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von

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Abstract:

In the light of the Convention on Biological Diversity the German Advisory Council on Global Change has recommended the use of the concept of total economic value consisting of use- and non-use values as a criterion for public decision making concerning projects which influence biological diversity. But it is controversial which economic valuation methods are to be employed to this end. This paper investigates the applicability of stated preference methods, i.e. contingent valuation (CV) and attribute based choice modeling (ABCM), for the assessment of use and non-use values of biodiversity preservation projects. While CV measures the total value of an environmental change, ABCM aims at the valuation of single characteristics of a project. In the light of recent literature the main criticism of each method toward the measurement of biodiversity values is discussed. It turns out that the main obstacles for the design of sound valuation studies are the issues of substitutability between biodiversity and market goods, and the level and method of information provision as a basis for valuation. Concerning the applicability of either method, this study suggests their use depending on the question whether the total value or the values of several elements of a biodiversity preservation project are of interest. It is stressed that the success of a valuation study depends heavily on the interdisciplinary cooperation between biologists and economists.

JEL-Class.: D61, Q22, Q26

1 Introduction

Especially since the United Nations Conference on Environment and Development in 1992 in Rio de Janeiro, also known as the Earth Summit, the issue of loss of biodiversity, and with it the possibilities for its preservation, has become one of the primary topics in the global environmental debate. One of the outcomes of that conference was the adoption of the Convention on Biological Diversity (UNEP 1992) by 157 States with the objective to establish a framework for the sustainable use of biodiversity. Whereas earlier practices of biodiversity policy stressed the issue of conservation to counteract the negative consequences of resource exploitation, the Convention sets a new paradigm by explicitly acknowledging the nature of biological diversity as a resource for human use. Resource use *per se* is no longer seen as the reason for the loss of diversity but under certain conditions as a means to ensure its conservation on an efficient level. Thus, sustainable use in the sense of the Convention can be circumscribed as dealing with the conflict between use and preservation of biological resources in such a way that present needs be met and the potential to meet future needs be retained. To this end, it is proposed to prevent a long term decline of biological diversity. The three main objectives of the Convention are: conservation of biological diversity (1), sustainable use of its components (2), and the fair and equitable sharing of benefits of its use (3). This paper will deal with the first two objectives and will apply the cost-benefit framework as a means to make appropriate decisions.

The issue of how to deal with biological resources was motivated by the finding that human use has started an extinction process that has been found to be the sixth largest in history of life (Chapin et al. 2000). It is estimated that 5 – 20% of the species in many groups of organisms, especially mammals and birds, have already become extinct and that current rates of species extinction are 100-1000 times larger than pre-human rates (Pimm et al. 1995). Hawksworth and Kalin-Arroyo (1995) estimate that the 1.75 million described species may be only around 10% of the total number of species on earth. At a discovery rate of 300 new species described per day (Purvis and Hector 2000) there is considerable concern that many species will become extinct before they are even discovered.

The Convention on Biological Diversity defines the term "biological diversity" as: "[..] the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems." In Article 10 of the Convention it is mandated that "each contracting party shall, as far as possible and as appropriate: "[..] integrate consideration of the conservation and sustainable use of biological resources into national decision-making; [..]". Article 14 calls for "[..] public participation in such procedures [..]". Since cost-benefit analysis is a well-established tool for decision-making in the context of public projects, it is of importance in the light of the Convention to analyze its applicability to determine the impacts of projects that influence or harm biological diversity. Biological resources can be seen as a subcategory of environmental goods for the valuation of which in economic terms various techniques, most prominently the contingent valuation method, exist.

However, as will be analyzed in detail, biodiversity represents a special case and the applicability of the existing methods in cost-benefit analysis must be scrutinized. It will be shown that an alternative method, attribute based choice modeling, exists that seems to be more appropriate for the valuation of biodiversity than contingent valuation.

The paper is organized as follows: after the brief introduction section 2 describes the two perspectives, natural sciences and economics, from which the value of biodiversity can be seen. In section 3 two stated preference methods, contingent valuation and attribute based choice modeling, commonly used to assess the economic value of biodiversity are described and their main criticisms are discussed in the light of the recent literature. Section 4 takes up the issue of biodiversity valuation and analyzes the main obstacles for the use of stated preference methods. The applicability of the two methods is scrutinized and recommendations for the use of each method in specific valuation tasks are given. Section 5 concludes.

2 Why should we value biodiversity?

This section defines the concepts of value of biological diversity on different levels: the level of the natural sciences and the level of economics. It is important to distinguish between those levels because each offers a different approach and only in combination of those two can the value of biodiversity appropriately be analyzed.

2.1 The natural science perspective

The issue of loss of biological diversity has traditionally been dealt with in the realm of the natural sciences, in particular biology. It must be noted, however, that the term "biological diversity" or "biodiversity" appeared only relatively recently in the scientific and political discussion when the famous ecologist Edward O. Wilson used it as an expression that would be attractive in a well organized campaign to bring the problem of increasing extinction rates of species to the attention of the American public in the late 1980s. Especially since then, aspects of loss of biodiversity and its role in ecosystems have appeared on the research agenda of biologists. But even before that date biologists were interested in the role of species diversity in ecosystem processes. The following section will put forward the main scientific issues of discussion relating to the function of biodiversity in nature.

