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Motorways versus Nature

A Welfare Economic Valuation of Impacts

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Preface

This report is the conclusive output from a joint project between the Environmental Assessment Institute (IMV) and the Environmental Economics and Rural Development Division of the Food and Resource Economics Institute at The Royal Veterinary and Agricultural University (KVL). Using state-of-the-art economic valuation methods the project is aimed at estimating the welfare economic values/costs of the impacts on nature from motorway projects in Denmark.

The primary purpose of the project is to widen the scope of welfare economic assessments of motorway projects in Denmark. Motorways are long-term, wide-ranging infrastructures, which have a major impact on nature and the environment. However, due to the absence of value estimates, impacts on nature have not been included in Danish cost-benefit analyses of infrastructure projects. Instead, these impacts are identified and presented in physical terms in environmental impact assessments – leaving the cost-benefit analysis incomplete and potentially misleading. Hence, there is an obvious need for knowledge on the welfare economic values associated with the impacts on nature by motorway projects.

Special attention has been given to the issues surrounding the choice between two alternative layouts of a new motorway in the Silkeborg area. It is our hope that the results of these investigations can support the ongoing political decision making process in this context.

The report is aimed at people who work with the planning of public projects, which have an impact on nature. More specifically, people interested in valuation techniques should find it useful reading.

Abstract

The purpose of the present study is to provide better scientific basis for incorporation of impacts on nature in the decision-making process when planning future motorways in Denmark. Previously, impacts on nature have only been taken into account in the mandatory Environmental Impact Assessments, which provide a *qualitative* description of impacts in physical terms. The present study provides a *quantitative* description of impacts in economic value terms. This will facilitate direct incorporation of preference-based values of the impacts on nature in the cost-benefit analyses, which are regularly carried out when new motorways are planned.

Two state-of-the-art valuation techniques – the Contingent Valuation Method and the Choice Experiment Method – were employed in order to estimate the monetary values associated with loss of nature due to motorway encroachment.

A Contingent Valuation study is carried out on a sample of respondents living in the Silkeborg area – an area which is currently undergoing a motorway planning process. Results show that faced with the choice of the two proposed layouts for the Silkeborg motorway, 76% of the respondents prefer the Resendal layout whereas only 24% prefer the Ringvej layout. To ensure realisation of the preferred layout, those preferring the Resendal layout on average are willing to pay 1318 DKK per household per year, while those preferring the Ringvej are willing to pay 1428 DKK.

Further, a Choice Experiment study is carried out on both a national and a local Silkeborg sample. Results show that respondents in general have strong preferences, i.e. high willingness to pay, for protection of forests and wetlands against motorway encroachment whereas protection of heaths is less valued. It is suggested that non-use values account for more than half of the elicited values, and the presence of anchoring and embedding biases is established. Furthermore, preferences in the Silkeborg sample turn out to be quite similar to those of the national sample, and it is assessed that collection of data via an internetpanel is an effective and feasible alternative to ordinary mailout of questionnaires.

On the basis of results from both studies, it is finally concluded that the Resendal layout is the preferable layout for the Silkeborg motorway when considering the welfare economic value of the impacts on nature.

Resume (in Danish)

Formålet med undersøgelsen er at muliggøre en videnskabeligt funderet forbedret inddragelse af indvirkninger på naturværdier i den fremtidige planlægning af nye danske motorveje. Hidtil har naturværdierne kun været inddraget i kraft af de lovpligtige VVM-analyser, som *kvalitativt* beskriver motorvejens fysiske indvirkninger på naturen. Nærværende studie tilvejebringer en *kvalitativ* beskrivelse af den økonomiske værdi af indvirkningerne. Dette giver mulighed for direkte indarbejdelse af præferencebaserede værdier af sådanne indvirkninger på naturen i de cost-benefit analyser, som i forvejen normalt gennemføres i forbindelse med planlægning af nye motorveje.

