Defensive Expenditures: A Dual Method of Valuation

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1. Introduction

The purpose of the present paper is to reflect on the validity of the defensive expenditures (DE) method to measure changes in individual welfare through monetary valuation in the face of variations in the supply of environmental goods.

The study then focuses on the analysis of the defensive expenditure method, taking into account the traditional classification of valuation methodologies. This section considers the main criticisms aroused by the method, to the point where most of the literature does not consider it appropriate for valuation of changes in individual welfare.

The argument of the present study is that the defensive expenditure method (in certain circumstances) is an appropriate methodology for monetary valuation. Although the results are an approximation to the measurement of the change in environmental welfare, it is true that the requirements for obtaining data give it a clear advantage over other methods which have to assume restrictive hypotheses (degrees of freedom). On the other hand, the estimation of the defensive expenditures necessary to improve an aspect of the environment represents an adequate measurement to estimate the burdens placed on society by different forms of pollution and therefore provides significant information for social cost-benefit analysis.

Finally, reference is made to the validation of the method as a measure of environmental benefits, taking into account nomological networks allowing comparisons of the results obtained with direct valuation techniques (contingent valuation).

2. Methodologies of monetary valuation based on the production function approach

Assuming the Pareto optimality conditions to maximise the personal utility function subject to certain restrictions, the estimation of the value of environmental goods may come from the observed data on people’s actions in the real world, (where people live with the consequences arising out of their actions), or through hypothetical situations.
posed to people. In both cases, the observation methods may be direct (action of individuals in a competitive market in an attempt to maximise their utility) or indirect (analysing a utility-maximising behaviour through an indirect observation of the value of goods which do have price and market).

When it comes to analysing these methodologies, Freeman (1992) considers a certain progression from naïve forms of environmental valuation to direct methods collecting more elaborate data for monetary valuation. The early studies used the damage function approach as an approximation to measure the change in welfare of both, the advantages of improving an environmental quality, and the cost of worsening it. This damage function (which is not always easy to estimate) relates the physical measurements of harm or loss through a dose-response function of a market variable in the face of changes in environmental variables. As the former tend to be valued at market prices, the estimation of this cost (benefit) represents the change in well-being produced in an individual.

Most indirect methods imply some kind of substitution or complementary relationship between the environmental good and the market good. It is of interest here to highlight the defensive expenditure method, or avoidance expenditure method, as a way of estimating individual preferences. In the case of indirect hypothetical methods, it is also possible to use the averting behaviour method. In general, the steps to be followed involve deriving individual willingness to pay (WTP) as a function of the environmental variable through an indirect utility function, or an expenditure function (constant utility in the face of changes in the environmental variable). From there, a model is developed to maximise individual utility, the first-order conditions are derived (and hence the marginal substitution rate for some price ratios), and it is observed whether any link exists between the marginal value of the change in the environmental variable and some variable observable on the market. If so, this variable could be used to measure the change in well-being produced by a modification in the environmental variable (Freeman, 1992).

Although this methodology does not seem so naïve within the Environmental Cost-Benefit Analysis (ECBA) context, as it provides objective elements to be able to judge certain projects, things are different within the framework of utility theory, as changes in consumption of a good represent modifications in income and this may imply considerable changes in the consumers’ choices when it comes to making a further choice on a basket of goods. These changes affect utility, of course, because omitting this component may lead to an under- or over-estimation of changes in welfare.

2.1. Defensive expenditure methodology

This section will review the defensive expenditure methodology and its ability to estimate changes in individual welfare as a result of modifications in environmental variables.

For many kinds of environmental variables there is the possibility (acting through certain measures, known as “defensive measures”) of avoiding or abating the consequences of the environmental variable under analysis. For instance, it is possible to reduce the level of noise pollution suffered by an individual, using certain measures such as the installation of double windows, or sealing doors and roofing. As this
involves incurring monetary expenditure, it seems appropriate to consider, as economic theory does, that the disutility suffered by an individual when purchasing double windows must be compensated, even though partially, by the utility enjoyed by that individual through having to bear a lower level of environmental noise, or a greater level of peace and quiet inside her home.

