Environmental cost-benefit analysis and anomalous behaviour – a review

Umweltbezogene Kosten-Nutzen-Analyse und Verhaltensanomalien – Ein Überblick

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Zusammenfassung

Durch die vielfältigen Verbindungen zu natürlichen Ressourcen ist die Land- und Forstwirtschaft oft mit Konflikten im Bereich Natur- und Umweltschutz konfrontiert. Die Kosten-Nutzen-Analyse (KNA) ist eine gebräuchliche Methode zur Analyse derartiger Problemstellungen. Die Anwendung im außermarktlichen Bereich impliziert in drei Bereichen Schwierigkeiten: Externalitäten und öffentliche Güter, Fehler bzw. Verhaltensanomalien bei der Entscheidungsfindung und die Kohärenz von Präferenzen. Dieser Beitrag beleuchtet den Einfluss von ausgewählten Verhaltensanomalien auf die KNA und zeigt die Hauptrichtungen der aktuellen Forschungsaktivitäten auf.
Schlagworte: Kosten-Nutzen-Analyse, Umwelt, Verhaltensökonomie

Summary

Through its various links to natural resources the agriculture and forestry sector is frequently confronted with questions of environmental protection. Cost-Benefit-Analysis (CBA) is a common procedure in this respect. Despite its theoretical applicability to non-market goods such analyses are affected by obstacles, which can be divided into three categories: externalities and public goods, mistakes/anomalies in decision making, and tastes ("preference coherence"). This paper reviews impediments for Environmental-Cost-Benefit-Analysis (ECBA) which are rooted in the empirical evidence of anomalous behaviour of indi-

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viduals. Based on the likely consequences for ECBA the main directions of current research are elaborated.
Keywords: Cost-Benefit-Analysis, environment, behavioural economics

1. Introduction

Efficient decision-making based on economic analysis in many instances relies on CBA (Cost-Benefit-Analysis). Recently, in particular the challenges which environmental issues (and environmental policies) pose for CBA have contributed to this progress. ECBA (Environmental-Cost-Benefit-Analysis) is an application of CBA to evaluate projects where market failure with impact on the environment is taken into account. ECBA is needed for allocating public goods (such as environmental quality), yet the assumptions of the first theorem of welfare economics which are necessary that the outcome of a market process leads to an efficient allocation, are not fulfilled. ECBA informs about efficient (and theoretically also optimal) allocation which would occur if market forces were in place. This paper briefly reviews the empirical evidence of behavioural anomalies which may influence the theory and practice of ECBA.

2. Theoretical Foundations of ECBA

The theoretical foundations of ECBA rest in the standard economic model (SEM), which assumes rationally behaving agents which maximize an objective like utility or profits under given constraints. Based on these behavioural assumptions, the SEM allows predicting the behaviour of agents if prices, quality or income change, provided that preferences remain unchanged. The benefits and costs of changes in environmental quality can then be predicted by integrating over the changes of the aggregated demand and cost curves. Estimation of the demand curve for public goods is one of the major tasks in ECBA. For a public good, the demand curve is theoretically constructed as aggregated Willingness To Pay (WTP) or Willingness To Accept (WTA). In order to identify WTP/WTA, it is assumed – in line with neoclassical consumer theory - that it is possible to derive people's preferences from their monetary valuations of environmental changes. Empirically, this

is either done by revealed preference valuation (e.g., travel cost method, hedonic pricing) or by stated preference valuation (e.g., contingent valuation method or choice modelling in the form of choice experiments).

Environmental quality changes often stretch over a long timeframe, and consequently benefits and costs must be discounted. In the SEM utility is discounted exponentially which is logically consistent over time. Knowing the benefits and costs of a change in environmental quality for all individuals affected allows the calculation of net benefits.

In most ECBA decisions have to be made where the possible outcomes are only known with probability (decisions under risk) or not even the probabilities are known (uncertainty). Since risk and uncertainty can influence utility, it substantially complicates all welfare economics. Advanced ECBA integrate risk in their analyses.