2.1.1 Stability and ecosystem functioning

The main discussion evolved around the hypothesis that increased species diversity enhances ecosystem stability. Elton (1958) and Odum (1953) independently found in repeated experimental studies that greatly simplified terrestrial communities are characterized by more violent fluctuations in population density than diverse terrestrial communities. Thus, stability of an ecosystem was seen in terms of variations of population density over time. Stability was defined as an ecosystem's ability to return to an equilibrium population of a species after some kind of disturbance. Such a disturbance could be some exogenous abiotic shock resulting in a movement away from an equilibrium, like a particularly wet or hot year or some biotic variation within the system like the increase of a predator species putting pressure on a prey species. The time required for an ecosystem to return to its equilibrium after a disturbance is captured by the term "resilience". An ecosystem is assumed to be more stable the shorter the time needed for its return to equilibrium after a disturbance (McCann 2000). Both concepts, stability and resilience, have later been extended to non-equilibrium dynamics by considering the return of the system to some attractor state, a hypothetical equilibrium which might never be reached because the system will again be disturbed before reaching that state. However, in contrast to the experimental findings of Elton and Odum, Robert May (1973) used a mathematical model with randomly constructed communities and randomly assigned interaction strengths between the species of the communities and found that increased diversity tends to destabilize community dynamics in that increasing fluctuations of population densities could be observed. Thus, the question remained whether species diversity and ecosystem functioning are related and in which way. Ecosystem functions can be defined as (1) functions influencing stocks and flows and (2) functions that are related to characteristics of the systems. Examples of the former are growth of biomass, decomposition of organic matter or nutrient retention, the latter contains e.g. resilience, stability and resistance (e.g. to invasion of alien species). According to Lawton (1994) four hypotheses concerning diversity and ecosystem function can be formulated: there is no relationship ("null hypothesis"), ecosystem functioning increases linearly with diversity, i.e. each additional species is beneficial ("niche complement hypothesis"), ecosystem functioning increases considerably at first, then each additional species has only marginal effects, those species are redundant ("redundancy hypothesis"), and the relationship between diversity and ecosystem function cannot be predicted, some species are important, others are redundant ("keystone species hypothesis"). Numerous scientists have attempted to test these hypotheses (e.g. Naeem et al. 1995, Tilman et al. 1997, Wardle 1997). The results are not unambiguous. Naeem et al. and Tilman et al. find evidence that supports the niche complement hypothesis as well as the redundancy hypothesis. Wardle et al., studying flora and fauna on Swedish islands of different size, clearly identify keystone species, e.g. the Norway spruce (*Picea abies*) with its dominant influence on soil chemistry. Taken together, the findings so far suggest that certain keystone species with specialized ecosystem functions are particularly important while there may be a vast number of redundant species that, when some keystone species disappear, might be able to perform missing functions, thus serving as insurance within an ecosystem. It follows that no simple relationships between diversity and ecosystem functions can be determined, it is particularly clear that focusing purely on species diversity has only very limited explanatory power since functional relationships of species are ignored.

Thus, from a natural science perspective the value of a species is manifested by its function within an ecosystem, and due to the distinction between keystone species and redundant species has to be determined on a case by case basis. It would be elusive to recommend a general policy that could serve as a guideline for the correct use of biodiversity, a sustainable level of biodiversity involving trade offs among species cannot be determined. All authors mentioned above are in favor of the precautionary principle; some argue that biological systems should be left untouched and all species preserved since effects of their loss on ecosystem function and structure might possibly be very large, some relax this extreme view and recommend the adoption of a safe-minimum-standard of diversity in order to assure the continuation of all basic ecosystem functions.

2.2 The economic perspective

The economic approach to the value of biological diversity focuses on the well-being that nature provides to individuals of a society. Here, nature is seen as a compilation of biological resources that contribute to individuals' utilities in different ways. An important part of this contribution relates to the values of biological diversity as seen from the natural science perspective since ecosystem functions might have an impact on people's well-being. In the economic context it would be more appropriate to define those functions as ecosystem services. Ecosystem services are defined as the processes and conditions of natural ecosystems that support human activity and sustain human life (McCann 2000). Such services include the maintenance of soil fertility, climate regulation and natural pest control, and provide flows of ecosystem goods such as food, timber and fresh water. The provision of ecosystem services depends on the functioning of the ecosystems providing these services, and in that respect the debate on the relationship between diversity and functions of ecosystems becomes relevant in the economic realm, as well. Whereas the biologist was merely concerned with those functions and tended to recommend preservation of species and habitats due to a lack of knowledge in principle of how a loss would affect ecosystem functions, economists are always interested in the trade-offs that can be made. From an economic point of view, an individual would always search for the maximum utility, or well-being, that can be extracted from a resource. In the case of biological resources, e.g. a diverse forest habitat, it is clear that there are various ways in which utility can be derived from that resource. First, it could be left untouched and thus continue to provide all beneficial ecosystem services as defined above, secondly, it could be used and harvested to some degree, thus providing market goods such as timber and at the same time be left sufficiently intact as to provide valuable ecosystem services, or, thirdly, it could be completely harvested and converted to a different structure, e.g. an agricultural or industrial area, not providing the ecosystem services associated with the natural habitat. Each way of using that forest bears an opportunity cost, i.e. the forgone benefits of not using the resource in an alternative way. Thus, it would be economically unwise to leave the forest intact if the alternative use of complete harvesting and converting into a productive industrial area would yield a higher benefit. Conversely, if the ecosystem services provided were of such an importance for the regional environment and could, if at all, be replaced only with an enormous effort, conversion to an industrial area would not be the right choice. Before concentrating on the issue of making the economically correct choice of the use of a biological resource, further categories of economic value need to be introduced.

It has become common to use the term "total economic value" as an expression that aggregates the various value categories associated with a biological resource. The next hierarchy would be a distinction between use values and non-use values (Krutilla 1967). Within the category of use values it can be distinguished between direct use values, i.e. values arising directly from consumption of a commodity (e.g. harvesting of timber, a recreational walk in a natural forest), and indirect use values, i.e. values that arise indirectly through ecosystem services without consuming the resource (e.g. ground water purification). Within the category of non-use values three subcategories can be distinguished: existence value, option value and bequest value. Usually, the existence value dominates within this category. It arises if an individual puts a value on the pure existence of a species or an ecosystem without ever considering to use it directly. Moral or ethical beliefs and attitudes play a major role here. Option value accrues from the possibilities of using the resource in the future. If the benefits from a possible future use are still unknown, as is the case in bioprospecting for pharmaceutical use, for example, this would represent a quasi-option value. Finally, bequest value refers to a present generation's value of leaving a resource for use or non-use of future generations. The value concept described is based on an anthropocentric perspective and as such does not capture intrinsic values of nature, i.e. nature having a value on its own, as often postulated by biologists (see Lockwood 1999 for a discussion of intrinsic value). However, anthropocentric values do not preclude the consideration of ethical values towards nature. It has been made clear that existence value captures any moral feelings of man towards the environment which form the very basis of the concept of intrinsic value.