In this context, the expression even though partially has given rise to discussions about the validity of the method to value changes in individual welfare.

It could be said that economists have agreed that the sum of these defensive expenditures can be used as a measures of the costs imposed to society by some types of pollution, implying that the use of this methodology would be acceptable from the point of view of ECBA in any specific project. Nonetheless, such agreement is far from being achieved when it comes to measuring changes in individual welfare.

Perhaps one of the first questions to be taken into account in the defensive measures method should be the definition of the kind of relationship existing between the environmental good (from notion in advance referred to as (T) for domestic peace and quiet inside the household -internal noise- and “R” for the level of noise pollution -external noise-) and the individual’s utility function. This relationship can have two forms:

a) When the environmental good forms part of the production-utility function as a factor input together with other market goods.

b) When the environmental good, together with other market goods, is an argument of the individual utility function. This last relationship may, in turn, be considered direct (if the environmental good forms part of the utility function) or indirect (when the environmental good is an input for a good which influences the utility function).

2.2. Production Function

In the first case, where the questions linked with individual welfare are not involved, defensive measures can be used through the definition of damage functions establishing the ratio between the level of noise (R) and the private good. When the environmental good forms part of the production function as a factor input, any change in its supply will imply alterations in the production function for that good. Let us suppose that the noise level (R) as an argument (as one more input) of the egg-production function (H) of a particular farm. If the partial derivative [dH/dR], is known, a measurement of the change in H (with a known demand curve) can be established with respect to R either by avoiding occurrence of the change (known as the benefits derived or averted costs) or else by analysing the defence required vis-à-vis a specific change: defensive expenditure.

This relationship is not without problems: a) What will the demand curve opposing the private good be like? b) Is the dose-response function correct? c) Do the use of other inputs and production remain constant in the face of changes in the level of peace and quiet? d) Are the defensive measures perfect? e) How can the beneficiaries be identified? but these do not affect the essence of the method to analyse a situation linked to environmental cost-benefit.
Should there be a perfect substitution of both goods, and when the relationship is known, the calculation of the benefit (cost) is straightforward, providing that market structures are not affected. The defensive expenditure method is therefore very useful when it comes to assessing the monetary valuation of any change in an environmental good.

2.3. Individual Utility Function.

This is the point of the defensive expenditure method attracting most criticism as a method for showing the changes in individual welfare in the face of changes in the environmental variable. To this end, stress is placed on the differences existing between the willingness to pay (WTP) for change in individual welfare and the observed defensive expenditure.

Below, we consider some of the changes in individual welfare caused through an increase in the noise pollution “R” in a specified area. The noise pollution affects the utility function indirectly through the effect it has on the level of internal noise and it does not directly enter the utility function\(^4\). The function “f” is a continuous second-order differentiable function in order to guarantee the resolution of the optimisation problem.

\[
U = f(X,T) \quad [1] \quad \text{Utility Function}
\]

In the relevant domain: \(f_X > 0\), \(f_T < 0\)

To this end, it is assumed that there is an environmental problem “R” and a single defensive measure “A” (acoustic insulation). Combined in a technological functional relationship, these give a level of internal noise “T”. On the other hand, a defensive expenditure function “D” can be considered for soundproofing to indicate the necessary level of expenditure to achieve a certain level “T” with a given level of external noise “R”.

\[
T = t(R,A) \quad [2] \quad \text{Technological function}
\]

\(t_R > 0\); \(t_A < 0\)

\[
D = d(R,T) \quad [3] \quad \text{Cost (Soundproofing) function}
\]

\(D_R > 0\); \(D_T > 0\)

The function [1] is weakly separable with respect to the final variables (X,A,R) and given that the variables (A, R) are integrated within the set “T”, the individual is out to maximise:

\[
f(X,T) = f(X,t(R,A))
\]

\(^4\) Where the noise pollution directly affects the utility function, the conclusions with regard to the differences observed between marginal willingness to pay for “R” and observed defensive expenditure can no longer be maintained.
s.t. \( M - X - P_A X_A = 0 \) \[4\]

where: \( M \) is income and \( P_A \) is the price of good “A”.

