Monetary Valuation of Environmental Goods: Alternatives to Contingent Valuation

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Citation for published version (APA):
Chapter 7
Conclusions and Summary

"Nothing is impossible in an inexact science as economics."
(Samuelson, 1980, p. 381)

Most people may argue that some goods are invaluable. However, as the quote above suggests: in economics everything is possible. And so, economists try to find ways to put monetary values on goods like peace and quiet, natural beauty and threatened species of animals and plants. These goods are typically non-market goods, that is, goods that are unpriced or priced too low, either because no markets exist or because existing markets do not work properly. Such a form of market failure is called an 'externality' or 'external effect', since it manifests itself external to the market. The existing markets fail to achieve a Pareto efficient allocation, viz. one for which not every individual is as well off as possible (given the level of utility of others). And, economists argue, if there is some way to make somebody better off without hurting any one else, why not do it?

7.1 Monetary Valuation of the Environment

According to the (neoclassical) economic point of view, externalities can be dealt with by putting a price tag on environmental goods, thereby internalising them within the market. The purpose of pricing environmental goods is to give them a weight (viz. money) that most policy makers, business people and others consider as a matter of course in their decisions and that can be easily compared with the weights of other goods. Some, or even most people may object, on the basis of emotional or religious arguments, to the economic solution of valuing environmental and other non-market goods in monetary terms. However, in view of the current environmental problems, pricing environmental effects is merely rational to come to a better management of natural resources. This does not mean that we should create markets for all kinds of
non-market goods or to make everything saleable. Nor does it mean that we are able to measure the value of environmental goods. However, one can elicit preferences for environmental goods.

Revealed and stated preferences for environmental goods
And that is exactly what the methods discussed in this thesis do: they elicit preferences for an environmental good, which are stated in hypothetical market settings (via surveys) describing a project involving the environmental good under valuation. On the other hand, other kinds of valuation methods exist which elicit preferences that are revealed in an actual market and are, therefore, observations of real-world choices. An example of a revealed preference method is the so-called travel costs method. When using this method, one estimates the economic value of a specific recreational site by looking at the costs of the trips made to this site (e.g., transportation costs, entrance fees, and the opportunity costs of time).

However, the value of most environmental goods is not solely related to market transactions. Generally speaking, market transactions relate to goods, which have a use value to the buyer, where this use could refer to either direct or indirect, current or future use of the good in question. For example, a woodland is planted because of the timber revenues, or because trees can act as a strategy to fix carbon dioxide levels, or because we want to pass it on to our descendants as a green area. On the other hand, some goods have a value that is not related to use. An example is the existence of humpback whales; even if we do not ‘use’ them, we could still value their existence. Using data on observed behaviour in actual markets, it is only partially possible to account for the non-use value of a good. In other words, revealed preference methods are not capable of fully measuring the total economic value of a good.

Unlike revealed preference methods, stated preference methods use hypothetical markets, where all kinds of goods can be surveyed and, thus, also goods that individuals do not have a user-relation with. Consequently, all stated preference methods are capable of measuring the total value of a good, including non-use values. And since most environmental goods have non-use characteristics, stated preference methods are a suitable manner for the valuation of environmental goods.

Contingent valuation method
One of the most well-known stated preference methods is the contingent valuation method (CVM). The CVM is very popular among valuation researchers. Most textbooks about environmental economics deal with the CVM, journals publish piles of articles about the CVM, and most valuation papers presented at conferences are based on the CVM. This popularity is, to a large extent, caused by legislative developments in the
United States. By now, the use of the CVM has been given a legal status. On the other hand, the popularity has also increased since leading economists, like Nobel Prize winners Arrow and Solow, argued that the CVM represents the most promising approach yet developed for determining prices for the environment (Arrow et al., 1994). Lastly, the popularity is probably also caused by the fact that a large amount of money is spent at improving the CVM, and many scientists earn their living by conducting CVM studies.

