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On a New Approach to Social Evaluations of Environmental Projects

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Abstract: Conventional cost-benefit rules typically assume that the alternative to the project under evaluation is "doing nothing" or "business as usual". In this note we contrast this approach to one where the alternative is to provide another environmental good or service. We show that this approach, which draw on methods like Habitat Equivalency Analysis and Resource Equivalency Analysis, imply that all cost and benefit items can be estimated using market prices. This is in sharp contrast to the conventional approach which typically require the use of controversial stated preference techniques to estimate the willingness to pay for non-market goods.

Key words: Cost-benefit analysis, habitat equivalency analysis, non-market goods, resource equivalency analysis, stated preference methods.

JEL codes: D61, H43, Q51, Q57.

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1. Introduction

In this note we derive a simple and very conventional cost-benefit rule that can be used to assess an environmental project. The rule is conventional in the sense that the alternative or base case is "doing nothing" or "business as usual". This is the most common way to assess the social profitability of a proposed project. Typically, since markets for environmental goods are lacking survey instruments are needed in putting a price tag on the environmental values or losses that a project causes. We contrast this rule to one where the alternative to the proposed project is an adjustment or "compensation" of another environmental good or service. This approach avoids the use of controversial stated preference methods such as contingent valuation and choice experiments; see Bennett (2011) for state-of the-art techniques, Bateman et al. (2002) for a cookbook/manual, and Cummings et al. (1997) for a critical assessment. The cost of the project is valued against the cost of the alternative. Hence one can base the evaluation on observable prices of the factors and goods that used to produce the considered alternative goods/services.

2. Model and results

We consider an extremely simplified economy with a single representative household and ignore complications such as taxes and market imperfections and time. We choose this approach in order to be able to concentrate on the focal point of this note, namely providing a new and augmented cost-benefit rule which accounts for the possibility to make tradeoffs between different environmental resources. Therefore the simple social welfare function is stated as follows:

$$W = V(p, w, \pi, z_1, z_2, \ldots\ldots, z_n) \tag{1}$$

where p is the market price of the commodity under consideration, electricity say, all other market goods prices are suppressed, w is the wage rate, π is the profit of the representative firm producing the considered commodity, using labor as the sole variable input, and z_i (i = 1,…..,n) is the exogenously given quantity/quality of an environmental (non-market) commodity.

Consider a small perturbation or reregulation such that the production of the considered market commodity is marginally reduced. This causes some environmental benefits in the sense that z_1 increases while all other environmental goods by assumption are unaffected. The example we have in mind is a reduction of hydropower production that causes an improvement for salmon and other species and possibly some recreational and aesthetic benefits (for example, better fishing and a less moonlike landscape downstream the dam due to a more even water flow). The associated change in societal welfare converted to monetary units is:

$$dW / \lambda = d\pi + (V_{z_1} / \lambda) \cdot dz_1 = (p \cdot dy - w \cdot d\ell) + (V_{z_1} / \lambda) \cdot dz_1 \tag{2}$$

where λ denotes the marginal utility of (profit or lump-sum) income, i.e. $\partial V/\partial \pi$, $d\pi < 0$ is the loss of profits in the production of the considered market commodity (hydropower) assuming that all markets are perfect, V_{z_1} denotes the marginal utility of the first environmental good, dy denotes the change (reduction) of equilibrium output of the considered market good, and $d\ell$ denotes the change of equilibrium level of employment; using Hotelling's lemma, see, for example, Jehle and Reny (2001), it can be shown that $d\pi$ is equal to the first expression within parentheses in the right-hand side of equation (2). Multiplying through by $1/\lambda$ converts the expression from unobservable units of utility to observable/estimable monetary units. Therefore, the final term in equation (2) represents the marginal willingness-to-pay for the environmental good. We assume that dz_1 captures all environmental values created by the considered reregulation[1]. Also note that equation (2) would look the same even if prices adjust so as to maintain equilibrium in markets. This is so because we multiply the small change in a price by the difference (equal to zero) between supply and demand for a commodity. It might also be pointed out that we consider equilibrium prices and z_1 in equation (1) as functions of the size of the considered project. Note in particular that equation (2) requires an estimate of the marginal willingness-to-pay for z_1. Typically one would need stated preference techniques (survey techniques) such as contingent valuation or choice experiments to estimate $(V_{z_1} / \lambda) \cdot dz_1$ due to lack of markets for environmental goods and services[2].

Equation (2) provides a simple (general equilibrium) conventional cost-benefit rule. The considered project is evaluated versus a scenario which can be interpreted as doing nothing or business as usual. The reader is referred to, for example, Boadway (1975), Johansson (1993), Myles (1995), or de Rus (2010) for this kind of (general equilibrium) cost-benefit rules. Recently it has become quite popular to calculate compensation for the loss of some environmental asset. The technique often referred to as Habitat Equivalency Analysis (HEA) essentially calculates the amount, hectares, for example, that must be created to replace an equivalent level of ecological services that was lost due to an accident. The approach focuses on scaling replacement costs on a service-to-service basis. A similar technique, Resource Equivalency Analysis (REA), scales replacement costs on a resource-to-resource basis; the reader is referred to, for example, Zafonte and Hampton (2007), Dunford et al. (2004), Flores and Thacher (2002), Jones and Pease (1997), and Unsworth and Bishop (1994), for details. Drawing on these ideas, in general, one expects that there must be a number of different measures that allows

[1]Since we focus on a reregulation, any direct inputs needed for the provision of more of z_1 are ignored.