2.3 Cost-benefit-analysis

It is now possible to return to the question of how good and informed decisions on the way a resource should be used can be made. It has been shown that benefits of alternative uses have to be compared and the necessary value categories to describe the benefits that accrue from those alternative uses have been set out. In reality, the framework of cost-benefit analysis is employed for such decision making which usually occurs in public policy processes. Let us assume a public project aiming at building a highway that, as planned, crosses a natural forest area considered valuable by biologists in terms of the fauna and flora inhabiting it. Biologists note that a fragmentation of the habitat will lead to forest patches not considered large enough to sustain that diversity in the long run so that there is a possibility that some species might become extinct due to a reduction of the genetic pool through fragmentation. The forest is also a popular recreation area for hikers and bird watchers while some areas are closed for visitors due to the existence of rare species that cannot tolerate disturbance. Let us consider the case that a local group files a motion and proposes to build the highway around the forest. In such a situation it is clear that there would be winners and losers of this alternative. The additional cost to society would be increased construction costs and travel time of future highway users. The benefits to society would be the preservation of the forest with its species, ecosystem functions and recreational possibilities. Assume for now that those who bear the costs (the “losers”) and those who get the benefits (the “winners”) from the project are two distinct groups in society. Under which condition would it be advisable for the society to bear the additional costs and build the highway around the forest? It is clear that the net benefits from the detour must be positive in this case. Stated differently, it must be possible for the winners to compensate the losers of the project for the incurred costs and leave both groups at least as well off as they would be if the highway were not built around the forest. This decision rule in public decision making is called Kaldor-Hicks potential compensation criterion which states that a project should be carried out if it is possible for the losers of the project to be compensated by the winners. However, in practice there is no clear distinction between the winners and the losers since individuals might lose as well as gain at the same time because it can reasonably be assumed that everyone will have to come up for the increased construction costs, will use the future highway, and, at least from time to time, will visit the forest for recreational purposes. While the costs are relatively easy to measure, the assessment of the benefits is more complicated. In analogy to the above described economic value concept, there will be direct and indirect use values as well as non-use values through the knowledge of the existence of species that one might never see. How can those different value categories be assessed? The following section will describe and analyze various methods for the assessment of the benefit side of public projects involving biodiversity.

3 The methods

This section deals with the existing methods for the valuation of environmental goods which also form the basis for the valuation of biological diversity. As noted above, individuals' valuations of goods are based on the utility they derive from their consumption or use and the trade-offs between goods they are faced with. It is assumed that each individual has an underlying preference structure towards these goods. Unfortunately, these preferences for goods are not directly observable, thus representing private information. Since the economic value concept is founded on individual preferences it is necessary to gain access to this private information if some reliable measure for people's valuations of goods is to be obtained. Ideally, we would want to be able to observe the actions of economic agents and infer their respective valuations for goods or services from behavior that has actually occurred. For goods that are traded in markets this is usually an easy task for economists since we can be sure that if someone purchases a good at a certain price, the price paid represents a lower bound for this individual's valuation of the good since otherwise she wouldn't have spent the money on that good. Such data about market transactions are usually easily available and reliable information on individuals' valuations of goods is obtained through this revelation of preferences by market transactions.

In the case of environmental goods, however, such market transactions do generally not occur since the public good character of most environmental amenities, such as air quality or in this case biological diversity, makes a system allowing them to be traded in markets very difficult to implement. However, in certain instances environmental amenities, even with characteristics of pure public goods, enter market prices implicitly. The classical example for such a case is the market for apartments or houses having or not having some scenic view or good air quality or the like. Through data of market transactions of equal apartments or houses differing only in the level of the environmental good the implicit price of the environmental good contained in the total price for the house, and as such the valuation, can be obtained. This method is called method of hedonic prices and belongs to the class of indirect methods since data about goods that are somehow related to the good of interest are used for its valuation. Other indirect methods are the travel cost method that tries to assess people's valuation of a recreational site through the analysis of money and time spent for its visit, the averting behavior method using expenditures to avoid a negative impact of a decreased environmental quality and the production function method analyzing the impacts of an environmental quality change as an input into production processes. Nunes and van den Bergh (2001) give an overview of applications of these revealed preference methods for the valuation of biodiversity changes.

However, in most instances these methods are only capable of capturing use values since the amenities considered are directly consumed or used in some way. A rare example of existence value implicitly contained in a market price could be the price consumers are willing to pay for tuna caught with dolphin friendly fishing methods in excess of the price for conventionally caught tuna. In most instances non-use values are not implicitly contained in prices for market goods and thus techniques relying on people's stated preferences have to be employed for their elicitation. In this paper the term "stated preference methods" comprises both the contingent valuation method (CVM) and the attribute based choice modeling (ABCM) unlike a number of other authors which place CVM in a separate category. Since both methods rely on surveys and as such on people's stated instead of revealed preferences subsuming both methods into that term seems appropriate.