Following the traditional line proposed by Courant and Porter (1981), the maximisation problem can be solved by considering the indirect utility function. And then applying the conventional method to obtain first order condition. Freeman (1992)

\[
V = v(P_A, R, M) = f(X^*, T^*) + \lambda (M - X^* - P_A A^*)
\]

[5]

where, apart from the conventional arguments (income and price) there is an index reflecting the amount of environmental impact (R) instead of the price or willingness to pay, which is precisely what we wish to obtain. Taking expression [5] into account and considering the budget restriction required to achieve a specified level of utility \((u^0)\), we obtain (e: dual minimization of expensive)

\[
V = v(P_A, R, e(P_A, R, u^0))
\]

[6]

after differentiating this expression and equalling it to zero, clearing the partial derivative of \( e \) with respect to \( R \) and taking into account the first order condition, (assuming \( dP=0 \)) of the Lagrangian with respect to \( A \), gives:

\[
\frac{de}{dR} = e_R(P_A, R, u^0) = -P_A \frac{f_R}{f_A} = w_R^{u^0}
\]

[7]

Where \((w)\) is the marginal valuation of the change in “R” (WTP) while keeping utility constant. If we consider that the consumer may purchase an amount of internal noise at a constant price \( P(R) \), the indirect utility function is then:

\[
V = v(M, P(R))
\]

[6a]

Considering equations [3] to [6] (Courant and Porter), the effects of a marginal change in \( R \) and assuming that the expenditure function \( e \) is equal to \( M \), we see:

\[
\frac{de}{dR} = e_R(P_A, R, u^0) = T \frac{dP(R)}{dR} = w_R^{u^0}
\]

[7a]

An increase in the level of noise (\( R \)) increases the insulation cost necessary to achieve the level (\( T \)) determined in the utility function or, in other words, an increase in (\( R \)) indicates the increase in income necessary to achieve an increase in (\( e \)) which leaves the individual in the initial position (constant utility).

Bartik (1988) takes a different approach. In this article the utility is maximized by taking into account the expression maximisation of the utility is effected by taking into account the function [3], so that the indirect utility function becomes:

\[
V = v(R, M) = f(X^*, T^*) + \lambda (M - X^* - D(R, T^*))
\]

[5a]
and the solution, taking into account equations [1] to [4] (Bartik, 1988) is:

\[
\frac{dM}{dR} = e_R(R, u^0) = -\frac{V_R}{V_e} = D_R = w^u_R \tag{7b}
\]

Equation [7b] represents the saving in defensive expenditures in the face of changes in (R) to achieve the original level of (T).

Expressions [7] and [7a] do not reflect the dependence on the degree of interchangeability or complementariness existing between the defensive measures to be taken. However, if it were supposed that both goods are perfect substitutes, and that the technological function were linear, it would be sufficient to know \( P_A \) and the (fixed) coefficient of the marginal rate of substitution between "R" and "A" to obtain the marginal valuation of the change in “R” (WTP) while keeping utility constant (Freeman, 1992, page 113). In this case, it is possible to state that the defensive expenditure method is an exact measurement of the marginal willingness to pay (WTP) for a change in “R”, so that:

\[
\frac{de}{dR} = e_R(P_A, R, u^0) = -P_A b = w^u_R \tag{7c}
\]

When defensive behaviour of individuals is considered as a monetary valuation method, expressions [7], [7a] or [7b] must be taken into account as the level of noise (R) is thus valued while keeping the utility level constant. In this sense, expression [7c] is a special case (perfect substitution and lineality in the expenditure function) allowing a measure of the change in individual welfare to be obtained.

