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Alternative Methodologies for Social Assessment of Environmental Projects

The main objective of this contribution is to propose different methodologies in order to find and compare new solutions for evaluating social projects. We have chosen two approaches: hedonic price and contingent valuation. These procedures can be presented in a quantitative and/or qualitative form. We emphasize the social assessment in terms of benefits of the related environmental projects.

1. Conceptual Framework

The objective of social assessment is to judge on the convenience of executing a particular social project instead of others. Social assessment is based on a cost-benefit comparison that truly belongs to the project; in fact, the target community decides which projects bring welfare to them. Therefore, costs and benefits, from a social point of view, should be clearly identified.

In general, the project's costs are well known, because the project design is made by skilled people. The prices used at the design level correspond to market prices; their correction in terms of social prices (shadow prices) must be considered. The social price represents the economic value of the best alternative given the resources.

The social benefits are those that allow undertaking a project. In order to identify them, we should first identify the different groups that will benefit from the project. After that, we value the benefits from each group in monetary terms. If the benefits do not have a market price, then the most suitable method for its assessments should be implemented.

As the benefits are a measure of social welfare, a methodology of maximization the consumers' utility is proposed. Environmental projects are difficult to evaluate since they are not traded in markets (non-market goods). Then, the methodology requires a special treatment. An econometric analysis can be implemented for each methodology. Alternative methodologies are the hedonic price and the contingent valuation; we will illustrate the economic and econometric methods in order to obtain comparable outputs.

2. Method of Hedonic Price

One way of obtaining the benefits of an economic valuation is to use the property prices as a function of their different characteristics and attributes which, in theory, represent all the direct benefits of households modified by the implementation of the project. The price variation of the property associated with the variation of the attribute of the project is considered as a measure of benefits.

Its advantage lies in the fact that we need just one step to obtain the expected values for benefits without having to analyse each type of benefits separately.

To apply this method, it is important to establish a sample of properties inside and outside the project zones and to take into consideration all the attributes of the place (type of land, property characteristics, local services, etc.).

Concerning the price of the property, we can consult the owner directly by means of a questionnaire and then verify by a specialized expert. Another way is to use the tax evaluation of properties.

2.1. Economic Model

The theoretical model of the function of hedonic price was developed by [Rosen S. (1974)]. This model identifies the price relation of differentiated or heterogeneous goods using the objective evaluation of attributes, resulting from the equilibrium of supply and demand for each of these attributes. Moreover, [Brown and Rosen H. (1982)] and then [Palmquist (1984)] affirm that the goods may be described as an ensemble of attributes or characteristics, which are not traded explicitly in the markets. However, the implicit prices of these attributes may be revealed by hedonic regressions.

In this theoretical framework, the formation of hedonic price models indicates that in the market of supply and demand of goods i at price P_i, there exits an ensemble of attributes $(1,\dots,M)$, named $Z = Z_{i1},\dots,Z_{iM}$. The function of attributes prices $P(Z) = P(Z_{i1},\dots,Z_{iM})$ is obtained by equating the demand quantities $Q^d(Z) = Q^d(Z_{i1},\dots,Z_{iM})$ with the supply quantities $Q^s(Z) = Q^s(Z_{i1},\dots,Z_{iM})$ for all attributes.

The optimal set that the consumer obtains by maximising its utility depends on the goods and their attributes $Q(Z) = Q(Z_{i1},\dots,Z_{iM})$ and other types of goods x, subject to the constraint that total expenditure does not exceed his income y:

$$\begin{cases} \max\limits_{x\geq 0;\, Q(Z)\geq 0} u(x, Q(Z)) \\ \text{such that } xP_x + Q(Z)P(Z) \leq y, \end{cases} \tag{1}$$

where xP_x is the total expenditure on other goods x, and $Q(Z)$ is the quantity of heterogeneous goods. The quantity $Q(Z)$ offered on the market assumes that producers maximise their profits π in the following way:

$$\max \pi = Q(Z)P(Z) - cQ(Z), \tag{2}$$

where $cQ(Z)$ is the total cost of production of Z quantities of attributes for the quantities $Q(Z)$ of heterogeneous goods. The marginal cost of an attribute thus becomes:

$$\frac{\partial cQ(Z)}{\partial Z_m} = CM_{Z_m};\ m = 1,\dots,M. \tag{3}$$

Given the fact that the demand and supply depend on the hedonic price function $P(Z)$, we might have a situation in which the demand and supply quantities lead to an efficient price or equilibrium at $Q^d(Z) = Q^s(Z)$. This situation can only occur if the differential formula defining $P(Z)$ is not linear. The equilibrium condition is given by the marginal price of the attribute or the marginal willingness to pay for this:

$$\frac{\partial P(Z)}{\partial Z_m} = P_{Z_m} = \frac{u_{z_m}}{u_x}. \tag{4}$$

Graphically, in Figure 1, we assume a demand function for households $\theta(Z_m, u, y)$, which measures the willingness to pay for the different alternatives of attributes, as well as a supply function of producers for the goods *i*, $\varphi(Z_m, \pi)$. The equilibrium occurs when supply equals demand and the hedonic price function $P(Z)$ represents the ensemble of all these equations. On the graph, the equilibrium gives us the quantities z_m^1 and z_m^2 for two different households at different prices which are accepted by producers and consumers.

In Figure 2, the marginal price associated with a certain attribute Z_m must be in equilibrium with the marginal willingness to pay for this attribute. These equilibriums give the implicit price function P_{Z_m}, which indicates the required expenditure to acquire the goods *i* following an increase in the quality of attributes.

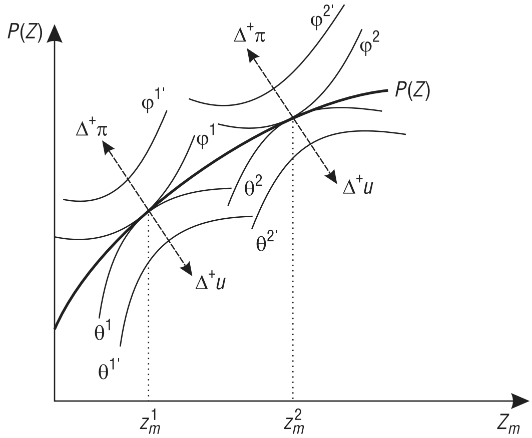

Figure 1. Relation between the hedonic price function $P(Z)$ and the equilibrium of attributes

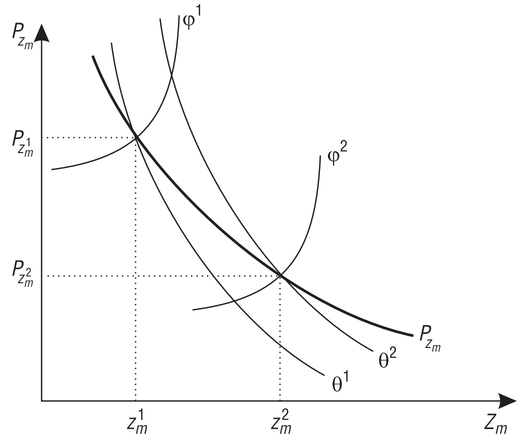

Figure 2. The implicit price function (P_{Z_m})

The hedonic function can also include an environmental variable which represents different qualities of the environmental phenomenon related to the project. The objective is to measure the effect that the environmental variable will have on the property value which is equivalent to the project benefit for each household.