For at estimere monetære værdier tilknyttet tab af natur som følge af nye motorveje, anvender undersøgelsen to 'state-of-the-art'-teknikker – Den Betingede Værdisætningsmetode og Valghandlingseksperiment-metoden.

Et Betinget Værdisætningsstudie er gennemført på respondenter fra Silkeborg-området, hvor en ny motorvej længe har været i planlægningsfasen, og det resterende spørgsmål er nu, hvilken af to foreslåede linieføringer for motorvejen skal realiseres. Resultaterne viser, at 76% af respondenterne foretrækker Resendallinien, mens 24% foretrækker Ringvejslinien. For at sikre realisering af den foretrukne linieføring, er dem, som foretrækker Resendallinien, i gennemsnit villige til at betale 1318 kroner årligt pr husstand, mens dem, som foretrækker Ringvejslinien, vil betale 1428 kroner.

Desuden er et Valghandlingseksperiment anvendt på både et nationalt og et lokalt Silkeborg sample. Resultater herfra viser, at svarpersonerne har stærke præferencer, dvs. høje betalingsviljer, for beskyttelse af skove og vådområder mod nye motorveje mens beskyttelse af heder er mindre vigtigt. Resultaterne antyder, at ikke-brugsværdier udgør mere end halvdelen af de opgivne betalingsviljer, og desuden påvises problemer med såkaldt 'anchoring' og 'embedding'. Respondenter i Silkeborg samplet viser sig at have præferencer svarende til respondenter i det nationale sample. Endelig viser dataindsamling via et internetpanel sig at være et effektivt og troværdigt alternativ til almindelig postomdeling af spørgeskemaer.

Ud fra den velfærdsøkonomiske værdi af indvirkninger på naturen, peger resultaterne fra de to metodestudier på, at Resendallinien bør vælges som linieføring for den fremtidige Silkeborg-motorvej.

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1 Introduction

According to neo-classical economic theory market mechanisms allocate goods and services according to the supply and demand for such provisions, such that prices reflect the value of the goods and services. However, not all goods are traded in markets. Environmental services are usually non-marketed goods[1]. Consequently, the market mechanisms cannot ensure that such resources are used efficiently, i.e. ensure that supply meets demand. This failure of the market system to allocate and price environmental goods creates a need for economic valuation to guide policymaking (Freeman 2003). Since the early 1950's, economists have developed methods to estimate the economic value of changes in the quantity or quality of environmental goods. These value estimates can be used in cost-benefit analyses of public projects and policies.

In recent years Danish traffic and transport authorities have adopted the cost-benefit analysis technique to support the political decision-making process (Trafikministeriet 2003). Ideally, the analyses should identify and value all relevant changes that arise as a result of a project. Motorways are large-scale and long-term infrastructural public projects, which can have a significant impact on nature and landscape amenities. The construction of motorways can cause barrier effects for plants and animals, and habitats risk being destroyed. Recreational areas might disappear while others may be adversely affected both visually and in terms of noise. In welfare economic terms such impacts can be costly to society.

However, up till now Danish cost-benefit analyses do not include a sufficient valuation of these negative impacts on nature. They are only partly taken into account indirectly through e.g. noise studies. The Danish Ministry of Transport and Energy has declared that impacts on nature are too complex to incorporate in cost-benefit analyses and, therefore, should be taken into account through qualitative measures only (Trafikministeriet 2003).

[1] Environmental services often have the characteristics of a public good, which cannot be allocated through the market mechanism. This is due to the fact that a public good is non-excludable meaning that once the good is provided to one individual others cannot be prevented from using it. It is another characteristic of a public good that it is non-rival, which means that one person's use of the good does not diminish the utility, which other individuals may attain from it.

How impacts on nature are incorporated into the decision-making process when planning a motorway is an unanswered question. Within the legal framework of EU directive 85/337/EEC an Environmental Impact Assessment (EIA)[2] *must* be carried out before large public and private construction project decisions are made. Impacts on nature are therefore only addressed through the EIA processes. The assessments describe the impacts on wildlife, flora, cultural and recreational sites in qualitative terms, but these are not valued in monetary terms. In contrast, other externalities arising from motorway projects, such as time savings, fewer traffic fatalities, changes in air pollution etc. *are* valued in monetary units in cost-benefit analyses of motorway project.