Apart from the large group of proponents, there are also those researchers who criticise the CVM. Many of these critics were present at a symposium on environmental valuation held by the petroleum industry in 1992 (cf. Hausman, 1993). The discussions from the petroleum industry symposium prompted the appointment of the National Oceanic and Atmospheric Administration (NOAA) panel, headed by Arrow and Solow, to provide an unbiased assessment of the validity of CVM measures of non-use values. Since the panel found that, if appropriately conducted according to their guidelines, the CVM could convey useful information (Arrow et al., 1993, p. 4609), the debate has become more fierce and charged. Perhaps that is logical, given the fact that the social and financial stakes in the use and abuse of the CVM are very high.

One of the aims of this thesis is to examine this debate regarding the pros and cons of the CVM. The next section reviews these pros and the cons in further detail. The main objective, however, is to introduce valuation methods that could serve as alternatives to the CVM. Section 7.3 examines this main objective.

### 7.2 Debate Regarding the Pros and Cons of the CVM

According to the literature, preference-based valuation methods –like CVM and conjoint measurement– depart from the neoclassical welfare theory (e.g., Bateman and Turner, 1993; Hanley and Spash, 1993). Indeed, these methods have for their primary objective the translation of losses and gains of environmental goods in monetary values, yielding an analysis that tries to determine compensating or equivalent variations. However, as was shown in chapter 2 and 3, such an analysis is not without problems.

In chapter 2 the pros and cons of the neoclassical model of behaviour were discussed. The discussion in chapter 3 dealt with specific issues that are especially relevant to the CVM.
Problems with neoclassical assumptions about behaviour

Preference-based valuation methods depart from the neoclassical model of individual behaviour. The assumptions that underlie this model are reproduced in table 7.1.

Table 7.1: Overview of the neoclassical assumptions about behaviour discussed in chapter 2

<table>
<thead>
<tr>
<th>Assumption</th>
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<tbody>
<tr>
<td>Consumer sovereignty</td>
</tr>
<tr>
<td>Well-structured preferences</td>
</tr>
<tr>
<td>Assumptions of choice: completeness, reflexivity and transitivity</td>
</tr>
<tr>
<td>Local non-satiation</td>
</tr>
<tr>
<td>Rationality/Utility maximization</td>
</tr>
<tr>
<td>Strict convexity of indifference curves</td>
</tr>
<tr>
<td>Ceteris paribus, time dimensions and complete certainty</td>
</tr>
</tbody>
</table>

Valuation surveys ask ordinary individuals to state their willingness to pay (WTP), since, according to consumer sovereignty, it is assumed that they are the best judge of what gives them utility and what not. Some people argue against this fundamental aspect of preference-based valuation methods, as they feel that ordinary people are unable to give well-informed judgements. Moreover, it is assumed that people have ready-made and well-structured preferences for environmental goods. As most respondents do not have (market) experience with environmental goods, this assumption of well-structured preferences may be unjustified. Respondents' bids may be influenced by either the hypothetical market or the commodity-specific information given to them in the survey, which indicates that the WTP bids or the willingness to accept (WTA) bids are endogenous to the valuation process.

Taking the well-structured and well-informed preferences of ordinary people for granted, it is then assumed that these preferences can be captured in a utility function. Such a utility function will exist if preferences are complete, reflexive, transitive and locally non-satiatile (Varian, 1992). However, valuation results often do not satisfy these axioms. For example, completeness (any two bundles of goods can be compared) is violated if people are unable to answer a valuation question because they cannot compare the good with money amounts, viz. they do not know their WTP for that specific good. Another example concerns the violation of local non-satiation (more of a good is always better) in some valuation studies: WTP estimates do not increase for higher levels of natural resource services (e.g., Desvouges et al., 1993).
Given the existence of a utility function, individuals will act rationally and maximize their utility, or, in other words, they will try to reach their highest indifference curve, given their budget constraints. However, some valuation researchers found that respondents behave irrationally and do not consider their budget constraints when answering valuation questions (Loomis et al., 1994). Local non-satiation ensures that the best choice of commodities will lie on the budget constraint. In order to guarantee a unique solution to this maximization problem, it is assumed that indifference curves are strictly convex to the origin. This implies that people will pay less additional money as the environment further improves. In some valuation studies this assumption does not hold (e.g., Navrud, 1989).

