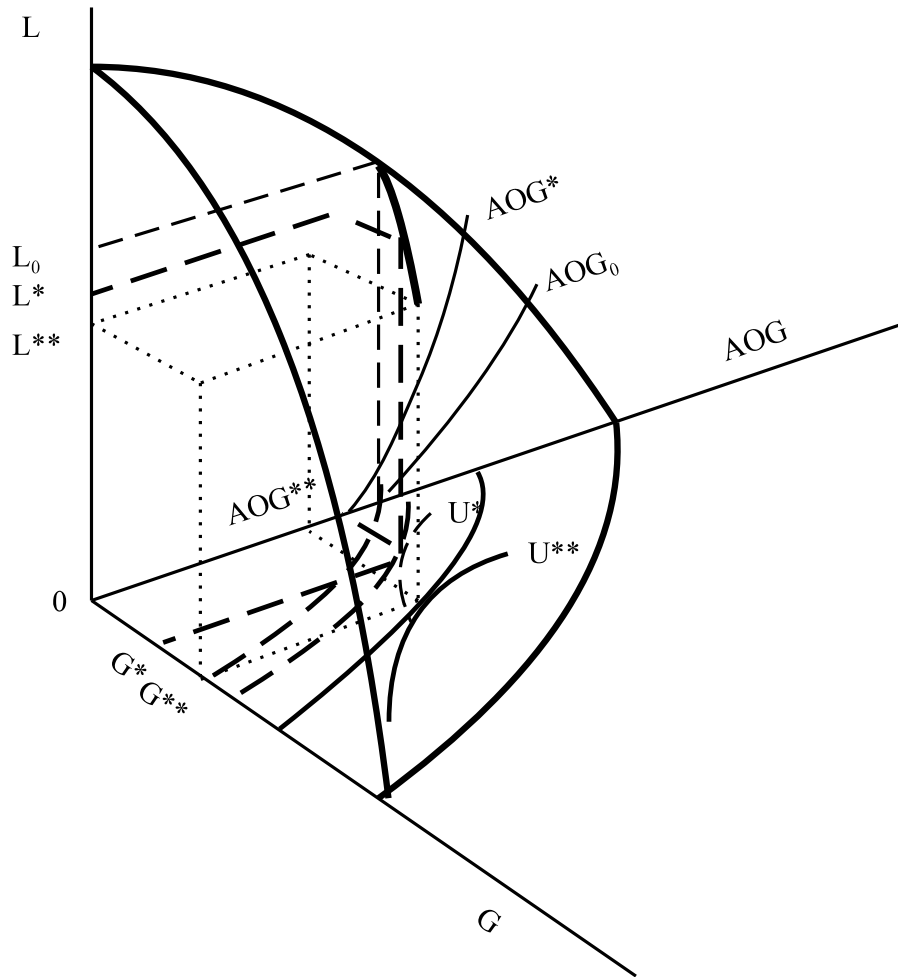U* (too little work)

X

Figure 2. Leisure Choice with Ordinary and Public Goods

Figure 3. The Marginal WTA and WTP, "True" and "Apparent"

AOG

D

A

B

C

(AOG**, G**)

U*

U_1**

U**

U_0**

G*   G*+ΔG   G**   G