3.1 The Contingent Valuation Method

The first stated preference method described in this paper is the contingent valuation method. This method is a survey based technique for the elicitation of people's willingness to pay (WTP) for the provision, preservation or improvement of an environmental good. The underlying assumption of this method is that individuals have a coherent set of preferences for goods, including non-market goods like environmental goods, that these preferences would be revealed in proper markets and that there is a direct relationship between an individual's statement about her preferences and her true WTP. To this end, a hypothetical market for the environmental good is constructed and people are asked to make their decisions about the amount they are willing to pay contingent on the specific characteristics of the market set out during the questioning procedure. These contain the definition of the good, the way it would be provided, preserved or improved, and the mechanism of financing it, e.g. tax payments, contributions to a fund etc. Although hypothetical in nature, the survey respondents should be led to believe that they are confronted with a real situation since it is usually explained to them that their responses will influence public decision making and payments will be real once a positive decision on the realization of a project has been made. Carson (1997) terms those questions "consequential survey questions" and argues that only for those questions does economic theory provide predictions concerning respondent behavior.

The design of CVM surveys has been subject to continuous change since first applied in the early 1960s. Early studies used designs employing the open ended question format asking respondents simply about the amount of money they would be willing to pay or contribute to the described project. As has been shown by many authors, e.g. Carson et al. (2001), the open ended format is susceptible to various biases such as hypothetical and strategic bias. Various designs were proposed to overcome these problems, e.g. using a payment card with predefined amounts from which the respondent could choose one or a bidding game, but biases remained. Bishop and

Heberlein (1979) developed a closed ended format in which people were simply asked to accept or reject a proposed amount (bid level). This format, called dichotomous choice or referendum method, intended to approach the real decision situation in a market where people are confronted with a given price and have to decide whether to buy the good or not. In order to extract more information per respondent Hanemann et al. (1991) proposed the double bounded dichotomous choice format which has become the standard in CVM surveys since then.

Apart from the value elicitation question format the scenario description is the other crucial element of a CVM survey design since the valuation decision relies on the respondent's as complete as possible understanding of the project to be valued. Respondents are asked to value a change in environmental quality from the status quo to some alternative quality. It is essential that no doubt or possibilities for interpretation remain as to the direction or magnitude of the change and the respective consequences. Since the result of a CVM study should represent exactly the welfare change to society of a project relative to the status quo, every change to the specification of the project after the survey has been carried out would lead to a different result.

The CVM has been extensively applied to questions of valuation of endangered species and biological diversity. Nunes and van den Bergh (2001) and Loomis and White (1996) provide an overview and listing of studies. The latter paper finds values of average annual willingness to pay per household for rare and threatened and endangered (T&E) species to range from US$6 for the Striped Shiner, an endangered fish species in Wisconsin, to $70 for the Northern Spotted Owl (all in 1993 dollars). The former distinguishes the studies between the level of biological diversity valued. For single species valuations a range of US$5 for the Striped Shiner to US$141 per year and household for the Whooping Crane is found, for multiple species valuations ranged from US$2 for the conservation of fisheries in Montana rivers to ca. US$166 for the preservation of endangered species in West Germany. Valuations of entire natural habitats started from US$4-11 for the Mono Lake in California and went as high as US$242 for the preservation of water quality for all rivers and lakes in the United States.

3.2 Attribute Based Choice Modeling

The second stated preference method was originally developed in the field of marketing research and transportation economics and has only relatively recently been employed in the valuation of environmental goods. It is based on Lancaster's (1966) characteristics theory of value according to which individuals do not derive utility from a good *per se* but rather from the characteristics or attributes composing it. In attribute based choice modeling (ABCM), also called conjoint analysis, a good to be valued is constructed by defining a set of attributes which in conjunction characterize the good as a whole. By assigning different levels to the set of attributes, alternative goods can be specified which are called profiles. Various valuation techniques have evolved from this specification. The simplest valuation task presented to a survey respondent, and at the same time the closest to a real market situation, is to choose the most preferred profile from a set of given profiles. Once a profile has been identified as the most preferred, the other profiles become irrelevant. This approach is often called choice experiment (CE) and forms the basis for all other ABCM techniques. The choice between the profiles can be interpreted as reflecting the trade-offs that a respondent makes between the various attributes. By including a price or some other cost factor as an attribute into a profile it is possible to estimate economic values associated with the other attributes. In its simplest form, the choice between two profiles one of which representing the status-quo, the valuation task becomes identical to the CVM with choosing the status-quo being equivalent to stating a WTP of zero. If two alternative profiles to the status-quo are presented to the respondent the valuation task of a CE has already become more complex than in the CVM.

Proceeding to the next level of complexity yields the technique of contingent ranking in which the respondent is asked to put all given profiles in an ordinal sequence according to her preferences. From a statistical point of view, this technique is able to extract more information from the respondent since the choice process is repeated through all given profiles instead of ranking all remaining profiles to be equal after having chosen the most preferred (Foster and Mourato 2000). Consequently, the estimator is more efficient although this comes at the cost of more restrictive assumptions which might not always be justified by the underlying data.

The technique of contingent rating aims at adding another level of information. With this method, respondents are asked to give each profile independently from the other profiles a rating on a given scale, e.g. one to ten. Apparently, through this technique it is tried to extract cardinal information from respondents' stated preferences which in itself is considered by many economists to be a futile attempt. However, Roe et al. (1996) have shown under which assumptions it is possible to derive economic welfare measures like compensating variation from ratings data. Hanley et al. (2001) have analyzed the described techniques with respect to their consistency with welfare economics and come to the result that only CE yield a welfare consistent estimate in general. Contingent ranking estimates need not necessarily be welfare consistent if the status quo option is not presented to all respondents. Due to the cardinal nature of ratings data no welfare consistent estimates can be expected from contingent rating.

Compared to the CVM, methods of ABCM have less been applied to the valuation of environmental goods, let alone biodiversity. Johnson et al. (1995) explore the applicability of a contingent ratings approach to a combined water quality and health improvement project and derived estimates of WTP on an individual and aggregate level. Stevens et al. (1997) use three different ABCM models to value groundwater protection programs. Foster and Mourato (2000) apply a contingent ranking approach in order to estimate the value of the human health and biodiversity impacts associated with pesticide applications. Kahn et al. (2001) report on a project for which they are developing an environmental index containing biodiversity that can be used for the valuation of an environmental quality improvement project using contingent ranking. Finally, two studies, Garrod and Willis (1997) and Haefele and Loomis (2001) apply ABCM models on forest health, the former focuses on forest biodiversity in the UK using a ranking model while the latter estimates household WTP to reduce insect infestations per acre in the US using a ratings approach.