[2] In rare cases the evaluation might draw on market-based approaches such as travel costs or property values.

the same utility gain as the considered change in z_1. These include resources that are considered to be close or even perfect substitutes for z_1. Formally:

$$V_{z_1} \cdot dz_1 = V_{z_i} \cdot dz_i \quad i = 2,....,n \tag{3}$$

where V_{z_i} denotes the marginal utility of the ith ($i = 2,.........,n$) environmental good[3]. Each of these measures is associated with a cost. Our idea is to find the cheapest measure that achieves the same welfare level as the change in z_1. In other words, we would like to find:

$$c_{\min} = \min\{c_2,.......,c_n\} \tag{4}$$

where $c_{\min}$ refers to the lowest cost and c_i refers to the cost of implementing project i in equation (3). Note that the cost of the change in z_1 is equal to $-d\pi$ (> 0) in equation (2).

As long as $-d\pi > c_{min}$, even if $dW > 0$ in equation (2) the considered increase in z_1 is *second-best*. There is at least one other environmental measure that causes a larger gain to social welfare. Those measures in equation (3) which are cheaper to implement than dz_1 should be undertaken before dz_1 is considered. In particular, in cases where the social profitability of increasing z_1 is questionable it seems to be important to complement a conventional social cost-benefit analysis by the aforementioned "cost-effectiveness" analysis. There might (but need not) be other measures that are more likely to be socially profitable.

Next, let us look at the reverse case in which we give up of z_1 in exchange for more of commodity y (e.g. electricity). Accounting for the possibility indicated in equation (2) what we term the *augmented* social cost-benefit rule can be stated as follows:

$$dW^A / \lambda = d\pi + (V_{z_1} / \lambda) \cdot dz_1 + (V_{zm} / \lambda) \cdot dz_m - c_{\min} = d\pi - c_{\min} \tag{5}$$

[3] An obvious generalization is to consider a combination of measures as an alternative to z_1.

where $d\pi > 0$, $dz_1 < 0$, $dz_m > 0$ refers to the cost-minimizing alternative in equation (4) and c_{min} to the cost of providing more of z_m. This approach combines two projects[4] and the combination is socially profitable if $d\pi > c_{min}$. Equation (5) could be seen as cost-benefit counterpart to Habitat Equivalency Analysis and Resource Equivalency Analysis. In particular, it involves only items that can be estimated using observable market data; it avoids the use of more controversial stated preference techniques such as contingent valuation and choice experiments.

We claim that in many cases natural scientists and economists should be able to come up with reasonable estimates of equation (3). In other cases benefits transfer techniques might be used to provide a rough estimate of equation (3). Given such estimates, economists should be able to estimate equation (4). Then it is reasonably straightforward to estimate equation (5). Overall, therefore, we believe our approach is quite easy and cheap to implement relative to the cost of undertaking a full-scale conventional cost-benefit analysis[5].

We conclude with a real-world illustration of the approach. In the middle/northern part of Sweden a high-speed railway line, known as the Bothnia line, has recently been constructed; see, for example, Wikipedia (2011). Eventually, it will provide a coastal connection of the Swedish capital Stockholm and the northern university city of Umeå (once some remaining lines are built). A concern is that it runs through a nature reserve close to Umeå that is essential resting area for migratory birds (and it was deemed too expensive (for example, in terms of travel times) to change the scheduled route). In order to compensate for infringement it was decided on a number of measures designed to give the bird life at least as good conditions as before the railroad was built. The measures consist, inter alia,

[4] Of course, One might think of the reverse case in which we give up something of z_m in exchange for more of z_1. This would simply reverse the signs of the items in equation (5).

[5] In still other cases, choice experiments, where attributes of a commodity are valued, might be used to generate estimates of equation (3). However, then the cost of using the approach reasonably increases.

of the construction and restoration of wetlands, creation of new nature reserves and production of coarse grains.

One could view this as an attempt to apply our equation (3) to a real-world project. It still remains to be seen if the measures fully compensate for infringement. For example, we don't yet know if birds and other species as well as birdwatchers are indifferent between the alternatives. However, if the alternatives are deemed equivalent, then a social cost-benefit analysis of the Bothnia line would remind of our equation (5) with $c_{\min}$ reflecting the estimated present value cost of measures taken to compensate for infringement.

3. Concluding remark

We do not claim that the approach outlined in this note should replace conventional cost-benefit techniques or even other evaluation approaches. Rather we suggest that our approach could be a complement when willingness-to-pay estimates are too costly to collect or considerable uncertainty remains with respect to a project's social profitability. Moreover it replaces the traditional and somewhat questionable "doing nothing" or business as usual alternative with a possible more realistic alternative to the considered project (change in z_1). In this sense it adds to a more complete evaluation of proposed projects associated with environmental consequences. Both a conventional cost-benefit analysis and the augmented one proposed here could be presented to the decision-maker in order to broaden his/her information set. However, if resources available for evaluation are limited we believe that the approach suggested in this note might be cost-effective.

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