Three additional, simplifying assumptions are often made. First of all, the dimension of time is left out. Secondly, it is assumed that people have perfect foresight, that is, there is no uncertainty about, for instance, price effects, the availability of environmental goods, or preferences. Finally, the analysis is carried out 'ceteris paribus', suggesting that all other factors remain equal. In sum, valuation studies should address only short-term, certain and marginal environmental changes. Notwithstanding these assumptions, both CVM studies and other valuation studies often value substantial environmental changes that involve long-term and uncertain effects.

Although chapter 2 criticises some of the neoclassical assumptions about behaviour, it is not the intention to completely discard the theory or its assumptions. In many situations the model is indeed successful. Moreover, sometimes we simply have no alternative: if our purpose is to establish monetary values or prices for environmental goods, we simply cannot get around certain elements of the neoclassical theory, because monetary valuation methods are based on this theory, i.e., the Hicksian analysis of demand and/or various assumptions about individual behaviour. However, it is important to consider the assumptions under which these monetary valuation methods give valid and reliable results.

**Specific issues regarding the CVM**

Chapter 3 is specifically aimed at the discussion of several hot issues regarding the CVM. These issues are summarised in table 7.2. Since most of these issues can be traced back to the discussion of neoclassical assumptions, the discussion in chapter 3 may have overlapped with parts of chapter 2.
Table 7.2: Issues regarding the CVM discussed in chapter 3

<table>
<thead>
<tr>
<th>Embedding effects</th>
<th>Endowment effects</th>
<th>Overestimation</th>
<th>Aggregation</th>
</tr>
</thead>
</table>

The embedding phenomenon encompasses situations where different, but similar, samples of respondents are asked about their WTP for public goods that are identical except for their scale. One speaks of an embedding effect if the WTP amounts do not differ among these samples. One of the many empirical examples is the following: the stated willingness of Toronto residents to pay increased taxes to prevent a drop in the fish populations in all Ontario lakes is not significantly higher than the WTP to preserve fish stocks in only a small area of the province (Kahneman, 1986).

An endowment effect occurs when responses to CVM surveys show a persistent difference between WTP and WTA measures. In short, endowment effects arise if respondents overvalue an asset due to their possessing it, or, in other words, due to loss aversion. The precise magnitudes of the WTA/WTP difference vary between studies, but ratios of four to fifteen times or more are not uncommon.

A third problem that is of great relevance for the CVM, is the persistent overestimation of true values. For instance, a lot of CVM researchers tested and rejected the hypothesis of no significant difference between the values reported by subjects when the payment of these values is real or when it is hypothetical (e.g., Blackburn et al., 1994). In most studies, the real payment gave significantly lower results than the CVM survey.

The fourth issue regarding the CVM is the aggregation of individual welfare measures. This issue raises several questions. For instance, is it theoretically feasible to aggregate individual preference orderings to a consistent collective preference ordering? According to most economists the answer to this question is 'no', since it is assumed that, among other things, utility is only ordinally measurable and interpersonal comparisons are not possible. The valuation methods discussed in this thesis are based on the assumption of interpersonal comparability, for instance, when the individual WTP values are aggregated to calculate the mean WTP, the median WTP or the total WTP.
Conclusions

One of the principal assumptions underlying the CVM is that people have true, but hidden, economic values for environmental goods, which can be revealed through the creation of a hypothetical market. The question is whether these true values exist, or whether several true values exist. A second question is whether the CVM can elicit true values, where 'true' refers to Hicksian welfare measures. CVM believers assume that, under certain circumstances, a neutral survey could convert subjective feelings into scientifically viable expressions of value.

Although the CVM pretends to obtain these scientific estimates (since they are related to theoretical concepts like compensating variation and equivalent variation), I do not think that the CVM—or any other stated preference method for that matter—is capable of eliciting an unambiguous, theoretically correct value. The WTP principle, on which CVM estimates are (supposedly) based, is elastic enough to allow a huge range of estimates. Apart from anything else, it shows that different assumptions and procedures will lead to widely different results.