3.3 Critique of the methods

There is an ample literature that analyzes the validity and reliability of the described methods, especially the CVM. The Exxon Valdez oil spill in Alaska in 1989 boosted scientific research in this area since it was planned to admit the CVM for the calculation of compensation payments under the Oil Pollution Act of 1990. For a compilation of studies opposing the use of the CVM see e.g. Hausman (1993), the view of proponents however can best be contemplated in Carson et al. (2001) and Carson (1997). Recent studies to issues of validity of ABCM analysis methods are e.g. Adamowicz et al. (1998), Boxall et al. (1996) and Johnson and Mathews (2001). This section will briefly highlight some of the main criticism of both methods.

Concerning the CVM various effects have been detected that could possibly bias WTP estimates. Hypothetical bias would arise from the fact that respondents are confronted with a hypothetical situation instead of a real choice in a market. It is argued that since payments are not real, respondents fail to consider their budget constraint and therefore do not take into account that their consumption of alternative goods would be reduced by their stated WTP. In order to avoid hypothetical bias Carson (1997) proposed, as described above, to use only consequential questions. The use of a specific payment vehicle for financing the public good specified in a project is considered another source of bias. Respondents might for example have an aversion against new taxes due to a general distrust towards politicians deciding about the use of tax revenues. If it is determined that this is the case in a specific population, the researcher should consider the employment of an alternative payment vehicle, e.g. the mandatory contribution to a specific fund to finance the public project. Other biasing effects could occur through the presence of an interviewer in a face-to-face interview in the sense that a respondent might be induced to give an answer that pleases the interviewer, through statistical biases in the selection of the sample of respondents and through strategic considerations in the statement of the valuation. Carson et al. (2001) show that in principle all question formats are susceptible to strategic bias and that different formats are expected to yield different results because of varying incentive structures associated with the respective format.

Closely associated with these biases is the question of the underlying motivation of a respondent to state a positive WTP. One would want a respondent to formulate a well reflected valuation for the specific good in question, Kahneman and Knetsch (1992) however, argue that positive valuations for environmental goods rather reflect the desire of moral satisfaction to contribute to a public good and that the valuation is therefore not specific to the good valued. Andreoni (1989) has termed this effect "warm glow of giving" in the context of charitable contributions. However, even if this is the case, the economic value concept is not violated since a feeling of moral satisfaction would enhance an individual's utility so that this individual would, in turn, be willing to pay for the possibility to purchase this feeling. Yet, the significance of the warm-glow-hypothesis is still subject to much scientific controversy. Another issue of great controversy is the question whether WTP estimates exhibit sensitivity to the scope of the good being valued. Economic theory would expect to find higher estimates for a project that e.g. preserves 200,000 birds instead of just 2,000 (see Desvousges et al. 1993). Some studies claim to have found evidence of insensitivity to scope, but Carson (1997) has re-analyzed a multitude of studies and shows that presumed insensitivities to scope are due to "poorly executed survey design and administration procedures" and to inappropriate statistical methods.

As to methods of attribute based choice modeling, some of the possibilities for biases, e.g. hypothetical bias, payment vehicle bias, interviewer bias, are present as well and the surveys have to be designed as carefully as CVM surveys in order to prevent the estimates from being biased as far as possible. However, there are two major issues that are critical in ABCM. The first refers to the completeness of the scenarios. Adamowicz et al. (1998) argues that unlike in CVM it is essential that all relevant attributes be included in the choice set since the accidental omission of an attribute that determines a respondent's value of a project may lead to serious underestimation. In reality, though, researchers want to keep the number of attributes low to avoid an explosion of the number of profiles that have to be presented to a respondent. The other issue refers to the restrictiveness of the assumptions that have to be made in order to apply the statistical methods of the random-utility-model (RUM). Foster and Mourato (2000) show that the assumptions about the statistical distributions of the error terms of the RUM are crucial and while these can be justified in choice experiments in which only the most preferred profile is considered, this is not the case for the model aiming at a ranking of profiles. Therefore, they recommend the use of choice experiments and suggest intensive testing of the validity of the assumptions before arriving at specific valuation results.

4 Biodiversity Valuation

This section scrutinizes the methods described above with respect to their applicability to the measurement of the value of biodiversity for households. The valuation of biodiversity constitutes a special case of an environmental good and therefore deserves a separate consideration. First, the characteristics making biological diversity valuation more complicated are set out. In a second step, the main obstacles for its valuation are discussed in detail and the perspectives of each method to deal with them are analyzed. Finally, the employment of each method to specific valuation tasks is discussed.

4.1 Special characteristics of biodiversity as an environmental good

In previous sections we have seen that there is no single definition of biodiversity. It rather represents a complex concept within nature that manifests itself on various levels. Thus, it is futile to expect to be able to value biodiversity in the same way as this might be possible for e.g. ground water quality. Also, the value of biodiversity is not the same as simply the value of an endangered species or the sum of those or an entire wetland habitat. Biodiversity comprises a set of species and all their known and unknown interactions and functions for the development of ecosystems on small and large scales. Species are merely components in a complex system and as mentioned above their importance in ecosystems may vary from being simply another redundant species, at least in the current state of the ecosystem, to being a keystone species of which a change in population size or even its extinction will have large and unforeseeable impacts on the entire ecosystem. But from the practical point of view of cost-benefit-analysis it is clear that only components will be of interest depending on the respective decision to be made in society, e.g. developing a natural habitat for commercial use. The methods of interest here take only the part of obtaining information about the importance that the general population lays into special components of biodiversity. But as such, the reasons for its valuation may vary from individual to individual depending in some sense on that individual's cultural background. It is expected that each individual attaches to some degree use values as well as non-use values to biodiversity and therefore it must be ensured that the specific valuation design employed is able to capture both categories. Moreover, it is important that the valuation results from each methods be adequately interpreted.