According to [Rosen (1974)], there is no reason to assume a linear specification of the hedonic function. This would only be possible if the goods could be totally or partially linked to their attributes. Moreover, this linear hypothesis is not possible from the economic point of view, as it gives constant marginal prices whatever the attribute level.

2.2. Econometric Model

Because of the problem of linear parameters in the hedonic function, a transformation proposed by [Box and Cox (1964)] allows normalization of the error distribution and obtaining non-linear regressions estimated by the method of maximum likelihood.

As it is difficult to impose a functional form a priori, a generalized linear model presented below, which includes all functional forms of interest, that is to say linear, logarithmic, semi-logarithmic, trans-logarithmic, etc., can be used:

$$P_i^{(\theta)} = \beta_0 + \sum_{k=1}^{m} \beta_k Z_{ik}^{(\lambda)} + \frac{1}{2} \sum_{k=1}^{m} \sum_{h=1}^{m} \gamma_{kh} Z_{ki}^{(\lambda)} Z_{hi}^{(\lambda)} + \varepsilon_i . \qquad (5)$$

This equation is known as the Box-Cox quadratic functional form, which includes a stochastic error term ε_i having a normal distribution. $P_i > 0$ is the price of the goods in question (explained variable) of the i^{th} observation. Z_{ki} is the value of the k^{th} attribute (explicative variable, either continuous or binary) of the i^{th} observation. This type of attribute represents also a quality of the environment.

We let $\gamma_{kh} = \gamma_{hk}$ for simplification. $P_i^{(\theta)}$ and $Z_{ki}^{(\lambda)}$ are Box-Cox transformations used in the model:

$$P_i^{(\theta)} = \begin{cases} \dfrac{(P_i^\theta - 1)}{\theta} & \text{if} \quad \theta \neq 0 \\ \ln P_i & \text{if} \quad \theta = 0 \end{cases}; \quad Z_{ki}^{(\lambda)} = \begin{cases} \dfrac{(Z_{ki}^\lambda - 1)}{\lambda} & \text{if} \quad \lambda \neq 0 \\ \ln Z_{ki} & \text{if} \quad \lambda = 0 \end{cases}. \tag{6}$$

To simplify the derivation of other functional forms, we can rewrite formula (5), if $\theta \neq 0$ and $\lambda \neq 0$:

$$P_i = \left\{ 1 + \theta \left[\beta_0 + \sum_{k=1}^{m} \beta_k \left(\frac{Z_{ki}^\lambda - 1}{\lambda} \right) + \frac{1}{2} \sum_{k=1}^{m} \sum_{h=1}^{m} \gamma_{kh} \left(\frac{Z_{ki}^\lambda - 1}{\lambda} \right) \left(\frac{Z_{hi}^\lambda - 1}{\lambda} \right) + \varepsilon_i \right] \right\}^{\frac{1}{\theta}}. \tag{7}$$

As the transformations are continuous functions around $\theta = 0$ and $\lambda = 0$, the limit for the case $\theta \neq 0$ and $\lambda \neq 0$, when $\theta \to 0$ and $\lambda \to 0$ is respectively ln P_i and ln Z_{ki}. Formula (5) can thus be written in the translog form proposed by [Christensen, Jorgenson and Lau (1973)]:

$$\ln P_i = \beta_0 + \sum_{k=1}^{m} \beta_k \ln Z_{ki} + \frac{1}{2} \sum_{k=1}^{m} \sum_{h=1}^{m} \gamma_{kh} \ln Z_{ki} \ln Z_{hi} + \varepsilon_i. \tag{8}$$

Other functional forms, to which formula (8) leads, are:

i) if $\theta = \lambda = 1$, the quadratic form. If we impose $\gamma_{kh} = 0$ for all k, h we obtain the linear form.

ii) if $\theta = 2$ and $\lambda = 1$, the quadratic form of the generalized square root. If the β's are equal to zero, then we obtain the quadratic form of the square root [Diewert (1974)].

iii) if $\theta = 1$ and $\lambda = 0.5$, the generalised Leontief [Diewert (1971)]. If the β's are equal to zero, we then obtain the linear form of the generalised Leontief.

iv) if $\theta = 0$, $\lambda = 1$ and $\gamma_{kh} = 0$, the semi-logarithmic functional form [Gillingham (1975)], [Palmquist (1979)] and [Thibodeau (1995)].

For a more advanced study of the estimation of parameters θ and λ see [Halvorsen and Pollakowski (1981)].

The last specification with $\theta = 0$ and $\lambda = 1$ is used widely because the semi-logarithmic function allows variation (rate of variation) of the implicit value (hedonic) of a particular attribute with others attributes identified in the model. This semi-logarithmic specification is:

$$\ln P_i = \beta_0 + \sum_{k=1}^{m} \beta_k Z_{ki} + \varepsilon_i, \quad \varepsilon_i \sim N(0, \sigma^2). \tag{9}$$

The maximum likelihood method is used for estimation. Under the normality hypothesis for the probability density function of the transformed explained variable formula (5) becomes:

$$f\left(P_i^{(\theta)}\right) = (2\pi\sigma^2)^{-\frac{1}{2}} \exp\left[-\frac{\left(P_i^{(\theta)} - \beta_0 - \sum_{k=1}^{m} \beta_k \ln Z_{ik} - \frac{1}{2} \sum_{k=1}^{m} \sum_{h=1}^{m} \gamma_{kh} \ln Z_{ik} \ln Z_{ih} \right)^2}{2\sigma^2} \right]. \tag{10}$$

If we are interested in the probability density of the non-transformed explained variable, it becomes:

$$f(P_i) = f\left(P_i^{(\theta)}\right) J(\theta; P_i) \tag{11}$$

with $J(\theta; P_i)$ being the transformation Jacobian, which is equal to $P_i^{(\theta-1)}$.

By definition, the likelihood function, including a sample of n observations of the non-transformed explained variable P_i, is the product of the density functions of all observations. By maximizing this function we obtain estimations of the β's parameters. Using an appropriate redefinition of the variables, formula (9) may be written in a matrix form as follows:

$$P^{(\theta)} = X'\beta + \varepsilon, \tag{12}$$

where $P^{(\theta)}$ is the column vector of explained variables, X is the matrix of the transformed explicative variables $Z_{ik}^{(\lambda)}$ and $Z_{ik}^{(\lambda)} Z_{ih}^{(\lambda)}$, which also includes the constant term (first column of matrix X is equal to 1), β is the column vector of model parameters, and ε is the random perturbations vector.