For instance, the implication of the issues surrounding the CVM (like embedding effects and endowment effects), is that the CVM is open to political influence: by framing the questions in a certain way, by embedding the good in a larger context, or by using a WTP measure instead of a WTA measure, CVM practitioners can deliberately influence the results so as to please themselves or their sponsors. In other words, the method appears to be susceptible to serious manipulation, which is not a good feature of a method on which damage awards and allocation decisions are to be based, and which claims to be scientific (unambiguous). Some people even suggest that it seems to be a case of 'tell me the figure you'd like, and I'll provide a justification' (Diamond and Hausman, 1994).

This latter remark goes too far in its sarcasm towards the CVM. The main benefit of the CVM (and of other monetary valuation methods) lies in the discipline it imposes, not in the bottom line that creative practitioners are able to squeeze out of it. The CVM is a systematic procedure for collecting and organizing information that can be used to make decisions. It is a decision tool. So, instead of using the CVM as an analytical tool to provide scientific values, it should be used as a policy decision method.
7.3 Alternatives to the CVM

After the discussion about the pros and cons of the CVM in part of chapter 2 and in chapter 3, we get to the main objective of this thesis in chapter 4, namely the introduction of alternative valuation methods to the CVM. The underlying idea is that the monopoly position of the CVM does not seem completely justified. The discussion in chapter 3 shows that the popularity of the CVM is considerable. However, due to the many problems related to the method, it is fair to state that this popularity is not caused solely by its scientific superiority, but also by a strong and effective pr-offensive of the proponents. Therefore, it seems reasonable to introduce other methods that do not necessarily replace the CVM but complement it. The alternatives discussed in this thesis include:

- **the conjoint measurement method:**
  Respondents have to *rank* and/or *mark* a set of vignettes (cards with several qualitative and quantitative attributes of the good in question). Respondents are also asked to indicate which of the vignettes are *acceptable* to them. Provided that one of the vignette’s attributes is a monetary value, it is theoretically possible to deduce prices from the answers to the vignettes questions as stated by the respondents.

- **the welfare evaluation method:**
  Respondents are asked to fill in six income levels which, according to them and considering their personal situation, correspond to the qualifications ‘very bad’ to ‘very good’. By relating these levels to personal and environmental circumstances, it is theoretically possible to determine the influence of a particular environmental effect on the evaluation of income. The corresponding income change necessary to compensate for a change in the environmental effect can then be calculated.

- **the well-being evaluation method:**
  This method resembles the welfare evaluation method, except for the fact that it measures a broader concept than income positions or welfare, namely well-being (satisfaction with life as a whole). The self-reported well-being positions are related to various personal and environmental circumstances. From this relation it is possible to determine the influence of a particular environmental effect on the evaluation of well-being. Compensations are now calculated based on the idea that well-being should not be affected by a change in a specific environmental effect.

Table 7.3 summarises the main characteristics of the four valuation methods.
Conclusions and Summary

Table 7.3: Main characteristics of the four valuation methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Valuation ground</th>
<th>Way of questioning</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contingent valuation</td>
<td>Welfare</td>
<td>Direct</td>
<td>One-dimensional, absolute monetary value:</td>
</tr>
<tr>
<td>Conjoint measurement</td>
<td>Welfare</td>
<td>Indirect</td>
<td>Monetary values for various attributes of the good; values are relative in relation to the other attributes.</td>
</tr>
<tr>
<td>Welfare evaluation</td>
<td>Welfare</td>
<td>Indirect</td>
<td>A monetary value for the good in question is derived from the evaluation of income; the value is relative in relation to the other variables that explain the evaluation of income.</td>
</tr>
<tr>
<td>Well-being evaluation</td>
<td>Well-being</td>
<td>Indirect</td>
<td>A monetary value for the good in question is derived from the evaluation of well-being; the value is relative in relation to other variables that explain the evaluation of well-being.</td>
</tr>
</tbody>
</table>

All of these methods are stated preference methods, and thus use questionnaires to elicit preferences. The essential difference between the CVM on the one hand and the alternatives introduced in this thesis on the other hand, is the fact that the CVM asks people directly for a monetary value of an environmental good, whereas the other methods use an indirect way of questioning. Using conjoint measurement (CM), environmental goods are analysed as multi-attribute goods rather than as single composite goods, as is the case in CVM studies. While the CVM provides an estimate of the value for just one option, CM can, in principle, generate estimates of any option that can be constructed from the attributes and their levels represented in the vignettes. The welfare evaluation method and the well-being evaluation method envisage the environmental good as a possible factor influencing the feeling of welfare or well-being, respectively.