In this context, two issues have emerged that need to be explored in detail: how ethical beliefs and in conjunction with these, notions of possible or impossible substitutability can be appropriately dealt with, and to what extent familiarity with biological diversity and the level of information of respondents play a role. Each issue is taken up below.

4.1.1 Ethical Beliefs and Substitutability

In order to derive value estimates that can be interpreted in a meaningful way the assumption of substitutability between goods has to be made. In the context of environmental goods this means that respondents accept that in principle a trade-off between market goods and environmental goods is possible to some extent. Hence, it would be possible to compensate a decrease of one by an increase of the other good and still remain on the same level of utility. This concept is essential for the applicability of cost-benefit-analysis since it relies on the Kaldor-Hicks potential compensation criterion according to which a project should be carried out if it is possible for the winners of a project to compensate the losers, at least potentially. If for example losers of a project that leads to a decrease in biological diversity cannot be compensated in principle, the Kaldor-Hicks criterion would fail and no benefits of whatever magnitude would lead to an adoption of the project according to the mentioned decision rule.

There is empirical evidence by Spash and Hanley (1995) and Hanley et al. (1995) that the assumption of substitutability may be violated to a considerable degree in the case of biodiversity. Their study shows that at least 25% of sample respondents reject the notion of substitutability. They interpret this particular behavior economically with a lexicographic preference structure of those respondents. In economic theory, lexicographic preferences stand for a situation in which one good has such a high priority in an individual’s preference ordering that it needs to be satisfied first before an increase in other goods can lead to an increased utility. In the case of an environmental good an individual would be willing to give up its entire income or consumption of other goods in order to prevent a decrease of that good. In other words, for people with lexicographic preferences there “does not exist a reservation price at which they are willing to trade a good” (Rosenberger et al. 2003). This extreme version of lexicographic preferences has been criticized by economists as being unrealistic and thus irrelevant for economic analysis. The only example for this kind of lexicographic preferences occurring in reality is if one's life or the life of a close relative or friend is threatened.

A less extreme version is proposed by Stevens et al. (1991) by defining a level of subsistence in terms of income below which an individual would not give up income for an environmental good. Now, it is obvious that this level of subsistence is a weak definition since it is not an objective criterion. For one person subsistence might mean a basic shelter and just enough food to survive while some other person could under no circumstance imagine to live for example without a car. The mentioned authors argue that biodiversity, or elements of it, are subject to lexicographic preferences. In a valuation study this preference structure will manifest itself by a high proportion of protest answers, i.e. individuals who either outright refuse to participate in the valuation study because of rejection of the notion that biodiversity could be traded off against income or, as a protest, state a zero willingness to pay (in the case of CVM; the equivalent of zero WTP in ABCM would be choosing the status quo profile). It is obvious that both types of protest answers present a problem to researchers since they cannot be treated just like "normal" answers. If protest answers are excluded from the analysis of the sample, a possibly important part out of a representative sample of a population would be neglected. This is problematic since a protest represents an extremely high valuation of the good in question. The same is true for those stating a zero WTP while their real valuation is very large.

Returning to the question if the existence of lexicographic preferences in biodiversity is a valid explanation of observed respondent behavior in valuation studies, a real world comparison is helpful: how much income would people actually give up to save 100 children in a poor country from starving? Probably not that much as to reach a level of subsistence as proposed by Stevens et al. Is it reasonable to suppose that known or unknown species of plants and animals are really more important to us? Probably not, and therefore protest answers should be taken for what they are: rejections of a process that respondents believe is not right! Thus, the concept of lexicographic preferences appears not to be the right framework to explain this protest behavior since it assumes that the respondents have already accepted the situation of trade offs between market consumption and environmental goods. But in reality it is this rejection of the process that leads to protest answers that seem to stem from a lexicographic preference ordering. But how could the empirically found discrepancies between actual behavior that clearly exhibits the acceptance of trade-offs between income and "goods" of high ethical relevance, such as healthy children or biodiversity, and the occurrence of protest answers in valuation studies be explained? An alternative approach to this question could be to distinguish the respective contexts in which decisions are made by respondents. First, it must be noted that the goods valued are typically “commons” for which, as is well known from public economics, a market allocation is not Pareto efficient because of their characteristics of nonexcludability, but rivalry in consumption. In order for an allocation of “commons” to be efficient, an omniscient and omnipotent planner needs to exist who can enforce the efficient allocation which would otherwise not be reached because of the existing incentives for individuals to free ride on the actions of others (tragedy of the commons). However, a valuation study does exactly create the possibility for individuals to act in place of that planner. Usually, respondents are told that a valuation study is embedded in some real decision to be made in society and that their answers have the potential to influence the direction of the decision. This is what Carson (1997) describes as a "consequential question" as mentioned in section 3.1. In this position a respondent acts as a *homo politicus* instead of a *homo oeconomicus*. This distinction has been formulated and described e.g. by Faber et al. (2002) and reflects the idea that people's decisions are not always driven by private utility maximization as the concept of the rational *homo oeconomicus* that forms the basis for all analysis of private, sometimes in the case of public choice even public, decision making. A *homo politicus* is someone who focuses on the well-being of society as a whole and is exempt from the ubiquitous free-riding possibilities in private life. While the *homo oeconomicus* is often circumscribed as the traditional “consumer”, the *homo politicus* stands for the “citizen”. Put into such a situation in a valuation study, the respondent can free herself from the feeling that individual action will only have a marginal impact and will lead to no significant change in a public good allocation decision. It is obvious that personal ethical beliefs that may exist towards e.g. saving children or protecting biological diversity and are suppressed to a large degree in private decision making will manifest themselves when put into the situation of a public decision maker. Thus, responses from valuation surveys of ethically sensitive public goods should be interpreted as what they think a good should be worth to everyone. A statement by Gowdy (1997) distinguishing between people's private versus public preferences points in the same direction.