The estimation procedure must choose the best-fit data. The maximum likelihood estimation is given by the following likelihood function:

$$L(\theta, \lambda, \beta, \sigma^2 | P^{(\theta)}, X) = \prod_{i=1}^{n} f\left(P_i^{(\theta)}\right) P_i^{(\theta-1)} \tag{13}$$

and its monotonous transformation (logarithmic):

$$\ln L = -\frac{n}{2}\ln(2\pi) - \frac{n}{2}\ln\sigma^2 - \frac{(P^{(\theta)} - X'\beta)'(P^{(\theta)} - X'\beta)}{2\sigma^2} + (\theta - 1)\sum_{i=1}^{n} \ln P_i. \tag{14}$$

By maximizing formula (14) we obtain estimates for β, λ, θ and σ^2 which are BAN (Best Asymptotic Normal). If we attribute a value to parameters θ and λ, we get the least square problem. Therefore, the parameter β is estimated by ordinary least squares. That is to say, the maximum likelihood of β's is the least square estimation for the explained variable $P^{(\theta)}$. The estimation of σ^2 is thus given by:

$$\hat{\sigma}^2 = \frac{\sum_{i=1}^{n} (\hat{\varepsilon}_i)^2}{n}. \tag{15}$$

2.3. The Evaluation of Benefits

The properties presented above can be also used in a hedonic regression, which includes the environmental quality (E) as an important characteristic to evaluate benefits from a project. The semi-log specification is:

$$\ln P_i = \beta_0 + \beta_1 E + \delta Z_i + \varepsilon_i, \quad \varepsilon_i \sim N(0, \sigma^2), \tag{16}$$

where

$\ln P_i$ = natural logarithm of the property value i,

E = vector which measure the characteristics of the environmental phenomenon,

β_0 = regression constant,

β_1 = coefficient of variable E,

Z_i = vector of attributes of property i,

δ = vector of coefficients for the attributes of property i.

This functional form shows that the change of value associated with the environmental phenomenon is constant in percentage and approximately equal to β_1. This parameter is estimated by ordinary least squares as well as all the parameters of the regression. The final selection of the model includes only the variables, which are statistically significant.

Then, the environmental variable could or could not be significant in the model. If it is significant we can carry out the methodology, otherwise a new specification of the variable should be proposed (ordinal, categorical, etc) in terms of the responses given by the interviewers.

The objective of a project is to improve well-being due to environmental conditions. Thus, the important point is to calculate the difference in the environmental condition with regard to the situation with or without the project. A key assumption could be that the situation may stay as it is or be improved, no considerations given to works, which aggravate the situation. The mathematical expression is given below:

$$\Delta E = Minimum\,\{0;\, E_{with\ project} - E_{without\ project}\}. \tag{17}$$

The next step is to calculate the expected benefits in terms of the difference in property values with and without the project. Thus, each variation of the environmental conditions affects the property price. The exact formula is as follows:

$$\frac{\Delta P}{P} = \frac{E(P|E_{WITH}) - E(P|E_{WITHOUT})}{E(P|\,E_{WITHOUT})}, \tag{18}$$

where the price follows a lognormal distribution, then its expected value:

$$E(P|E_{WITH}) = e^{\left(\hat{\beta}_1 \cdot E_{WITH} + \hat{\delta}\bar{Z} + \frac{\hat{\sigma}^2}{2}\right)};\quad E(P|E_{WITHOUT}) = e^{\left(\hat{\beta}_1 \cdot E_{WITHOUT} + \hat{\delta}\bar{Z} + \frac{\hat{\sigma}^2}{2}\right)}. \tag{19}$$

Replacing (19) into (18), we get:

$$\frac{\Delta P}{P} = e^{(\hat{\beta}_1 \cdot \Delta E)} - 1, \tag{20}$$

where

ΔP = estimated increase value of the property (benefit with project),

P = average price of the property,

$\Delta P / P$ = estimated change in percentage of the expected value of the property,

β_1 = coefficient of variable E,

ΔE = the difference between the final value (with project) and the initial value (without project) of the environmental conditions.

Finally, from formula (20) we can obtain different variations of the value of the property from different levels of the environmental conditions. The benefit for the project in the best situation of well-being is when ΔE reaches its minimum, that is to say when the environmental phenomenon is avoided by the public project.

3. Method of Contingent Valuation

This method uses a systematic process of interviews of households in order to obtain an estimation of their highest willingness to pay (*WTP*) for the environmental project in a simulated market. This value corresponds in hypothetical conditions or contingent to the benefits of a change in the environmental service.

3.1. Economic Model

In the theoretical framework, the optimal set that the household obtains by maximizing its utility $u(x, q)$ depends on the vector of private goods x (at market prices p_x) and the vector of public or environmental goods q (non-market prices), subject to the constraint that the total expenditure does not exceed its income y. The utility corresponding to this optimal consumption is called the *indirect utility function V*:

$$V(p_x, q, y) = \begin{cases} \max\limits_{x \geq 0} u(x, q) \\ \text{such that } x' p_x \leq y. \end{cases} \tag{21}$$

The utility function $u(x, q)$ is continuous, non-decreasing and strictly quasi-concave in x. The households choose x freely but the quasi-concavity of the utility function in q is not assumed because the perception of q by individuals lies in the empirical domain.

The dual problem is when the expenditure function m is minimized:

$$m(p_x, q, u) = \begin{cases} \max\limits_{x \geq 0} x' p_x \\ \text{such that } u(x, q) \geq \bar{u}. \end{cases} \tag{22}$$

The method of contingent valuation may be used to evaluate the change of utility in terms of m and V. There are two equivalent ways of describing measures of economic well-being:

- using the compensated variation (*CV*) and the equivalent variation (*EV*),
- using the willingness to pay (*WTP*) and the willingness to accept (*WTA*).

Table 1 shows the relations between these measures of well-being and the variation in utility. It is either positive ($\Delta u > 0$) or negative ($\Delta u < 0$), under the hypothesis of uncertainty.

Table 1

Relation between the different measures of well-being

	CV	EV
$\Delta u > 0$	*WTP*	*WTA*
$\Delta u < 0$	*WTA*	*WTP*

If $\Delta u > 0$, *CV* measures the maximum *WTP* of the individual to benefit from the change of utility. As for *EV*, this measures the minimum individual's *WTA* to refuse the change.

If $\Delta u < 0$, *CV* measures the minimum *WTA* of the individual for a degradation. As for *EV*, it measures the maximum individual's *WTP* to avoid it.

3.2. Measuring Well-Being Related to Quantity Variations

[Mäler (1974)] and [Braden and Kolstad (1991)] have proposed compensated and equivalent measures of the value of public or environmental goods with respect to variations in q, assuming that the prices and available income remain constant. We are interested in measures of well-being related to variations in q. Let q^* be the quantity vector of public or environmental goods, with all values greater than or equal to q, and where at least one inequality is strictly greater :

$$V(p, q^*, y - CV) = V(p, q, y), \tag{23}$$

$$V(p, q^*, y) = V(p, q, y + EV) \tag{24}$$

with $q^* > q$ seen as positive improvement. Then $\partial V / \partial q_i > 0$, so $CV > 0$ (or $WTP > 0$) and $EV > 0$ (or $WTA > 0$).