Table 7.4 compares the four methods on several points, viz. strategic bias, cognitive stress, embedding effects, endowment effects, overestimation and aggregation issues.

Firstly, respondents to CVM surveys are more readily inclined to give strategic answers, because in a CVM setting very few incentives exist for people to express their true value. Of course, CVM researchers claim that, by constructing the survey carefully, the potential for strategic bias can be minimized. But still, this potential for strategic bias is very large compared to other, more ‘veiled’ questioning methods like the three alternatives discussed in this thesis.

Secondly, the direct CVM question entails a relatively high level of cognitive stress, since respondents have to come up with an absolute monetary value for a good that is mostly novel and abstract to these respondents and which involves a lot of information. Although CVM researchers assume that respondents have clear and pre-defined ideas
about the worth and desirability of possible objects and events, it appears that most people do not have well-structured preferences. In these cases, so much cognitive constriction and perseverance may occur, that thought processes are disrupted and thinking becomes simplistic. The CVM no longer gives reliable and valid results, since coming up with the true values takes too much effort. By asking indirect questions (as with conjoint measurement, welfare evaluation and well-being evaluation), the cognitive stress probably declines.

### Table 7.4: Comparison of the four valuation methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Strategic bias</th>
<th>Cognitive stress</th>
<th>Embedding effects</th>
<th>Endowment effects</th>
<th>Over-estimation</th>
<th>Aggregation issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contingent valuation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conjoint measurement</td>
<td>++/-</td>
<td>+/-</td>
<td>+/-</td>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Welfare evaluation</td>
<td>+</td>
<td>++/-</td>
<td>NA</td>
<td>NA</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Well-being evaluation</td>
<td>+</td>
<td>+</td>
<td>NA</td>
<td>NA</td>
<td>?</td>
<td></td>
</tr>
</tbody>
</table>

- indicates that the method performs poorly on this point; +/- indicates a medium performance; ++/- indicates a good performance; + indicates a very good performance; NA indicates that the point is not applicable to the method; ? indicates that it is not obvious what the performance is.

Thirdly, a CM question format may provoke less embedding effects. One of the causes of embedding effects is the fact that the sequence in which (close) substitutes are valued matters, because the marginal utility of a good diminishes (see chapter 3, section 3.4.1). Since respondents to CM surveys are explicitly reminded of alternative situations which could be treated as substitutes, the potential for embedding effects declines compared to the CVM setting, where only one situation is valued. Embedding effects are not relevant for the welfare evaluation method and the well-being evaluation method, since these methods do not consider (different scales of) goods, but consider the quantities welfare or well-being, respectively.

A fourth issue is the presence of endowment effects. The evidence clearly shows that the CVM is sensitive to endowment effects, while no evidence to this effect exists as yet for the CM method. As with embedding effects, endowment effects are not relevant for the evaluation of the quantities welfare or well-being.

Fifthly, the CVM entails (large) overestimation. Since the evidence related to CM on this point is not unanimous, it is not clear whether CM results generally entail an
overestimation. Moreover, so far no evidence exists on this point for the welfare evaluation method and the well-being evaluation method.

Finally, aggregation issues apply to the four methods, since they all aggregate individual measures of welfare or well-being.

7.4 Empirical Studies

In the second part of the thesis the three alternative methods are applied in two empirical studies, viz. the IJburg study (chapter 5) and the Schiphol study (chapter 6).

The IJburg study

IJburg is a future new residential quarter in Amsterdam, to be built on artificial islands in the IJmeer (a lake east of Amsterdam). The quarter will contain 18,000 dwellings, the first of which will be completed in 2001. The construction of IJburg in the IJmeer involves the loss of certain values of nature and recreation areas, like certain kinds of water birds, plants and shellfish and diminished opportunities for sailing and rowing. In February and March of 1997, we sent a questionnaire to 1,204 Amsterdam residents. This questionnaire also included valuation questions. Half of the respondents received the CVM questions, and the other half received the CM questions. Except for these valuation questions, the questionnaire was the same for CVM respondents and CM respondents.