2.4. Observed Change

The observed change in the consumer’s expenditure as a result of applying defensive measures however do not coincide with the same measure of change in welfare, as what we see in this case is the marginal value of the noise level while keeping constant the level of income.

In the line shown by Courant and Porter (1981) (considering the noise level as the environmental variable), when observing the modification in defensive expenditures, the noise level (T) increases in the face of changes in the cost of insulation. The defensive expenditure is determined by the product of the cost of insulation and the level of internal noise “T”. Following the reasoning of expression [7a]:

\[
\frac{de}{dR} = -P(R) \frac{dT}{dR} + T \frac{dP(R)}{dR} = w^m_R \tag{8a}
\]

Comparing expressions [7a] and [8a], it can be seen that an increase in the level of noise (R) increases the expenditure on soundproofing, and this then leads to a greater level of internal noise (T) (spending less on domestic peace and quiet)
If \( \frac{dT}{dR} > 0; \frac{dP(R)}{dR} > 0 \) \( \Rightarrow w^m_R < w^u_R \)

Thus demonstrating that defensive measures under-estimate the true value of the change in welfare. So that, it is important to assume that demand for internal noise is elastic in the face of changes in prices of soundproofing.

The observed difference indicates the amount of the contribution of \( R \) to \( T \), weighted for the contribution of \( T \) to the individual’s utility, valued in terms of the marginal utility of income. In the case of Bartik, [7b] does not coincide with the defensive expenditure because the value of \( T \) changes.

2.5. Non-marginal changes : \( u_0 \ u_1 \ u^0 \ u^1 \)

For those cases in which variations in \( R \) are non marginal, the expression of the change in welfare may be expressed in terms of compensating variation (CV) (as the necessary expenditure at a level of noise pollution \( R \) to achieve a level of utility “\( u^0 \)” or equivalent variation (EV) (where the level of utility is defined as “\( u^1 \)”):

\[
CV = e(R_0, u_0)-e(R_1, u_0) = M - e(R_1, u_0) \quad [9]
\]
\[
EV = e(R_0, u_1)-e(R_1, u_1) = e(R_0, u_1)- M \quad [10]
\]

Bearing in mind the equivalence between [2] and the expenditure function expressed in [9], and considering that the choice of the internal noise level “\( T \)” made by an individual is:

\[
T = t \left(R, e(R,u)\right) \quad [11]
\]

CV can be calculated as follows:

\[
CV = \int_{R_0}^{R_1} D_R(R, T)dR = \int_{R_0}^{R_1} D_R(R, t(R, e(R, u_0)))dR \quad [12]
\]

where \( D_R \) represents the compensated function of soundproofing expenditure, as \( T \) adjusts to the direct and indirect changes in “\( R \)”.

One of the problems posed when trying to estimate equation [12] consists in obtaining the function \( e(R, u_0) \) at the integration interval points \( (R_0, R_1) \). One possible solution would be to sub-divide the integration intervals into sub-intervals and to find a discrete solution for the integral.

Starting with \( (R_0, T_0) \) and knowing the function \( D_R(R_0, T_0) \), for a small variation in \( R=\Delta R \), \( CV \) (approximately within that interval) will be \( \Delta R \ D_R(R_0, T_0) \). In the next step, the utility is kept constant and an adjustment of \( T \) is allowed with a level of income where the approximation to \( CV \) is subtracted in the preceding step. The process is concluded when the last interval is measured and \( R_1 \) is reached.

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\(^5\) Hereafter all expressions for CV may be used to derive EV by changing the utility level \( u_0 \) to \( u_1 \).
A second problem that happens when estimating CV is that, knowing the partial derivative of (D) with respect to (R), the function \( t(R,e) \) and the argument \( e(R, u_0) \) but this latter is very difficult to estimate. For the calculation of the function (D) (which will be specific to each type of house studied), the various soundproofing techniques are analysed to achieve a level of internal noise given a specified level of external noise. The soundproofing costs should include items such as the transaction costs and the benefits that soundproofing contributes to, other elements such as heating expenses, etc. As for the calculation of the function \( t(R,e(R,u)) \) expressing the chosen level of “T” (for specified levels of income and (R)), this varies from one person to another. Its derivation therefore depends on a direct observation which can be obtained through hypothetical means.