Ignoring the impacts on nature in cost-benefit analyses means that the assessment of social costs and benefits is incomplete which may provide misleading results. At present several motorways projects are in the planning process in Denmark. The following examples have been taken from the website of the Danish Road Directorate: Odense – Svendborg, Holbæk – Tuse, Frederikssundmotorvejen, Ønslev – Sakskøbing and Herning – Århus. Hence, the question of valuing the impacts on nature is highly relevant.

The motorway at Silkeborg is still in the planning process and will act as a case study in parts of this report. The motorway is the last stage of the stretch from Århus to Herning – a decision taken in 1993. This final stage, therefore, is now a fact – however, the final specific layout is still to be decided. Two main proposals are being considered. The first is the *Resendal layout* north of Silkeborg and the second is the *Ringvej layout* through Silkeborg city.[3]

Both layouts will affect landscape amenities and recreational benefits. In the Resendal area it is primarily the landscape characteristics of a remarkable river valley whereas the Ringvej layout will affect - among other things - the recreational benefits from an urban forest. The characteristics of the two layouts are described in Appendix 1.

1.1 Purpose

The overall purpose of the present study is to generate a specific, as well as a generic, set of values measuring the welfare economic loss of nature caused by the construc-

[2] In Danish: VVM-redegørelse (Vurdering af større anlægs Virkning på Miljøet).

[3] The Road Directorate is presently working on a possible third route – the *Combi layout*. However, this third proposed layout is not included in the present valuation study, since the environmental impact assessment has yet to be completed for this proposal

tion of motorways. The valuation is carried out as a state-of-the-art valuation study based on the methods of contingent valuation and choice experiments.

Specific objectives:

- To examine the concept of nature values, which constitute the basis for the welfare economic valuation.

- To briefly assess methods to value loss of nature for use in cost-benefit analyses.

- To conduct a nation-wide choice experiment aimed at estimating a set of generic values determining the negative impact on nature in motorway planning.

- To conduct a contingent valuation survey of the negative impact on nature in relation to the main layout proposals at Silkeborg, the Ringvej layout and the Resendal layout.

- To conduct the generic choice experiment survey in Silkeborg in order to reveal the effects of motorways as a real life problem.

- To look deeper into the methodology underlying the advanced methods of choice experiment and contingent valuation. Specifically clarify how the method for sampling respondents affects the answers. In this case, Internet surveys by e-mail as well as surveys sent out by ordinary post will be used and compared.

When measuring the value of nature for use in a cost-benefit analysis it is essential to operate within a well defined societal framework. Among other things this entails the delineation of the individuals affected by the project under consideration. This can be the populations in a specific geographical area within the country. It can also be the whole nation, especially when non-use values are affected. In this study the population in the Silkeborg area as well as the whole Danish population were included in separate surveys. In principle one could also include people in other countries. Considering the limited scope of Danish motorway projects in a European or global context it seems unlikely that foreigners would experience significant adverse effects from these undertakings. Consequently, only inhabitants in Denmark were included in the valuation surveys.

Nature does not only contribute with recreational value or merely the value of its existence. Elements, such as the purification of soil and water, the retention of nutrients and decomposition of waste substances are examples of *ecological functions* which contribute positively to society (Freeman 2003). The landscape can also contain cultural riches, such as archaeological findings, which also represent a value to society. It has not been possible in this project to specify the value of the ecological functions or cultural values, which would be affected by the construction of a motorway.

1.2 Outline of report

Chapter 2 will discuss the value of nature as a concept. This includes a discussion of the values included in the present study and the kind of values, which it is impossible to take into account in a welfare economic analysis.

Chapter 3 gives an outline of different methods available for the evaluation of nature in economic terms. In addition to valuation this includes pricing methods and benefit transfer.