Reverting to the concept of a lexicographic preference ordering as an explanation for protest behavior in a CVM or ABCM survey concerning biodiversity it is now clear how it should be used. It is unreasonable to suppose that private consumers will hold lexicographic preferences for environmental goods since the existence of possibilities to free ride on other people’s “good deeds” will lead to some finite reservation price at which an environmental good would be traded. However, people’s public preferences could very well exhibit a lexicographic structure since an individual might hold the view that society should not strive for an increased consumption of market goods as long as a certain ethical or environmental standard is not reached or maintained. Thus, a citizen in the role of a public decision maker sees herself in a situation in which all individuals in society could be “forced” into full compliance with that individual’s view which allows this individual to express her preferences lexicographically.

The above discussion concludes with a proposal of how to deal with a situation in a valuation study where some respondents accept the principle substitutability between biological diversity and income leading to a meaningful estimate of WTP for conservation and some protest against the mechanism. First, the number of respondents whose stated WTP of zero actually represents a protest answer has to be determined. Those have to be taken out of the sample from which an average WTP is derived and added to those protesting the mechanism in principle. A meaningful report of household valuation of a project for public decision making should therefore distinguish explicitly between an estimate of average WTP and the percentage of the original sample considered protesters.

4.1.2 The Importance of Information

The second issue that needs to be discussed is that of the influence of respondents' information levels of an environmental good. In this sense biodiversity represents an interesting case because of the complexity of its definition and of the remaining scientific uncertainties. As mentioned in previous sections, there is still considerable controversy in the field of natural sciences as to the role of diversity on the various levels for the functioning of natural and human-influenced ecosystems. On the level of the general public, our target group for economic valuation, the situation is aggravated by the fact that knowledge about the concept of biodiversity, its role in ecosystems and its consequences for human well-being is very rudimentary with large variations depending on the level of education. Spash and Hanley (1997) have demonstrated a large gap between the knowledge about biodiversity of two groups in Scotland, students of the University of Stirling and the general public with the students being relatively better informed than the general public.

These findings raise two questions: (1) how does the level of respondents' information about biodiversity influence valuation?, and (2) what is the optimal level of information? Munro and Hanley (2001) have analyzed the first question in detail and provide a good overview of empirical CVM studies testing the effect of information on WTP. The findings are mixed: While four out of eight studies found significant positive relationships, the other four could not detect a significant change in valuations. The authors conclude that the information effect for use values is smaller than for non-use values since users of an environmental commodity are likely to have gathered information prior to the use. On the other hand, there seems to be no guarantee that the collected information was accurate so that additional information about substitutes or complements for a commodity was found to influence stated WTP down and up, respectively (Whitehead and Blomquist 1991). Therefore, it appears to be unwarranted to distinguish between use and non-use values in the context of sensitivity to information.

Moreover, the direction of additional information seems to determine the reaction of stated WTP, i.e. additional information that suggests an improvement of the commodity relative to the prior information will increase WTP while the opposite is the case for information indicating that prior information was too optimistic. For the case of wetland valuation containing both use and non-use values Blomquist and Whitehead (1998) show that the validity of WTP estimates can be increased by providing incompletely informed respondents with accurate information about resource quality. Another result of Munro and Hanley's survey is that dispersion, i.e. the variability of WTP answers, is not significantly influenced by additional information. The underlying hypothesis was that providing respondents with additional information narrows the information gap of prior information among respondents leading to more uniform WTP estimates. In conclusion, it was found that the level of a respondent's information about a commodity or resource has an effect on her stated valuation and that the discrepancy between prior and provided information determines the direction of change in valuation.

These findings have implications for the second question, the optimal level of information in a valuation study. In order to find an answer to this question, it is necessary to revert to the previous section stating that respondents in a CVM survey behave as *homines politici*, and clearly as such should base their decisions on as accurate and complete information as possible since otherwise the resulting decision would not be optimal. In this context the question arises why individuals remain uninformed about an issue that obviously should have and has considerable importance for the well-being of everyone? Again, the answer to this question can be found in the different contexts of decision making. Due to the public good nature of biological diversity individuals have no incentive to invest in information since they perceive that a higher level of individual information will not lead to any changes in allocation decisions of biological resources because these are taken on a higher political level. Therefore, the optimal level of information for a *homo oeconomicus* is zero. The case is different for the *homo politicus* since as such she perceives herself in the role of the decision maker, thus leaving her marginal role as just another individual. In such a situation the optimal level of information is complete information.

In the case of valuation of biological diversity this recommendation becomes complicated due to the mentioned low levels of prior information of respondents, the complexity and uncertainty of available scientific information about the function of biodiversity in ecosystems and the limited cognitive abilities of respondents who would have to assimilate and process large amounts of information during the limited time of an interview. These points pose large practical problems on survey techniques, not only on CVM but also on ABCM. One potential way to solve the problem of information provision could be to provide accurate information well in advance of the interview, e.g. through public discussion of biodiversity preservation in the media prior to a planned valuation study, so that the respondents have time to assimilate and process the information and do not suffer from overload during the interview.

4.2 Comparison of the methods

Based on the above discussion of the critical issues in biodiversity valuation it is now possible to turn to a comparison of the applicability of CVM and ABCM methods and give recommendations in which context each method performs best. As already mentioned in section 3.3, both methods seem to share some sources for potential biases of the valuation estimates. Hanley et al. (2001) confirm this assertion and argue that due to the hypothetical nature of the analysis, design issues are as important in ABCM as in CVM. In particular, this refers to the formulation of consequential questions, the payment vehicles used, the amount of information provision and the way it is provided, and specification of the scenarios.