As in the case of marginal changes, measurements are presented below for the change in the welfare representing the upper and lower bounds of the true change in welfare and with lower requirements in terms of the resources necessary for their estimation.

The reduction in (D) in order to achieve an initial level (T) given a reduction in (R) and the expenditure function to achieve a constant utility level and a constant internal noise will be:

\[
D(R_0,T_0) - D(R_1,T_0) \quad \text{[13]} \quad \text{Soundproofing expenditure}
\]
\[
e(R_0,u_0) - e(R_1,u_0; T_0^*) \quad \text{[14]} \quad \text{Expenditure function}
\]

So that [13] is equal to [14]\(^6\)

\[
D(T_0) = D(R_0,T_0) - D(R_1,T_0) = e(R_0,u_0) - e(R_1,u_0; T_0^*) \quad \text{[15]}
\]

Comparing [9] and [15], it can be seen that the savings in defensive expenditure on varying (R) and keeping (T) constant is a lower bound of CV. In the case of EV, it can be seen that the savings in expenditure constitutes an upper bound.

\[
CV = e(R_0,u_0) - e(R_1,u_0) = D(R_0,T_0) - D(R_1,T_0) - e(R_1,u_0) + e(R_1,u_0; T_0^*)
\geq D(R_0,T_0) - D(R_1,T_0) \quad \text{[16]}
\]
\[
EV = e(R_0,u_1) - e(R_1,u_1) = D(R_0,T_1) - D(R_1,T_1) + e(R_0,u_1) - e(R_0,u_1; T_1^*)
\leq D(R_0,T_1) - D(R_1,T_1) \quad \text{[17]}
\]

The foregoing bounds may be considered as a generalisation of the Paasche price index (what should be given to a person to be able to buy the same basket of goods in the face of variations in the price for which she can buy the original basket) and the Laspeyres price index (the money we would have to take away from a person in the face of variations in the price for which he or she can buy the original basket) (Azqueta, 1994)

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\(^6\) To do so we suppose that the expenditure on all other goods “X” is the same at any noise level “R” providing that the utility and the level of internal noise “T” are kept constant. This is so because the utility function [3] only depends on “X” and “T”.

\(^7\) This inequality is verified by \( e(R_1,u_0; T_0^*) \geq e(R_1,u_0) \) as expenditure is restricted in the first expression to a level of “T” while no such restriction exists in the second.

\(^8\) This inequality is verified by \( e(R_0,u_1; T_1^*) \geq e(R_0,u_1) \) as expenditure is restricted in the first expression to a level of “T” while no such restriction exists in the second.
providing the expenditure function on soundproofing is linear with respect to the variable “T”.

\[ D(R_0, T_0) - D(R_1, T_0) = T_0 [\Delta \text{Price} T]. \] \[18\]

The saving on soundproofing expenditure [12] need not coincide with the defensive expenditure observed on passing from \(T_0\) to \(T_1\) [17] therefore the relationship between the three measurements observed is:

\[ D(R_0, T_0) - D(R_1, T_1) \leq D(R_0, T_0) - D(R_1, T_0) \leq CV \] \[19\]

In this way, it is seen that the observation on expenditure associated with defensive measures is a defined approximation (both in marginal and non-marginal changes) of WTP and CV. In both cases, it is shown that this measurement is a lower bound, although the degree of under-estimation is offset by the ease with which the information required for the estimation is obtained.