Chapter 4 provides a more thorough and technical description of the stated preference methods used in this study.

Chapter 5 describes how the questionnaires are drawn up.

Chapters 6 and 7 explain how the actual analysis of the collected data and values is conducted.

In chapter 8 the results presented in the previous two chapters is used to analyse which layout is to be preferred for the Silkeborg motorway.

Chapter 9 provides a discussion of the results of the study and chapter 10 comprises the final conclusion.

2 Values of nature

This chapter provides a discussion of the concept of *value* from different perspectives – not just from an economic viewpoint. The different categories of value within, as well as outside the welfare economic framework are represented.

The analyses in this report are solely based upon the welfare economic approach to valuing nature. Before looking at the different concepts of value, the next section will briefly describe the basic theory behind the welfare economic approach valuation of non-market goods.

2.1 Welfare economic theory

The theoretical foundation for the economic approach to valuing nature and environmental goods[4] is *welfare economic theory*. This theory is based on the central assumption that each individual is the best judge of what is good for him or her. This means that the individual assumed to choose the combination of goods that ensures the greatest possible utility for the individual, subject to the limitations represented by the individual's budget constraint. Another central assumption is that the existence of perfect markets[5] will ensure that society's scarce resources are allocated in accordance with the preferences of the population, thus ensuring an optimal utilisation of those resources (Freeman 2003; Gravelle & Rees 1992).

The actual value of a good, marketed as well as non-marketed, is expressed through the individual's *preferences* for the relevant good. It is assumed that the value represents the *utility* experienced by the individual through satisfaction of his/her preferences (Freeman 2003). The value of a good is measured as the bundle of other goods, which the individual is willing to give up for one additional unit of the good in question. Money is normally used as the standard of value for representation of the combination of goods, as money is a practical unit of measure for the value of the many different real goods that are part of consumption. It follows that money does not have a value in itself but is used as a common denominator to compare the value of different types of goods.

[4] The term *good* covers all marketed and non-marketed goods and services. Goods can thus be comprised of more intangible concepts such as the *actual awareness* that you have access to clean air or are protecting a certain area of nature.

[5] The concept of perfect markets is an ideal state entailing a number of assumptions. For instance, there must be complete information, many suppliers and buyers of goods and no transaction costs.

If all goods could be freely bought and sold, the existence of perfect markets would, in itself, lead to an efficient utilisation of society's resources. However, the real world is affected by a number of conditions that have distorting effects on the market. Few goods are sold or bought on perfect markets, and as a general rule there is no market at all for most environmental goods such as biological diversity. Thus, the supply of environmental goods is often determined politically and it is uncertain whether the allocation of the environmental good is efficient, i.e., that supply and demand of environmental goods correspond to each other. Therefore, there is a risk that society does not allocate the resources that are available in the most appropriate and efficient manner (Freeman 2003; Gravelle & Rees 1992).

A number of economic evaluation methods have, with an increased knowledge and understanding of the environmental values, been developed to determine the value of changes in quality and quantity of environmental goods. This allows e.g. impacts on nature caused by motorways to be included in a cost-benefit analysis. Theoretically, cost-benefit analyses can thus incorporate all the consequences involved when, for instance, society considers the construction of a new motorway. This applies to market goods (e.g. labour, asphalt, signs etc.) as well as non-marketed goods (e.g. noise, emissions and loss of recreational areas).

The purpose of the economic valuation is not to identify a price that people have to pay for environmental goods, which are currently free of charge, but to point out that changes in the quality and quantity of non-priced goods are not free of costs for society. By promoting an integration of environment and economy in the decision-making process in this way, it becomes possible to enhance the policymakers' basis for decision-making and ultimately also the environmental prioritisation. This means that it will be possible – in the environmental area as well – to allocate society's resources in agreement with the individual preferences of the population.

2.2 Measuring Welfare Changes

As specified by Freeman (2003) changes in environmental quality can affect individuals' welfare through any of the following channels:

- Changes in prices for market goods;
- Changes in prices received for factors of production;
- Changes in quantities/qualities of non-marketed goods.