But apart from the similarities of critical issues of the two methods owing to a similar underlying model structure, there exist a number of differences that might have consequences for their applicability in practice. The first issue is the assertion by Bateman et al. (2001) who scrutinizes the double bounded referendum format in CVM and detects the possibility of an anchoring effect arising from the first bid. He argues that the first bid given to a respondent will be interpreted as an estimate of the true cost of the project. An increase of the second bid as a consequence of accepting the first bid might then signal to the respondent an excessive price for the project in question since it would have been available at a lower price, the first bid level. This could lead to a rejection of the second bid although the respondent might have accepted this level if it had been the first bid. Conversely, a decrease of the second bid due to rejection of the first bid level may signal a decrease in the project's quality since the respondent may doubt the government's ability to provide the same quality now at a lower cost than the first bid level. This could lead to a rejection of the second, lower bid level although the respondent might have accepted this level if it had been the first bid.

ABCM overcomes this problem by presenting only those scenarios to the respondent that show at least one change in the level of a non-monetary attribute if a monetary attribute is changed, thus avoiding different cost assumptions for equal project specifications. For example, if a respondent is confronted with a profile carrying a higher level of project costs, e.g. management costs of a natural reserve, the quality of the project, e.g. number of species preserved, will be enhanced at the same time. Thus, respondents will typically not doubt the appropriateness of the level of the cost attribute for a proposed project so that anchoring effects do not occur. The second advantage of ABCM analysis is its reduced potential to induce protest answers (Hanley et al. 2001). A reason for this is seen in the relative unimportance of the monetary payment since the monetary payment is simply another attribute out of a set of qualitative attributes. As noted above, it is hypothesized that respondents interpret this attribute as true costs of the project which they certainly regard as a legitimate claim if something has to be improved or preserved. Thus, ethical considerations, i.e. the rejection of expressing nature in monetary terms, will be less pronounced in ABCM. A third advantage of ABCM is the possibility to derive marginal values for each attribute included in the choice set. These marginal values are represented by the implicit prices for the attributes resulting from the linear specification of the underlying random-utility-model. The advantage in comparison to the CVM lies in an increased effectiveness of policy making since it can be assessed in detail which attributes are relatively more important to the respondents. This is not possible in CVM since a project specification has to be taken as given and only the entire package will be assigned a value.

On the other hand, compared to ABCM the validity and reliability of CVM estimates has been subject to ample research due to its early and almost exclusive use in environmental valuation and damage assessment. It rests on a sound welfare theoretic basis and as Carson et al. (2001) have shown, most severe problems that have been detected in decade-long scientific research can to a reasonable extent be dealt with. Therefore, CVM can be considered a method that does not carry more uncertainty in its results than commonly employed market methods of economic valuation. ABCM has widely been applied in the field of marketing research and transportation economics and as such focused on the elicitation of use values. Only recently has this method been applied to environmental valuation and the elicitation of non-use values. Problematic issues of this method were identified above as the importance of complete attribute selection and the possibly unrealistic restrictions concerning the distribution of error terms in the statistical model. Following Kriström and Laitila (2002) the most serious argument against ABCM is the assumption of the underlying indirect utility function as a linear relationship of the single attributes. This assumption requires that the single attributes be independent from each other and, therefore, exhibit no interaction effects. These obviously unrealistic assumptions have to be made in practice in order to assure computability of the model. To my knowledge no practical ABCM study of environmental goods has tried to use more complex specifications of the utility function. Therefore, until now the effects of the simplified linear specification are still unclear.

Returning to the project example in section 2.3, both methods could be employed to gain information about the fulfillment of the Kaldor-Hicks criterion. Employing the CVM would yield an estimate of use and non-use benefits of preserving the forest habitat in its initial state. If the benefits were found to exceed additional costs the local group's motion to divert the highway would be accepted. Employing ABCM, however, could yield additional information as to which attributes of the natural forest are seen as important. For example, the analysis could show that non-use values of rare species that can only survive if the habitat is left unfragmented are particularly high while there are various substitutes in the area for recreational purposes so that use values carry little importance. In such an instance, the planned project could be changed to building the highway through the forest but providing sufficient possibilities for animals crossing the highway by the means of "green bridges" as increasingly employed for the connection of habitats in highly fragmented landscapes in Germany. Thus, ABCM could lead to an improved project design and an overall more efficient allocation of scarce funds within an economy.

5 Conclusion

The objective of this paper was to scrutinize the importance of stated preference methods for the assessment of biodiversity benefits in cost-benefit analyses of public projects and to compare two existing methods with respect to their applicability in this context. Such cost-benefit analyses can be seen in the context of the Convention on Biological Diversity which calls for the sustainable management and use of biological resources within each member country. Here, sustainable management is seen as weighing benefits and costs of its use and in this sense it must be assured that informed decisions are taken. This carries two implications for economic valuation: biologists play an important role in the provision of information about indirect use values of ecosystems through research and expert knowledge on ecosystem functions and services to humans, and non-use values derived from biological resources need to be taken into account since they might represent a considerable share in total economic value of a resource, e.g. a forest habitat. This position combines the two perspectives set out in section 2, the natural sciences and the economic perspectives. As recommended for example by the German Advisory Council on Global Change (WBGU 1999) total economic value should form the basis of decisions on the use of biological resources. This clear commitment to a democratic way of decision making by individuals of society comes at the cost of low levels of the general public's information on the services ecosystems and especially diverse ecosystems provide to humans. To this end it is important that the community of natural scientists, mainly biologists and ecologists, participate actively in valuation studies by providing accurate and ample information about nature's ecosystem services and supporting researchers in the field of economics. In conclusion, this paper calls for interdisciplinary valuation studies in order to reap the full benefits of each discipline's expertise.

6 Literature

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