3. Validation of the defensive expenditure method.

Although there are differences in the estimation of changes in the welfare, the defensive expenditure methodology has been used in several empirical studies to estimate partially the benefits (costs) of an improvement (worsening) of the environment. Among the studies most often quoted, are the papers by Harrington, Krupnick and Spofford (1992), Abdalla, Roach and Epp (1992) and Gerking and Stanley (1986). On the other hand, as mentioned in the preceding heading, Courant and Porter (1981) Bartik (1988) and Freeman (1992) have shown that the theoretical relationships between, the theoretically correct value of the benefit (WTP) and the defensive expenditure (DE) depend on the interaction of the environmental quality and the effectiveness of averting behaviour.

Considering [16] \[ WTP_i = DE_i + \beta_i \] \[20\]

If \( \beta_i > 0 \), DE is the lower bound of WTP.

With the purpose of validating this methodology we can use some validation techniques, Comparating this method with Contingent Valuation (CV), on the basis of a nomological network such as that presented by Betz and Weiss (1987), Laughland (1996) shows the relationship between the CV and the defensive expenditure measures: the first level considered theoretical relates to the willingness to pay, the defensive expenditure and the exogenous variables influencing the other two factors; a second level shows the relationship between the theory and the empirical evidence; and a third level links the data obtained with each theoretical level.

Most of the theoretical studies try to obtain information about the value of \( \beta_i \) from the value of the average of the WTP and DE. To confirm the construct validity of the defensive expenditure methodology, however, emphasis should be placed on certain exogenous variables (\( L_i \)) such as the level of income or preferences:
\[ WTP_i = \int_{f(R_0)}^{f(R_i)} T_h(f(R), L_i) df(R) \]  \[ DE_i = T_m(f(R_0), L_i)(f(R_0) - f(R_i)) \]

where: \( f(R) \) represents the cost of abatement of noise pollution
\( T_h \) and \( T_m \) are the Hicksian and Marschalian demands of “T”.
\( L_i \) represents the exogenous variables.

Deriving [21] and [22] with respect to \( L_i \) provides the expressions:

\[ \frac{dWTP_i}{dL_i} \geq 0; \frac{dDE_i}{dL_i} \leq 0 \]  \[ dB_i = \frac{dWTP_i}{dL_i} - \frac{dDE_i}{dL_i} \geq 0 \]

Although the changes in [23] may be in the same sense, the sign of [24] may be different. Figure Nº 1 illustrates a situation in which changes in \( L_i \) displace the demand curves by an equivalent magnitude in parallel. DE is measured by the area \((a+b+c+g)\) instead of the original area \((a)\) and the WTP by the area \((a+b+c+g+h)\) instead of by area \((a+b)\). It can thus be shown that [24] is equal to zero.

Figure Nº1

Another possibility arises when the influence of the exogenous variables changes the value of the slope of the Hicksian demand curve thus making [24] positive. Finally, it is important to consider rotating movements of the demand curves around the same point, so that DE is constant but the WTP and of course \( \beta \) increase.

The paper by Laughland (1996) (based on some examples with WTP data obtained in CV studies and the information on DE) establishes a correlation analysis which allows us to infer the sign of expression [24] and offers the possibility of validating or not the
defensive expenditure method on the basis of the empirical analysis of the contingent variation.

4. Final Considerations.

The present paper has attempted to reflect on the validity of the defensive expenditure methodology for environmental valuation.

Considerating that individual welfare may be analysed from the standpoint of ordinal utility theory, a review is made of various views in the literature although almost all coincide in stating that defensive expenditure, in certain hypothetical cases,\(^9\) constitutes a lower bound for WTP and Compensating Variation (CV). Nonetheless, when it comes to valuing information requirements, the defensive expenditure methodology is appropriate for approximating measurements of changes in welfare.

The method’s dual nature can also be glimpsed, as it is an excellent approximation from a global perspective to measure the environmental damage affecting society as a whole.

Finally and as a conclusion to the paper, the possibility of establishing a validation technique for defensive expenditure is analysed on the basis of other methodologies (contingent valuation) and exogenous variables. The last consideration gives grounds to set aside theoretical considerations and enter the realm of empirical evidence where the defensive expenditure methodology seems to have greater protagonism.