It is unlikely that the motorway projects considered in the present study will have any significant impact on price relations. Hence, the first two channels are irrelevant. The welfare effects we are looking for will be in terms of changes in the quantities and qualities of non-marketed goods - or more specifically changes in the quantities and qualities of the natural amenities affected by the construction of a motorway.

Measures of welfare change are based on the potential Pareto improvement criterion. At the core of this concept is the notion of compensation and willingness to make compensating payments. Let us assume that an individual has the right to her present level of utility. In case of a deterioration of environmental quality we would ask how large the monetary compensation should be to make the individual feel as well of as before. If the individual does not have right to the present utility level the question would be how much the individual would be willing to pay to prevent a given deterioration of environmental quality. In technical terms the welfare changes illustrated are referred to as Hicksian Compensating Surplus and Hicksian Equivalence Surplus (see Freeman, 2003).

In the present study the benchmark is a motorway project which has already been decided. However, the details of the layout are still up for consideration. In the Silkeborg valuation scenario the respondent can chose between two layouts with different (negative) impacts on nature in the area. Everything else equal the respondent is supposed to prefer the lesser evil in terms of perceived environmental deteriorations. The valuation scenario assumes that whichever layout the respondents prefer they would have to pay in terms of a tax increase for having this scenario realised. In other words, the respondent has no right to the preferred alternative. This implies that the underlying welfare measure is the Hicksian Equivalence Surplus. In the national survey of preferences for the layout of a generic motorway the valuation scenario has the same properties.

2.3 Defining values

The word ‘value’ can have many meanings. The meaning may vary in daily speech and among professionals such as philosophers, biologists and economists. In ecology, value is usually taken to mean “that which is desirable or worth respecting for its own sake; things or quality with an intrinsic value” (Freeman 2003). Within economics, value is a relative concept, and it is only possible to define the value of something if it

can be swapped for or compared to something else. Value then becomes an expression of a "fair and appropriate equivalent in money or goods" (Freeman 2003).

This distinction corresponds to a philosophical distinction between *intrinsic* and *instrumental* values (Freeman 2003). A distinction is made between whether something constitutes a goal in itself and thus a value in itself, or if something is a means to achieve a given goal and therefore only has value as such.

The things to which we ascribe value thus depend on our ethical starting point. If the starting point is *anthropocentric*, only humans have a *moral* right to ascribe value to nature. Other living beings can thus only be attributed instrumental value, i.e. value, based on how they affect – or can benefit – humans. Consequently, nature only has value by means of its significance for human life. (Callicott 1999; Jensen 2001; Kortenkamp & Moore 2001).

However, we can also place our starting point outside the human sphere and believe that nature has its own intrinsic values, i.e., nature is a goal within itself independent of the value mankind might assign to it. This is the position taken by biocentrism, where all living organisms are moral beings with intrinsic values, or ecocentrism, where ecosystems also have an intrinsic value. Thus, within bio- and ecocentrism nature has a value, which is independent of its benefits to mankind. In philosophy, there is a discussion whether such values can be objective, i.e. exist outside human recognition, or subjective, i.e. exist only because humans choose to attribute such values to nature (Callicott 1999; Jensen 2001). Callicott (1999) and others conclude that *objective* intrinsic value in nature cannot exist, but that it makes sense to speak of a *subjective non-anthropocentric intrinsic value* when people value nature for its own sake. In the case of motorways objective intrinsic values could be nature's own inherent value completely independent of human values. A subjective non-anthropocentric intrinsic value could be the significance people assign to nature independent of their own utility, i.e. a value, which is not subject to trade-offs against other goods.

Still, it is an open question whether the latter is in fact *non-anthropocentric* because it still relates to human values and desires. In that way it would simulate the anthropocentric existence value or testamentary[6] value of nature, which belong to the value concepts recognised by welfare economics (to be explained further in section 2.4.1).