Finally, potential compensation tests, such as the Kaldor-Hicks test, are applied in CBA to compare different allocations of resources.

Even standard economics holds a long tradition of criticizing CBA for various shortcomings, e.g., the arbitrariness of the underlying "social welfare function", whether individuals' preferences can be a reliable guiding principle for social decisions, or the tension between economic efficiency and the distributional incidence of costs and benefits.

Recently, behavioural economics has added to this list because empirical evidence suggests that key assumptions of this model are probably not in accordance with individual behaviour (e.g., stable, context-independent, and internally consistent preferences). Consequently, the key assumption of maximizing behaviour has to be dropped. But then the calculated "optima" are not valid anymore, because there is no more reliable relationship between market equilibrium and welfare optimum, and between externalities and environmental policy instruments. If people no longer respond predictably to prices in comparing them with marginal values, fundamental problems for economic valuation and ECBA arise, because demand relationships – demand being a function of price – are no longer determined in a unique way.

3. Anomalous Behaviour and Economic Valuation

3.1 Gap between WTP and WTA

One of the most disturbing puzzles for ECBA is the reported wide gap between WTP and WTA, which seems to be empirically robust (HOROWITZ and MCCONNELL, 2002). In general, if individuals have a right to the existing level of environmental quality, WTA estimates are appropriate, and if households have the right to an increase in environmental quality, WTP is the proper yardstick. Theoretically, both measures should not diverge to a large extent. Economic literature provides two lines of explanation fur such a gap: the first, traditional line points to large income effects (cf. WILLIG, 1976) as well as a lack of substitute goods (cf. HANEMANN, 1991). A bunch of empirical work, however, indicates that individuals' Willingness To Accept (WTA) measures of value differ from their Willingness To Pay (WTP) measures of value to an extent which is by far larger than such factors can explain (CUMMINGS et al., 1986; SHOGREN et al., 1994).

In a meta analysis surveying 45 different studies HOROWITZ and MCCONNELL (2002) found that the gap between WTA and WTP is (i) not significantly different between real experiments and hypothetical experiments, and that (ii) the less the good is like an "ordinary market good", the higher is the ratio. This has strong implications for the valuation of non-market goods, where the ratio has been found to be the highest. Here, efficient market-supported distributions across individuals on the basis of the WTP criterion may become inefficient when the WTA criterion is applied.

Hence, the second line of explanation addresses behavioural aversion to losses and reference-dependent preferences. HAHNEMAN et al. (1991) try to explain this phenomenon differently on basis of the endowment effect theory. For them the WTA-WTP-disparity is caused by a disutility which the owner suffers from the mere act of parting (*parting disutility effect*). Consequently, this form of disutility cannot be compensated by owning another good in exchange. This parting disutility effect can explain the WTA-WTP-disparity without implying any bias in the prediction of tastes.

As the endowment effect refers to situations where the subjective valuation of an object depends on whether the object is being acquired

or given up, this effect may not equally apply to public goods because here consumers do not have exclusive property rights. Consequently the utility from "owning" publicly provided goods respectively the disutility from parting with them will likely be (much) smaller than for private goods.

3.2 Status-quo Bias and Loss Aversion

The *status-quo bias* implies that the utility of consuming a good x at time t will vary in relation to what was consumed in previous periods (x_{t-1}). Graphically, this effect generates an expected utility function that is "kinked" at the status quo, with the slope to the right-hand side (gains) strictly less than the slope to the left-hand side (losses). Hence, it becomes necessary to strictly distinguish between gains and losses when evaluating the net benefits of a policy proposal. In general, this effect implies that fewer policy changes are socially desirable than a standard CBA would suggest. With respect to ECBA the existence of this effect, e.g., makes the Kaldor-Hicks test more stringent, as a larger transfer of benefits is required to make losers feel indifferent. In order to overcome the choice problem with respect to WTP and WTA, BROMLEY and HODGE (1990) suggest that reductions in environmental quality below such a reference point should be assessed using WTA, and increases above it in terms of WTP.