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\(^9\) These include: a) Defensive expenditure are perfect substitutes for environmental goods. b) There is no other value for the individual. c) No significant adjustments are required in the abatement costs. d) The pollution level may be influenced by the Government. e) The cost of abatement is the same for all economic agents.
5. References


Methodological Note:

The paper analyses different alternatives when it comes to considering the valuation of environmental goods in an attempt to show that the monetary valuation methods using the concept of individual welfare in environmental cost-benefit analysis (ECBA) have to waive certain degrees of freedom in order to obtain such a valuation.

Monetary valuation of individual welfare.

There are many examples of the use of environmental cost-benefit analysis (ECBA) for the application of a specific policy or environmental valuation techniques to estimate the changes in individual welfare. Some authors have insisted on direct critique of ECBA and valuation methodologies with the sole intention of questioning this form of environmental valuation (Adams, 1993). Nonetheless, it is possible to pose an analysis from another perspective, including two aspects considered essential (normally excluded) such as agency aspect and deontological aspect of individual preferences (Westskog, 1996).

The agency aspect is what links people’s preferences with opinions and beliefs. This is extremely important when it comes to identifying the opinion of individuals regarding environmental valuation, as the theory of preferences or, in general, the theory of utility assumes that there is no difference between the concept of individual welfare and the aspects which link the individual to society (agency aspect). There are, however, arguments demonstrating important differences when analysing environmental goods (Sen, 1987).

The deontological aspect incorporates the elements related with ethical postures, even within the anthropocentric view of the environment.

Westskog (1996) shows that there are various possible directions for environmental valuation: an initial level includes the distinction between the anthropocentric and the non-anthropocentric positions; secondly, the author shows that in both cases it is possible to assume a view of specific actions (what is) and the ethical or deontological positions (what should be). Leaving aside the non-anthropocentric positions, both in terms of actions and of deontology, he considers that the anthropocentric view contains positions closer to the ethical vision when it comes to assessing the valuation of the environment (mention could be made here of the theories of Kant and Nozik on individual rights10) and positions such as those assumed by traditional economic theory, interested in the consequences deriving from actions in the scope of environmental goods. Monetary valuation techniques and ECBA are essentially based on the same classification.

The way to solve the abandonment of ethics in valuation techniques is to incorporate the regulatory framework of rights and principles in such a way that few environmental projects are susceptible to monetary valuation through ECBA. But, far from resolving

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10 What happens when valuing a protected area with very large net benefits but which involves relocating the local population from their land with the subsequent loss of their customary lifestyle?
the problem, it becomes even more complex because the law does not imply that everyone has the same ethical opinion with respect to environmental goods.

Finally, a distinction is drawn (within the framework of the anthropocentric vision in connection with the world of action) between the aspects associated with individual welfare (welfare aspect) and the aspects of individual welfare associated with society (agency aspect). Individual welfare is that welfare achieved by a person as a result of his or her consumer choice, whereas the welfare associated with the agency aspect is the welfare obtained by a person bearing in mind his or her opinions and beliefs which often interact with the individual’s participation in society.\textsuperscript{11}

In many cases, these two ways of viewing individual welfare do not coincide. A person may have a certain vision of how to act in a given situation but that person does not always think and act in the same way\textsuperscript{12}. Sen asks whether people really have motivations other than welfare when it comes to establishing preferences such as, for instance, beliefs and opinions. In many cases, a person’s welfare and therefore his or her actions are going to be constrained by their role in social organisations, thus making it extremely difficult to separate. Under observation (revealed preference) it is not possible to distinguish whether the preferences respond to the perspective of individual welfare or else to that of agency aspect. In many cases, the valuation of public goods can express a measurement associated with individual welfare but it may also show a way of creating a better society.

If two types of preferences are held at a given time, a double error may be incurred when valuing environmental good as the result obtained may not be the agency aspect or else the initial valuation may include the agency aspect when in fact the methodology only attempts to measure the aspect of individual welfare.