Given the existence of duality, we are able to measure the compensated and equivalent variations in terms of the expenditure function m which is assumed decreasing in q. Let be u^* greater that the initial individual utility u:

$$CV(q, q^*) = m(p, q, u) - m(p, q^*, u), \tag{25}$$

$$EV(q, q^*) = m(p, q, u^*) - m(p, q^*, u^*). \tag{26}$$

Figure 3 shows the effects of a change of quantity from q to q^*. For simplicity, we assume that the price p is constant, which implies that the expenditure function $m(p, q, u)$ is equal to $m(p, q^*, u^*)$ and also points out the minimum expenditure required to reach u and u^* respectively. The choice of consumer begins in A and after the improvement in the public goods it is situated in B. If the income of the consumer had to be reduced by a sum equal to the distance BD, his well-being would not be less than it was previously as it would still be situated in u. This distance BD corresponds to the CV, which represents the amount to pay in order to stay on the indifference curve following the quantity change. On the other hand, the consumer may receive the sum equal to the distance AC which would make him indifferent to an improvement in the public goods as it would allow him to place himself at the utility level u^*. This distance corresponds to the EV, which represents the amount to be accepted to reach the final indifference curve but rejecting a quantity improvement.

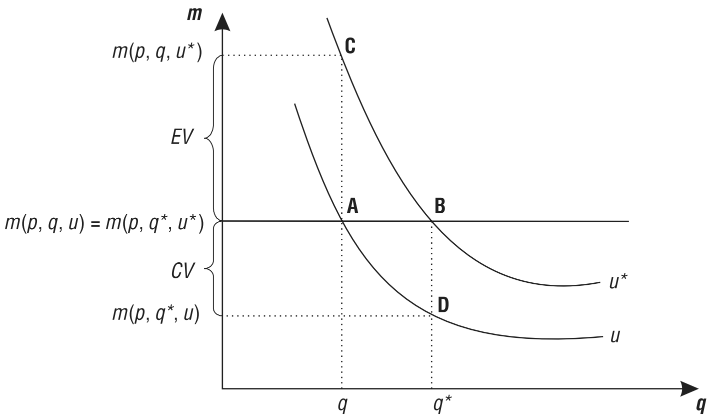

Figure 3. Representation of the *CV* and *EV* of quantity variations

The goods q being non-market valuated, it is not possible to observe their demand. The objective is to evaluate indirectly to what extent a change in q can influence the individual's well-being. This well-being change can be estimated by observing the change in consumption of private goods. For example, q would be the quality of water in a river (latent variable) and x would be the fact of going and bathing in this river (observable variable).

In effect, the hypothesis of «weak complementarity» may reconstitute the variation of the consumer surplus when q varies starting from the prices of private goods x. This way of valuing public goods is perfectly linked to the method of transportation costs and it may be applied to the method of contingent valuation using the referendum analysis. Actually, certain public goods in question and some special private goods are consumed together, so that, when private goods is not consumed the effective demand for the public goods is zero.

Given that the derivative of the expenditure function with respect to the price of private goods x is the function of the compensated demand, the preceding equations can be expressed in the form of integrals of the compensated functions of demand of the goods x, which are observable in the market and which are a weak complement of q. p_i is the price of goods x_i and $\tilde{p}_i$ is called the *choke price* (the price which annuls the consumption of x_i whatever the level of q). Then, the price vector $\tilde{p}$ represents the prices for which the consumption of private goods is zero. Formula (25) can then be formulated as follows:

$$CV(q, q^*) = \int_p^{\tilde{p}} x_i^h(p', q^*, u)\, dp' - \int_p^{\tilde{p}} x_i^h(p', q, u)\, dp'. \qquad (27)$$

This expression may be rewritten as:

$$CV(q, q^*) = \int_p^{\tilde{p}} m_p(p', q^*, u)\, dp' - \int_p^{\tilde{p}} m_p(p', q, u)\, dp', \qquad (28)$$

then

$$CV(q, q^*) = m(\tilde{p}, q^*, u) - m(p, q^*, u) - [m(\tilde{p}, q, u) - m(p, q, u)]. \qquad (29)$$

Given that at the price level $\tilde{p}$, the individual does not consume the private goods x, which is considered as complementary to goods q, and which is related to an improvement from q to q^*, so the minimum expenditure function remains unchanged, that is to say, $m(\tilde{p}, q^*, u) = m(\tilde{p}, q, u)$. This is the condition of weak complementarity, which effects equation (25).

Given this condition, formula (28) implies that the change in the individual's well-being is given by the difference in area between the curve of compensated demand and the choke price axis.

The hypothesis of weak complementarity is represented graphically in Figure 4 which shows two hicksian demands (compensated) for the goods i, which are weak complements of the public goods q. The demands differ in q but not in u. For simplicity, let us suppose that the price p is con-

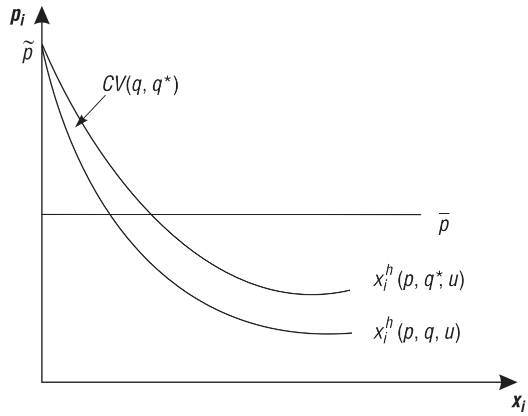

Figure 4. Weak complementarity

stant at $\overline{p}$. The weak complementarity says that the expenditure level, reaching the utility level, is independent of the consumption of public goods q, if the private goods i is not consumed. With the weak complementarity $m(\widetilde{p}_i, q^*, u) = m(\widetilde{p}_i, q, u)$, the *CV* is defined as the area between the two compensated demand curves and $\overline{p}$. If the reference utility level establishes itself at u^* then the area represents the *EV*.

3.3. Econometric Model

The econometric treatment depends on the format chosen for the questionnaire. In the literature, two types of format are proposed: the open and the closed questionnaires.

The open format is more simple to produce but it is little used in practice as it is more difficult to analyse due to the presence of numerous zero values as well as problems of justification of given answers.

The closed format, introduced by [Bishop and Herberlein (1979)], has been used by several researchers [Cameron (1988)], [Hanemann (1984)], [Cooper, Loomis et al. (1992)] and was latter supported by the [NOAA Panel (1993)]. It proposes a unique value (price) and asks the household to either accept or refuse it. The closed format eliminates biased answers but it does not allow obtaining a monetary value of the *WTP*. Then the binary answers (*YES-NO*) of the acceptation of the project are necessary to model, using econometrics techniques to estimate values of *WTP*.

At least three stages should be included in a closed questionnaire. First, it must incorporate a scenario of an environmental or public policy for which the household must give his preferences linked to the monetary value. Then, it must contain a mechanism (referendum), which will allow the household to give his choice. Finally, it must contain a section, which gathers information on the socio-economic characteristics of the household and on his attitudes with respect to the goods in question.