The aim of this study was twofold, one theoretical and one practical. The practical aim was to come up with a price tag to put on the changes in the natural environment and the recreational possibilities in and around the IJmeer when IJburg is built. The results of the CVM survey show that the average Amsterdam resident is willing to pay f8.62 to a Fund that will pay for projects to restore nature and recreation values. Summed for the total Amsterdam population, this amounts to a total of f3.4 million. In this particular study, the CM survey did not give a simple clear-cut result, i.e., the exact price could not be determined since the exact consequences of the construction of IJburg on the attributes nature and recreation are not known in advance. However, if the ‘before’ and ‘after’ situations in terms of the attributes are known, CM can also provide a monetary equivalent corresponding to the change. For instance, if the variables nature and recreation both increase by 3.85% and we depart from the analysis of the report marks, the corresponding mean WTP would be f8.62, which matches the CVM result. The CM results indicate that the Amsterdam residents value nature higher than they value recreation.
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The theoretical aim was to inquire into the differences between two monetary valuation methods, namely the well-known CVM on the one hand and CM on the other hand. The inquiry departed from the conjecture that CM is at least as useful as the CVM when pricing environmental goods. The conjecture is tested in terms of the following two hypotheses.

Firstly, the hypothesis is formulated that respondents find it easier and more acceptable to give an order of alternatives (a relative valuation, as in CM) than to state an absolute figure (as in the CVM). Based on the results found in this study, related to the overall response rates, to the non-response rates of the valuation questions, and to the number of protest voters, it seems justified to accept this hypothesis. Or, at the least, it seems safe to conclude that questions in terms of vignettes (CM) are as easy to answer and as acceptable to respondents as are direct valuation questions (CVM).

Secondly, the hypothesis is formulated that the monetary CVM results are comparable to the CM results. This hypothesis can be tested by comparing the results of the CVM survey with the answers of CM respondents to the so-called CVM-vignette. Every respondent in the CM experiment received such a CVM-vignette. This is a vignette containing exactly the same information about a fictitious situation that the respondent in the CVM survey has to evaluate: the loss of recreation and nature values will be fully compensated (e.g., no over- or undercompensation), and the monetary contribution to the Fund is the same. Since respondents evaluate exactly the same good, it is possible to examine the differences between the monetary results of the two methods. It was found that the WTP was (significantly) higher in the CM sample, namely between \( f_{12} \) and \( f_{12.50} \), as opposed to the CVM result of \( f_{8.62} \).

CM has at least two advantages over the CVM. The first is that CM also gives an idea of the relative importance of the attributes. The second is that the CM result is more flexible than the CVM result, because the CVM result is a one-dimensional figure whereas the CM result entails a price equation with the attributes as variables, which allows for the calculation of many different potential changes. In this case of IJburg, the two form an interesting couple: the CVM measures the total value, whereas CM provides an insight into the importance of the attributes.

In summary, the study shows that conjoint measurement is a useful and valid valuation method. Respondents seem to prefer the indirect way of questioning as used in CM over the direct way of questioning of the contingent valuation method. Conjoint measurement is, at the least, an important complement to contingent valuation.
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The Schiphol study

The second empirical study discussed in this thesis deals with the valuation of aircraft noise nuisance in the surroundings of Schiphol Airport. Schiphol is the Dutch national airport and is situated in the densely populated area surrounding Amsterdam. The enormous growth of air traffic has resulted in some environmental problems of which noise nuisance has acquired the most political weight. It has now come to the point where the noise capacity is setting the limits for the growth of aviation at Schiphol. It is, therefore, very important that Schiphol develops instruments to enhance the efficient use of the available noise capacity.

One such instrument entails the monetary compensation of noise nuisance for inhabitants of the Schiphol region. By compensating residents, it may be possible to increase the noise capacity for Schiphol and at the same time keep the level of utility constant for residents. The monetary compensations found in this study could be one step into the direction of developing a scheme of compensation payments to residents of the Schiphol region.