From this perspective, valuation implies accepting an anthropocentric vision where only human beings have intrinsic value. Secondly, ECBA moves in the realm of action, discarding ethical judgements and finally, in questions linked to individual welfare (standard theory of ordinal utility), it does not always consider the agency aspect when it comes to valuing individual preferences.

This implies that valuation techniques are limited for taking environmental policy decisions. In these cases, it is advisable to establish a mechanism to obtain the greatest possible amount of data, including data provided by other methods such as defensive expenditure where individual opinion (contingency valuation) can be avoided and where valuation is linked to market goods where confusion between individual welfare and agency aspect are less important.

\textsuperscript{11} For a discussion of the differences observed between individual welfare (from different standpoints) and the agency aspect, please refer to Sen, A. (1987).

\textsuperscript{12} When the French Government carried out nuclear testing in the Pacific Ocean, some people (within their social context) decided to boycott the purchase of French wine. A wine-lover who was also against the nuclear testing decided to buy French wine. He later regretted it, but from the point of view of individual welfare there is nothing to lament because he likes the wine and it increases his utility. From the point of view of the agency aspect, he felt uncomfortable because the purchase of the bottle of wine implied not respecting the social decision of a boycott.
Finally, defining and measuring individual welfare has been one of the basic challenges of economics, particularly because many essential ideas refer to the fundamental behaviour of maximising welfare levels.

Initially, utility was thought of as a cardinal numerical measure of the happiness of a person and the numerary represented *utils*. Nonetheless, conceptual problems of utility soon appeared: is utility the same for everyone?; is it possible for one good to have three times the utility of another? In view of the impossibility of providing adequate answers to these questions and to measure utility as a cardinal concept, the concept of utility is abandoned as a measure of happiness and is replaced by the concept of preferences where utility is intended to describe the consumer’s behaviour. The utility function assigns numbers to know the order of preference of one basket over another. This attempt to measure so-called ordinal utility attempted to identify which were the best individual decisions through preference analysis (Varian, 1992).

The choice of ordinal utility implies abandoning the concept of happiness as the way of designating utility but it is also true that the impossibility of finding an adequate measurement method led people to point out that what matters is not knowing the degree of happiness felt by an individual but the way he or she chooses the relevant preferences (without necessarily obtaining cardinal utility).

From that point on, the construction of a utility theory (not without its problems) became consolidated as the element justifying the affirmation that changes in utility implied changes in welfare. In order to identify preferences (derive the indifference curves), the route taken was to use information on the consumer to obtain preferences and not vice versa as postulated by demand theory. In this sense, assuming the hypotheses of convex preferences and constancy, the notion of *revealed preference* was used to identify demand. This observation of what is chosen or what *reveals preferences* is provided by consumer choices (demand).

From a hedonistic anthropocentric standpoint, it is possible to argue that, if welfare is equivalent to maximising preferences instead of maximising individual happiness, then our final goal of understanding human welfare is being restricted in its degree of freedom.

In fact, when the defensive measure method is not included in the classification of methodologies measuring changes in welfare as a result of modifications in the supply of certain environmental goods, the argument given is that averting behaviour does not imply knowing a change in individual welfare but it does constitute an approximation, as will be seen below. So far, however, it seems clear that the other methods considered by the literature as valid do not come close to an adequate measurement of changes in welfare either, as four restrictive hypotheses (degrees of freedom) are analysed in that an anthropocentric vision (1) where the only thing that counts is the world of actions (2) in order to obtain a measure of individual welfare, leaving aside something as essential in the valuation of public goods as the agency aspect (with the aggravation of not being able to tell whether the latter under- or over-estimates the measurement found) (3) and accepting the theory of ordinal utility which implies giving up on a measure of happiness from a cardinal point of view (4).
It is shown that the traditional methodologies of monetary valuation have to effect a series of implicit hypotheses in order to consider whether the estimation measures a change in individual welfare. In this sense, the observation of defensive expenditure is not affected by any of the limitations implying a waiving of lower degrees of freedom.