Certain dichotomous models may be applied to estimate the probability of observing the explained variable *WTP*. Discrete choice models as logit and probit are generally used. In these models, the explained variable is a dichotomous variable. The probability of observing its value also depends on diverse explicative variables.

3.3.1. The Logit Distribution Function

The logit model uses the cumulative distribution function of a logistic random variable, which can be linearized by a logarithmic transformation. Let us assume that for a household i, the probability π_i of giving a positive *WTP* value ($y = 1$) is a vector function of explicative variables x_i:

$$E(y_i) = P(y = 1) = \pi_i = \frac{\exp(\beta' x_i)}{1 + \exp(\beta' x_i)}. \tag{30}$$

The probability of giving a zero response ($y = 0$) is thus equal to:

$$P(y = 0) = 1 - \pi_i = \frac{1}{1 + \exp(\beta' x_i)}. \tag{31}$$

The logarithm of the relation between these two complementary probabilities is called the odds ratio and is expressed as follows:

$$\ln\left(\frac{\pi_i}{1 - \pi_i}\right) = \beta' x_i = F^{-1}(\beta' x_i). \tag{32}$$

Finally, the cumulative distribution function of probabilities is the following:

$$F(\beta' x_i) = \frac{1}{1+\exp(-\beta' x_i)} = \frac{\exp(\beta' x_i)}{1+\exp(\beta' x_i)}. \quad (33)$$

3.3.2. The Probit Distribution Function

The probit or normit model uses the cumulative distribution function of a normal random variable. Let y_i^* be a non-observable latent variable, such that:

$$y_i^* = \beta' x_i + \varepsilon_i, \quad (34)$$

where ε_i are independent and identically distributed random normal perturbations. Let the dichotomous variable y_i:

$$y_i = \begin{cases} 1 & \text{if} \quad y_i^* > 0 \\ 0 & \text{if} \quad y_i^* \le 0 \end{cases}. \quad (35)$$

Thus,

$$E(y_i) = P(y = 1) = \pi_i = P(y_i^* > 0) = P(\varepsilon_i > -\beta' x_i) = F(\beta' x_i),$$

where $F(\cdot)$ is the cumulative distribution function of a normal probability distribution.

Concerning the dichotomous choice, the logit and probit models are very similar, and they diverge only in the tails. But, the interpretation of the β coefficients is not the same. [Amemiya (1985)] gives an adjustment of $\beta' s$: $\beta_{logit} = 1.6\,\beta_{probit}$, the constant term being included in the parameter vector β.

3.3.3. The Closed Question and its Model

The basic model was elaborated by [Hanemann (1984)] and [Cameron (1988)]. In their model, they postulate theoretical formulations of the contingent valuation method, which allows analysis of the evolution of the well-being of individuals.

In this way, answers to closed questions are generally treated and modelled in the framework of random utility models (RUM). The models were developed to answer specifically the more precise needs of contingent valuation. It is necessary to distinguish the economic point of view, which requires that the questionnaire answers give coherent solutions to the problem of utility maximization from the purely statistical aspect. The conceptual framework of RUM is briefly presented below:

The answers obtained by closed questions are discrete dependent variables. For a model with just one closed question (*YES-NO*), we may specify the probability of accepting or buying the public goods in the contingent (hypothetical) market for a proposed amount A in the following way:

$$P(response = YES) = P\{V(q^*, p, y - A, s, \varepsilon) \ge V(q, p, y, s, \varepsilon)\}, \quad (36)$$

where

V = indirect utility function derived from the problem of maximizing the utility of the household,

q^* = improved qualitative attribute of the environmental or public goods (a situation with project),

p = price of private goods,
y = household income,
A = amount of *WTP* proposed to the household in the contingent market,
s = socio-economic characteristics of the household,
ε = stochastic perturbation term which imposes the RUM due to households preferences which are not observable.

In the framework of the utility maximization, the households respond *YES* if the utility that it obtains from a qualitative improvement q^* and from its available income $y-A$, exceeds the initial utility situation. The proposed amount A, constitutes the measure of the compensated variation *CV* of the willingness to pay which satisfies the following formula:

$$V(q^*, p, y-CV, s, \varepsilon) = V(q, p, y, s, \varepsilon), \tag{37}$$

where $CV = CV(q^*, q, p, y, s, \varepsilon)$ is the maximum *WTP* for a qualitative improvement $q^* > q$. The formula can be verified if the person answers *YES* when the proposed price is less than its *WTP*, and *NO* otherwise. The model formula may be reformulated to:

$$P(response = YES) = P\{CV(q^*, q, p, y, s, \varepsilon) \geq A\}. \tag{38}$$

In RUM the *CV* is a random variable. In effect, even though the household knows his *WTP*, the researcher cannot observe it directly and must consequently treat it as a random variable. Let F_{CV} and f_{CV} be the cumulative and density functions of *CV* whose parameters can be estimated from the contingent valuation questionnaire. Then, the preceding function becomes:

$$P(response = YES) = P\{CV \geq A\} = 1 - F_{CV}(A). \tag{39}$$

The presented equations constitute both an economic and a statistical model. There are two ways of formulating this expression:

- According to the approach suggested by [Cameron (1988)], which consists in specifying directly a particular form for the cumulative distribution function of *WTP*. Let $E(CV) = \mu$, $V(CV) = \sigma^2$, and $F(\cdot)$ be the cumulative distribution function of the standardized random variable $z = (CV - \mu)/\sigma$. We then obtain:

$$P(response = YES) = 1 - F_{CV}(A) = 1 - F\left(\frac{A-\mu}{\sigma}\right). \tag{40}$$

If $F(\cdot) = \Phi(\cdot)$, the normal distribution function, we obtain a probit model:

$$P(response = YES) = 1 - \Phi\left(\frac{A-\mu}{\sigma}\right) = \Phi\left(\frac{\mu - A}{\sigma}\right). \tag{41}$$

If $F(\cdot) = (1+e^{-x})^{-1}$, the logistic distribution function, we obtain a logit model:

$$P(response = YES) = \frac{1}{1+e^{\left(\frac{A-\mu}{\theta}\right)}}; \quad \theta = \frac{\sigma\sqrt{3}}{\pi}. \tag{42}$$

- According to the approach suggested by [Hanemann (1984)], which firstly involves specification of an indirect utility function $V(d, y, s, \varepsilon)$ and a distribution function for ε, and then constructing the distribution function for F_{CV} using these particular functions. The formulation of the model implies that the utility function of the household is:

$u_1 \equiv u(d = 1, y, s)$ if its answer is *YES*, and therefore $d = 1$, or,
$u_0 \equiv u(d = 0, y, s)$ if its answer is *NO*, and therefore $d = 0$,

where u_1 and u_0 are random variables with a parametric probability distribution $V(d = 1, y, s)$ and $V(d = 0, y, s)$ respectively, which depend on the observable characteristics of the household. These utility functions may be represented as follows:

$$u(d, y, s) = V(d, y, s) + \varepsilon_d; \quad d = 1, 0; \quad \varepsilon_d \; i.i.d. \tag{43}$$

If the household agrees to pay a sum A for the project, we can deduce that:

$$\begin{aligned} &V(d = 1, y - A, s) + \varepsilon_1 > V(d = 0, y, s) + \varepsilon_0 \\ &\underbrace{V(d = 1, y - A, s) - V(d = 0, y, s)}_{\Delta V} > \underbrace{\varepsilon_0 - \varepsilon_1}_{\eta} . \end{aligned} \tag{44}$$

In this conceptual framework, the household's answer (*YES* or *NO*) constitutes a random variable for the researcher. Consequently, the probability of an affirmative answer corresponds to:

$$P(response = YES) = P\{\Delta V > \eta\} = F_\eta(\Delta V). \tag{45}$$

We may verify from (39) and (45) that:

$$P(response = YES) = 1 - F_{CV}(A) = F_\eta(\Delta V). \tag{46}$$

Assuming a functional form for V and a probability distribution for η, we obtain a model, which explains the decision of the household.