For situations which involve risk, *loss aversion* characterizes preferences that are risk-loving over losses, and risk-averse over gains. Empirical evidence suggests that consumers often behave this way (BERG, 2002). THALER (1980) draws on prospect theory and argues that, even in deterministic settings, a substantial part of the disparity between WTP and WTA is caused by a general loss aversion: Individuals asked for their WTA for a certain good consider this good part of their endowment while individuals asked for their WTP do not. Given the asymmetric value function (KAHNEMAN and TVERSKY, 1979), this difference in point of reference causes the WTA to be substantially larger than the WTP (THALER, 1980).

Loss aversion is relevant for political decisions, as the collective will of voters may support action that acknowledges high risk in cases of extremely bad outcomes. Unfortunately, due to the curvature of the value function, "very bad" outcomes are penalized only slightly more than merely "bad" outcomes (BERG, 2002). In such cases ex ante subjective

benefits may deviate a long shot from ex post reality, which causes a problem for the validity of the Kaldor-Hicks principle as a justification of the policy measure. Hence, analyses of policy issues with a small probability of catastrophe have to explicitly take into account loss aversion. In agricultural economics, the cultivation of insect resistant genetically modified organisms (GMOs) vs. the use of pesticides are not comparable in a CBA if one outcome is potentially "very bad" while the other one is only "bad" and loss aversion is present.

3.3 Preference Reversal

Preference reversal - one of the best-documented violations of rationality which is widely immune against changed settings - exists when the rankings of two gambles differ according to whether people rank on the basis of strict *preference* or on the basis of *value* (LICHTENSTEIN and SLOVIC 1971). Preference reversals call into question the empirical validity of economic theory because they provide support for the conclusion that the preferences subjects reveal vary with the response mode (*choice* or *valuation*) that is used to elicit the preferences. This matters for ECBA, because if people state values that are inconsistent with their underlying preferences, it becomes impossible to judge the relative net benefits of alternate policies. Put differently, two risk reduction policies cannot be compared using a CBA framework.

The more akin a transaction is to a market setting, the less likely is preference reversal. In an experimental setting with arbitrage possibilities and repetitions CHERRY et al. (2003) showed that people learn to be rational when irrational choices become costly. Hence, despite the fact that in environmental problem areas there are no suitable institutions to prevent anomalous behaviour, it could be the case that the induced rationality from an arbitraged market could spill over to a second non-market choice setting that would otherwise promote preference reversals. The authors further demonstrated that this decrease in preference reversals does not occur because of a change in the person's preferences, but rather his stated values decreased.

In current agri-environmental programs farmers are confronted with a series of choices regarding the participation in conservation measures. The revealed choices are based on the preference rankings which could, according to economic theory, alternatively be represented by values collected by a survey among farmers how much they must be

compensated for conservation activities. Such values might then be used in an ECBA to evaluate the supply side of an agri-environmental program. Unfortunately, the above described WTA-WTP-disparity and preference reversal might both bias the results.

3.4 Hyperbolic Discounting

In contrast to the SEM which assumes that people discount future benefits/costs by a fixed percentage for each unit of time they must wait, in practice people often become more impatient when the consumption activity is imminent: they discount *hyperbolically*. Everyday illustrations of this phenomenon are procrastination in filing income tax returns, or will-power problems faced by dieters.

David LAIBSON (1997) prefers *quasi-hyperbolic* functions, which means that the early periods have much steeper discount rates than later periods. LAIBSONs research indicates that people's discount rates are 12% during days 0-5 but drop to 4% in days 20-25.

The consequence for ECBA is that consumer surplus is sensitive to the period in which it is measured. If consumers or voters actually are hyperbolic discounters, there is a gap between how they value relative benefits in the present versus the future. From a CBA point of view, projects with benefits far in the future are under-valued from the perspective of tomorrow, while those with costs far in the future are over-valued in the present.