In the Schiphol study, all three alternative methods discussed in this thesis were put into practice: the conjoint measurement method, the welfare evaluation method, and the well-being evaluation method. In this particular study the results of the welfare evaluation method are implausible, because the sign of the noise level variable is counter-intuitive, and/or because the effects are not significant in the explanation of the income-evaluation $\mu$.

It appears that, in this study, it is the well-being evaluation method that works best, since it gives significant and valid relations of well-being and noise nuisance, and since it produces monetary compensations for changes in the noise level measured in Kosten units (Ku).

The monetary compensations were derived from a model that relates the Cantril measure of well-being (based on the respondents' answers to the ladder-of-life question) to several personal characteristics and noise nuisance. Since the effect of noise in terms of Ku was not significant when we directly related well-being to noise in Ku, we constructed an intermediate variable noise nuisance on the basis of the actual nuisance as reported in the survey. Schematically, the model is specified as follows.
We then computed monetary compensations for changes in the noise level in Ku, departing from the idea that the level of well-being should not be affected by changes in noise levels.

We found that, for households with a net monthly income of f5,000 and living in a house without noise insulation, a rise in the noise level from 20 to 30 Ku would require a compensation of f215.25 per month. In a similar way, we constructed a compensation tariff that is not based on monthly incomes, but on living expenses and on the asking price for the dwelling. In the latter case, we found that, if the noise nuisance were to increase from 20 to 30 Ku, for example, a family living in a non-insulated dwelling of f400,000, with living expenses of f1,500 per month, would have to be paid a monthly compensation of f357.62.

Finally, we also computed the total amount of compensation for the Schiphol region, departing from the idea that only residents with noise nuisance above a certain critical limit of x Ku are compensated for the exceeding nuisance. If this critical limit is set at 35 Ku, the total yearly amount of compensations would be f3.75 million. This corresponds to a capitalised value of f75 million (assuming an interest rate of 5%).

Another method used in the Schiphol study is the conjoint measurement method. This method generates significant and plausible relations. For instance, when estimating the probability that a certain vignette receives a report mark z, where z ranges from 1 to 10, all attributes but one are significant factors for the prediction of the report mark. Furthermore, the coefficients of the variables describing the attributes have
the expected signs. The same pattern applies to the analysis which relates report marks to personal characteristics. Moreover, the signs of the effects of personal characteristics like income, age and education are the same as in the IJburg study.

Although the conjoint measurement method generates significant and plausible relations, it is—in this particular study—impossible to investigate the trade-off between the monetary attribute ‘housing expenses’ on the one hand, and the attribute ‘aircraft noise nuisance’ on the other hand. The reason is that the vignette attribute ‘aircraft noise nuisance’ is not presented in terms of Ku, as most respondents cannot interpret this measure and their answers would have no meaning whatsoever. Therefore, it is impossible to give a valuation per Ku, as was done in the analysis based on the Cantril question. However, even though it may not be possible to deduce a price per Ku, the vignettes analysis still yields very interesting results.

For instance, we deduced a price for flying during the nighttime from the trade-off ratio between ‘aircraft noise nuisance during the night’ on the one hand, and ‘change in housing expenses or rent’ on the other hand. If the noise nuisance no longer occurs during the night, people would be willing to pay an additional 57.1% of their housing expenses or rent. This figure equals 25.5% for the removal of noise nuisance during the day, and 45.2% for the removal of noise nuisance in the early morning and the evening. Furthermore, our results indicate a far less severe effect of flights during the nighttime than the current Ku measurement system assumes. This result is also found in other studies.

**Conclusions**

The most important conclusion that can be drawn from the empirical studies discussed in chapters 5 and 6, is that it is actually possible to estimate monetary valuations for different kinds of environmental goods by using valuations methods other than the CVM. Our studies show that both the conjoint measurement method and the well-being evaluation method are useful and valid valuation methods that constitute, at the very least, an important complement to the CVM. Despite the fact that in the Schiphol study the results of the welfare evaluation method did not come up to our expectations, there is no reason to suspect that the method could not give plausible and significant results in other valuation studies.