In a simplified model, if V is linear with respect to the income of the household questioned ($V_d = \alpha_d + \beta y, d = 1, 0$), the utility variation induced by the acceptance of the project is:

$$V_1 - V_0 = [\alpha_1 + \beta(y - A) - [\alpha_0 + \beta y];$$

$$\Delta V = \Delta\alpha - \beta A. \tag{47}$$

It is interesting to notice that β is positive, given that the expected value for the indirect utility V increases with the income. This implies that the higher the value of A, the less is the probability that a household will answer *YES*. Moreover, this model only allows estimation of the difference $\alpha_1 - \alpha_0$, and not each parameter separately.

In this approximation, $\Delta\alpha$ is the change of utility of an improvement of the quality of public goods; for simplicity we will call $\Delta\alpha = \alpha$, while β is the marginal utility of income (α / β). The payment, which would leave the household indifferent ($\Delta V = 0$), is equal to the utility change divided by the marginal utility of income (α / β).

If F_η is a logistic cumulative function, then by equation (46), the linear specification in ΔV, becomes:

$$P(response = YES) = \frac{1}{1 + e^{\left(\frac{A - \mu}{\theta}\right)}} = \frac{1}{1 + e^{-(\Delta V)}} = \frac{1}{1 + e^{-(\alpha - \beta A)}}. \tag{48}$$

This is a logit model identical to (42) with $\alpha = \frac{\mu}{\theta}$ and $\beta = \frac{1}{\theta}$. We infer that:

$$E(CV) = \mu = \frac{\alpha}{\beta}. \quad (49)$$

In this case, as η has a variance of $\frac{\pi^2}{3}$:

$$V(CV) = \sigma^2 = \frac{V(\eta)}{\beta^2} = \frac{\theta^2 \pi^2}{3}. \quad (50)$$

On the other hand, we also have the log-logistic function used by [Bishop and Heberlein (1979)] in the RUM model. This model uses a logistic distribution for η, and consequently V and CV follow a log-logistic distribution. It has been shown that this model is coherent with economic theory:

$$P(response = YES) = \frac{1}{1 + e^{\left(\frac{A-\mu}{\theta}\right)}} = \frac{1}{1 + e^{-(\Delta V)}} = \frac{1}{1 + e^{-(\alpha - \beta \ln A)}}. \quad (51)$$

Like formula (48), it is a logit model but now with a probability of an answer that depends on $\ln A$ insted of A. Using its properties, we deduce that:

$$E(CV) = e^{\left(\frac{\alpha}{\beta}\right)} e^{\left(\frac{\eta}{\beta}\right)} = e^{\left(\frac{\alpha}{\beta}\right)} \frac{\pi/\beta}{\sin(\pi/\beta)}, \quad 0 < \frac{1}{\beta} < 1 \quad (52)$$

and

$$V(CV) = e^{\frac{2\alpha}{\beta}} \left[\frac{2\pi/\beta}{\sin(2\pi/\beta)} - \left(\frac{\pi/\beta}{\sin(\pi/\beta)} \right)^2 \right], \quad 0 < \frac{1}{\beta} < 1. \quad (53)$$

The simplified logit model has the advantage of being solved analytically. This type of model uses as error terms a Gumbel logistic distribution, which gives a very simple covariance structure. On the other hand, the probit model assumes normally distributed error terms which, in theory, may accept a variety of error structures (variance-covariance matrix) and so their estimation can be difficult, it is necessary to use simulations.

3.3.4. The Well-Being Evaluation

We are interested in two statistics as measures of the monetary value of non-market goods:

- The mean of the estimated distribution of *WTP*, CV^+. By using integration by parts, it is possible to show that the expected value of a random variable may be calculated using the cumulative distribution function in the following manner:

$$CV^+ = \int_0^{\infty} (1 - F_{CV}(A))\, dA - \int_{-\infty}^{0} F_{CV}(A)\, dA. \quad (54)$$

If the probability distribution does not allow negative values for CV, the expected value would then be given by the first term of formula (54), CV'. To ensure that this condition is satisfied, it is necessary to check that the probability that the individuals answers *YES* when $A = 0$ is equal to 1 in the functional form adopted by $1-F_{CV}(A)$. This condition is satisfied when $1-F_{CV}(A)$ is given by a logit function which includes the logarithm of A as in formula (51). On the other hand, this condition will not be satisfied for the linear logit model with respect to A as in formula (48) or for the case of the logit model which uses a logarithmic utility function.

- The median CV^*, which is defined as follows:

$$1-F_{cv}(CV^*)=0.5. \quad (55)$$

The median may be found directly from the empirical probability function. It is the amount, which corresponds to 50% of the probability of answer *YES*; it is well-known only for the logit and probit models. The median corresponds to the point where the standardized variable is equal to zero.

We notice that the stochastic specification of RUM models may have substantial economic implications as different probability distributions have totally different effects on the relation between the mean and the median. Only the linear case implies $CV^+=CV^*$; in all other cases, we have $CV^+\neq CV^*$.

Table 2 shows the calculation of different estimators of the variation of well-being. In all cases, we assume that the probability of obtaining a positive answer follows a logistic probability distribution. What distinguishes the estimators is different functional forms of ΔV. All the models are worked out in order to have the coefficient A positive.

Table 2

Estimators of the variation in well-being

ΔV	Mean CV^+	Median CV^*	$\int$ positives values CV'
$\alpha-\beta A$	$\frac{\hat\alpha}{\hat\beta}$	$\frac{\hat\alpha}{\hat\beta}$	$\frac{\ln(1+e^{\hat\alpha})}{\hat\beta}$
$\alpha+\beta\ln\left(1-\frac{A}{y}\right)$	$y\left(1-e^{\frac{\hat\alpha}{\hat\beta}}\cdot\frac{\pi}{\hat\beta\sin(\pi/\hat\beta)}\right)$	$y\left(1-e^{\frac{-\hat\alpha}{\hat\beta}}\right)$	No analytical solution
$\alpha-\beta\ln A$	$e^{\frac{\hat\alpha}{\hat\beta}}\cdot\frac{\pi}{\hat\beta\sin(\pi/\hat\beta)}$	$e^{\frac{\hat\alpha}{\hat\beta}}$	$e^{\frac{\hat\alpha}{\hat\beta}}\cdot\frac{\pi}{\hat\beta\sin(\pi/\hat\beta)}$

To decide which measure is the most appropriate, we must take into account both statistical and economic criteria. For example, the mean is more sensitive to the distribution form than median, especially for extreme values, which can affect the third and fourth moments (skewness and kurtosis). Most RUM with non-negative preferences lead to very asymmetric distributions of *WTP*, it is often recommended to use the median because of its robustness.