If cost-benefit analysis attempts considering the time-specific nature of valuations, it must take into account the possibility that individual or consumers may have a tendency to contradict themselves through time in their opinions. In this respect, cost-benefit decisions with immediate benefits and deferred costs are most likely to be reversed through time, because voters who have hyperbolic discounting preferences move from assigning net positive valuations to assigning net negative valuations for the same project (BERG, 2002). To give an example, if cost-benefit analysis calls for benefits (and costs) one year from now to be discounted by a factor of γ, then benefits and costs two years from now could be discounted by less than γ^2 to control for the tendency of subjective valuations to place too much weight on the present.

However, the ensuing suggestions for practical decision making are far from being unanimous. HEPBURN (2003) warns that the use of hyperbolic discounting in environmental regulation may have unfortunate

consequences, because a planner being a 'naive' hyperbolic discounter fails to anticipate problems of dynamic inconsistency, and thus can oversee a collapse of a renewable resource. This model provides a explanation for resource collapses, warning governments to think carefully before they employ hyperbolic discounting in policymaking.

Stated preference valuations or auctions allow eliciting the costs of agri-environmental programs. If these programs cover several years though, these elicited costs might suffer from dynamic inconsistencies. This has to be taken into account if one compares cost efficiency of, e.g., auctions and fixed payment schemes for multi-year programs if preferences are elicited through standard valuation methods.

4. Current Research Directions/Where to proceed from here?

The anomalies described in the previous section motivated economists not only to scrutinize the consequences for economics in general and CBA in particular, but also to look for possibilities to fix these problems. Not surprising, there are diverging opinions with respect to the possibilities to solve the problems of ECBA.

One view is that some anomalies observed in valuations are a consequence of complexity. Helping individuals to become consistent can be done through exchange institutions penalising irrationality via an arbitrage mechanism which links private choice to social pressures. Unfortunately, this is only possible in hypothetical settings, as such strong institutional pressures usually do not exist for environmental goods. Another way to help individuals becoming consistent assumes that people can transfer rationality acquired in market-like settings into a non-market choice setting („*rationality spillover*", SHOGREN, 2002). Also sticking to the idea of rational behaviour but allowing the explanation of many anomalies, are the approaches of BERNHEIM (2009) and SMITH and MOOR (2009). The latter propose that all anomalies could be explained by including further restrictions such as cognitive capacity limits. The former try to exploit coherent aspects of choice by replacing the standard revealed preference relation with unambiguous choice relations, which are constructed as a constraint set of objects with characteristics and ancillary conditions.

Another approach replaces the problem of utility measurement by replacing utility with the concept of happiness, which is empirically bet-

ter treatable (WELSCH, 2009). With respect to environmental policy analysis data on subjective well-being as a proxy for utility makes it, at least in principal, possible to test the assumptions made in microeconomics. Of particular interest are the approaches which rely on individual consumption in relation to others (social comparison) and in relation to their own consumption in the past (adaptation) (CLARK et al., 2008). Yet, despite the extensive literature on the economics of happiness the number of applications to non-market valuation is still rare. As a bottom line, the current status of research with respect to the consequences of anomalous behaviour for ECBA is intellectually challenging, but still far from delivering clear directions for applied analysis.

5. Conclusions

Quite a few of the anomalies described in the behavioural literature are relevant for ECBA, if their robustness and non-triviality in the case of public goods can be established. Dependent on the specific effect, widely diverging approaches to explain the anomalies and adoptions of the ECBA methods are discussed in the literature. The current status of research points out obvious weaknesses of the SEM, but so far does not provide unanimous prescriptions how to fix the influence of anomalous behaviour on ECBA.

Nonetheless, this field of research is of considerable interest for effective/cost-efficient/optimal decisions with respect to tensions between agricultural production and the environment. Despite the view of widely rational behaviour of farmers with respect to their business environment many of the effects described in this paper become vital if it comes to managing environmental externalities. Henceforth, both the political decision for agri-environmental programs as well as their later fine-tuning will increasingly depend on taking into account insights from behavioural economics.

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