Some important aspects to be considered by the researcher in the definition of the *CV*:

- Censure: it is necessary to take into account the fact that $0<CV<y$.
- Truncation: $CV^{max}<\%y$, relevant percentage of income *y*, proposed by researcher.

Estimation subject to constraint and Bayesian estimation (where we introduce a priori information about the maximum at the moment of estimation of the model rather than at the moment of calculations of measures of well-being), use similar approaches.

3.3.5. The Estimation Method

If we use the referendum format in the questionnaire, it requires an econometric model, which allows estimation of the highest *WTP* of an interviewed person, given the *YES* and *NO* answers and the offered prices. For *single-bounded* estimation, the model is described by [Hanemann (1984) and (1989)]. For *double-bounded* estimation, the model is described by [Hanemann et al. (1991)].

The answers may be coded by 1 for affirmative answers, and by 0 for negative ones. Moreover, to facilitate the understanding, we assume that the only pertinent socio-economic variable is the income of the family group, y, while normally other variables are included such as the size of the family, the level of education, etc.

The initial selection of variables to be included must be made based on focus group results (sampling) for which open questions are generally used in order to establish the range of the prices and the important variables, which could influence them.

The final version of the questionnaire with twice proposed price questions is called *double-bounded*. This version, suggested by [Haneman et al. (1991)], follows the initial question with a second question to which the interviewee answers with *YES* or *NO*. A third proposed price does not add relevant inference to the estimation.

Let be A the amount proposed in the first question, then the following amount depends on the answer to the first question: if the interviewee answered *NO* to A, the second offer is then less ($A^- < A$), while in the contrary case *YES*, the second offer is higher ($A^+ > A$). Consequently, there are four possible answer sequences:

- two *YES* answers,
- two *NO* answers,
- one *YES* followed by one *NO* answer,
- one *NO* followed by one *YES* answer.

With the structure of $P(response = YES) = 1 - F_{WTP}(A)$ for a given distribution of *WTP* equal to $F_{WTP}(A)$, the answer probabilities are thus:

$$P_{YY} = P_{YES,YES}(A, A^+) = P[A \le WTP \text{ and } A^+ \le WTP] = P[A^+ \le WTP] = 1 - F_{WTP}(A^+); \tag{56}$$

$$P_{YN} = P_{YES,NO}(A, A^+) = P[A \le WTP \le A^+] = F_{WTP}(A^+) - F_{WTP}(A); \tag{57}$$

$$P_{NY} = P_{NO,YES}(A, A^-) = P[A \ge WTP \ge A^-] = F_{WTP}(A) - F_{WTP}(A^-); \tag{58}$$

$$P_{NN} = P_{NO,NO}(A, A^-) = P[A \ge WTP \text{ and } A^- \ge WTP] = F_{WTP}(A^-). \tag{59}$$

From here, the log-likelihood function for the *double-bounded* method may be written:

$$\log L = \sum_{i=1}^{N} [D_{YY} \log P_{i,YY} + D_{YN} \log P_{i,YN} + D_{NY} \log P_{i,NY} + D_{NN} \log P_{i,NN}], \tag{60}$$

where $D_{YY}, D_{YN}, D_{NY}, D_{NN}$ are dummy variables, which are equal to 1 when the answers take on respective values for the four possible sequences *YY*, *YN*, *NY*, *NN*; and equal to 0 otherwise. For example, if the interviewee responds *YES* to the first price option to accept the project and in the following question responds *NO* to the second price option (higher than the first price option), then D_{YN} is equal to 1, while D_{NY}, D_{YY} and D_{NN} are equal to 0.

The estimation for all observations is done by maximum likelihood (*ML*), which allows estimating the unknown parameters. The *double-bounded* version, using a logit model, performs high precision of the variance-covariance matrix of coefficients [Hanemann et al. (1991)], thus producing narrow confidence intervals for the median estimates of the *WTP*.

The *double-bounded* version is more efficient than the *single-bounded* one (only one price proposed) as the amount A^+ in the *double-bounded* version is much nearer to the median and allows lowering the estimation of the median of *WTP*.

In empirical applications it is usual to use the logistic distribution to define the F_{WTP} function. By inserting specification of (48) in (56), (57), (58) and (59) and consequently the latter in formula (60), we obtain an expression for *LogL*, parametric in α and β. To solve for the maximum of *LogL*, it is necessary to use non-linear optimisation programs, which allow finding the second derivative matrix, whose inverse is the variance-covariance matrix of coefficients.

In accordance with the basics of the RUM, we can determine the maximum *WTP* that is obtained from formula (60). We thus find the value of *WTP* for which the probability of obtaining a positive answer is 50% (the median value). In this way, by using the logistic model with the linear specification for ΔV, we obtain the highest *WTP*:

$$\widehat{WTP} = \frac{\hat{\alpha}}{\hat{\beta}}. \tag{61}$$

If it concerns the general model specification with explicative variables *x*, the individual *WTP* is given by:

$$\widehat{WTP}_i = \frac{\sum_{k=1}^{K} \hat{\alpha}_k x_{ik}}{\hat{\beta}}, \tag{62}$$

and if we consider an average individual, the highest *WTP* is given by:

$$\overline{\widehat{WTP}} = \frac{\sum_{k=1}^{K} \hat{\alpha}_k \bar{x}_k}{\hat{\beta}}. \tag{63}$$

The estimation process also allows obtaining the variance-covariance matrix of estimators $\hat{\alpha}$ and $\hat{\beta}$, from which we may obtain an estimation of the variance of the estimated *WTP* by using either the Taylor development formula or the Monte Carlo simulations.

Given the estimated coefficients by *ML*, a hypothesis test is used on the inclusion of explicative variables in the model, such as, Wald, likelihood ratio, Rao score tests. Concerning the measure of fit adjustment, the *pseudo-*R^2 is widely used in this kind of models.

4. Recommendations

The interest is to choose the best method to compute the benefit of an environmental or public project in order to avoid a double accounting.

The choice between alternatives (hedonic or contingent) depends on the type of questionnaires and the significance of the environmental variable in the model.

The type of hedonic questionnaire is non-experimental and is applied to properties with land only, whereas the contingent valuation questionnaire is of experimental type and uses the opinion of a household in terms of preferences and attitudes to the public project.

These two methods use different sources of information, which directly affect the household well-being. Hedonic methods inquire the characteristics and attributes of properties with land. As to contingent studies, they inquire the individuals with open/closed questions. The results are thus not directly comparable. However, it does not represent a disadvantage, because these results enable us to determine the relevance of each method in a cost-benefit evaluation of the public project.

For example, if the coefficient of the environmental variable is significant in one method, then this method can be proposed in the evaluation of benefits of the project. If the two methods have a significant coefficient of the environmental variable, then both methods should be selected, but its implementation will be decided in terms of the aim of the project, i.e. for the beneficiaries' target that the policy of the project was conceived for.

An important element is the sample size, which is affected by the project. We can differentiate direct and indirect beneficiaries of the public project. Hedonic methods can assess only the property benefits from the affected area of the project, whereas contingent methods can assess benefits of households from both the affected area and the neighbourhood.

An important advantage of the contingent method is thus the width of benefits (direct and indirect), which can be obtained from the project. Its disadvantages are the type of questionnaire, which makes it difficult to catch the opinion of the different households enquired and the strategic reaction to reject the project under the hypothesis that the proposed prices would be really charged.

Therefore, the bias of the contingent questionnaire is higher than of the hedonic one, which provides us with higher degree of accuracy in the answers. Indeed, the data used by the hedonic method are obtained through the property values, which are generally declared by the households.

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К. Гонзалес

Альтернативные методологии, применяемые для социальной оценки экологических проектов

Основная цель настоящей работы — предложение различных методологий сравнения и поиска новых решений для оценки социальных или экологических проектов. Задачей социальной оценки является определение целесообразности реализации конкретного социального проекта.

Социальная оценка основывается на сравнении затрат и результатов проекта, и это также является его частью. Фактически, сообщество принимает решение о том, какие проекты принесут ему наибольшее благо. Поэтому все затраты и выгоды, с социальной точки зрения, должны быть четко определены.

Обычно затраты проекта хорошо известны, так как разрабатывается он квалифицированными специалистами. Цены, которые используются на этапе проектирования, соответствуют рыночным. Их корректировка как социальных (теневых цен) также должна учитываться. Социальная цена представляет собой экономическую стоимость наилучшей из альтернатив с учетом ресурсов, имеющихся в местной экономике.

Общественная выгода — это та выгода, благодаря которой проект может быть реализован. Для того чтобы ее выявить, мы должны сначала идентифицировать те группы сообщества, которые получат выгоду от данного проекта. После этого, мы оцениваем в денежном выражении выгоду, получаемую каждой группой. Если эта выгода не имеет рыночной цены, применяется наиболее подходящий для такого случая метод оценки.

Так как общественная выгода является мерилом социального блага, предлагается методология максимизации выгоды для потребителя. Социальные и экологические проекты довольно сложно оценивать, так как они не выносятся на рынок (нерыночные товары). Таким образом, данная методология требует специального подхода. Для каждой методологии применим эконометрический анализ. Альтернативные методологии — это гедонистическая цена и оценка методом опроса. Проиллюстрируем эти методы с целью получения сравнимых результатов.

Один из способов выявления выгоды путем экономической оценки — использование стоимости имущества в качестве функции его различных характеристик и свойств, которые, теоретически, представляют непосредственную выгоду для домохозяйств и будут изменены в результате реализации проекта. Изменение цены имущества, связанное с изменением свойств в результате реализации проекта, считается мерилом этой выгоды.

Преимущество метода в том, что для получения ожидаемых значений различных видов выгоды нет необходимости проведения отдельного анализа каждого вида.

Для применения эконометрической модели важно сделать выборку имущества внутри и вне зон проекта, а также учесть все свойства данного места (тип земельного участка, характеристики имущества, наличие услуг и т. п.).

Касательно цены имущества, мы можем путем анкетирования проконсультироваться непосредственно у владельцев и сверить полученную информацию с измерениями, выполненными экспертом. Еще один способ — использование оценки имущества для целей налогообложения. Оценка производится на основании стандартного метода наименьших квадратов.

Целью проекта является улучшение качества жизни с точки зрения экологических условий. Далее важно рассчитать, как различие в экологических условиях влияет на стоимость имущества до и после реализации проекта. Выгодой проекта при оптимальном качестве жизни является случай, когда государственный проект не имеет экологических последствий.

Оценка методом опросов включает в себя использование опросов домохозяйств с целью выяснения их максимальной готовности платить (*ГП*) за реализацию экологического проекта, то есть величину, которая соответствует выгоде, получаемой ими на гипотетическом рынке.

При этом в анкетах обычно используется формат референдума, позволяющий использование эконометрической модели, в свою очередь дающей оценку максимальной *ГП* интервьюированных лиц, которые отвечают ДА или НЕТ, и предлагают цену проекта. Для одноразовой оценки модель описана Хенеманом [Hanemann (1984), (1989)]. Для двойной оценки — [Hanemann et al. (1991)].

Ответы могут быть закодированы — «1» для положительных ответов и «0» — для отрицательных. Более того, здесь включаются другие переменные, такие как количество членов семьи, уровень образования, доход.

Оценка дается на основе функции максимального правдоподобия (*МП*), которая позволяет оценить неизвестные параметры, возникшие в результате изучения данных. При практическом применении модели двойной оценки используется модель *логит*, которая обеспечивает высокую точность оценки ковариационной матрицы коэффициентов [Hanemann et al. (1991)], и дает узкие доверительные интервалы для медианных оценок *ГП*.

Таким образом, мы находим значение *ГП*, при котором вероятность получения положительного ответа составляет 50% (его медианное значение).

Интерес в том, чтобы выбрать наилучший метод расчета выгоды экологического или государственного проекта во избежание двойной бухгалтерии. Выбор между альтернативами (гедонистическая цена или оценка методом опроса) зависит от типа анкет и значимости экологической переменной в модели. Эти два метода используют различные источники информации, непосредственно влияющие на благополучие домохозяйств. Гедонистические методы используются для выяснения характеристик и свойств имущества вместе с земельным участком. Что касается исследований опросными методами, здесь респондентам задают открытые и закрытые вопросы. Следовательно эти результаты нельзя сравнивать напрямую. Однако это не является минусом, поскольку дает нам возможность выявить релевантность каждого метода в процессе проведения оценки государственного проекта с точки зрения затрат и результатов.

Например, если коэффициент экологической переменной значителен в одном из методов, то этот метод может быть предложен для оценки выгоды проекта. Если два метода имеют значительный коэффициент для экологической переменной, то необходимо выбрать эти два метода, но вопрос реализации проекта будет решаться относительно его целей, т. е. тех бенефициариев, на которые ориентирован проект.

Одним из важных элементов является величина выборки, которая подвергается влиянию со стороны проекта. Мы можем дифференцировать непосредственных и косвенных бенефициариев государственного проекта. При использовании гедонистических методов можно оценить только выгоду для имущества, расположенного в зоне, затрагиваемой проектом, в то время как методы оценки путем опроса могут быть использованы для оценки выгоды, получаемой домохозяйствами как в затрагиваемой зоне, так и в ее окрестностях.

Важным преимуществом метода оценки путем опроса по отношению к гедонистическим исследованиям является, таким образом, размер выгоды (прямой и косвенной), которая может быть получена от проекта. Минусом в данном случае является вид анкеты, усложняющий процесс выяснения мнений различных опрошенных домохозяйств, а также стратегический отказ от проекта по гипотетической причине, заключающейся в том, что предлагаемую цену придется реально заплатить.