[6] Sometimes also referred to as 'bequest' value in the literature.

Turner *et al.* (2003), for instance, distinguish between anthropocentric inner nature values (relating to humans as subjects and moral decisions) and non-anthropocentric inner nature values (seen as objective values, independent of human recognition).

'Non-anthropocentric inner values' cannot be included in the economic value concept, because in this case, nature's intrinsic values are objective and will exist regardless of whether humans understand or recognise the value. This means, for instance, that these values cannot be equated in monetary terms or compared on a common scale with other things to which we attach a subjective value. However, this does not mean that such values are necessarily absolute or sacred: intrinsic (subjective) values can be considered to be relative and also the object of prioritisation (Callicott 1999), although only in non-economic equivalents. This action may, however, be criticised for continually comparing different things and thus still be weighing – though not in monetary terms – different things against each other.

In general, the definition of what is of value and how values can be calculated is therefore largely a question of ethics. As noted economic valuation rest upon an anthropocentric ethical concept of nature as a resource having value due to human preference for its different attributes. These attributes can be multiform comprising use as well as non-use values as outlined in the next section.

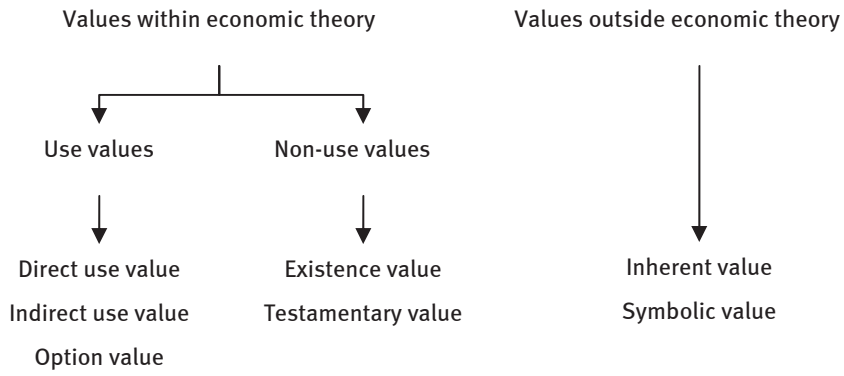
2.4 Different categories of value

The value of nature can be divided into several different categories. Some types of value can be included in an economic assessment, i.e. values that are important to human welfare. Other types of values cannot be addressed in an economic analysis due to their non-anthropocentric character. This section will discuss value categories within and outside economic theory respectively; see figure 2.1 below.

2.4.1 Value categories within welfare economics

From an anthropocentric perspective, the value of nature within economics is considered on the basis of the functions and properties that create *value to humans*. This means that, from an economic point of view, nature provides a flow of benefits and services, physical as well as aesthetic (Freeman 2003). These benefits and services can be divided into a number of different types of value, together forming a *total economic value* of an environmental good (Turner *et al.* 2003).

Figure 2.1 Relationship between the different categories of values described in this section



- **Direct use values** Direct use values denote the physical utilisation of nature, for instance in the form of direct material flows such as logging, fishing etc. but also in the form of recreational usage, such as sport fishing, sailing and walking. In addition to this, there is the extraction of natural resources and groundwater.

- **Indirect use values** Nature contains a number of indirect use values such as life-supporting functions, which are also called ecological services (not to be confused with values such as inherent or symbolic values). Among the important functions of nature are the collection, re-use and purification of waste products and by-products from human activities, the conversion and binding of CO_2 and protection of groundwater.

- **Option values** A third form of use value is the so-called option value. This concept covers the value that the individual attributes to the possibility of enjoying the natural good at a later point in time (Weisbrod 1964). An option value can also be linked to future potential applications as a result of unforeseen events or new discoveries. In the literature (Arrow & Fischer 1974) this is defined as a *quasi-option* value.

- **Existence value** This type of value concept occurs when an individual experiences satisfaction from the knowledge of the mere existence of the natural goods (Freeman 2003). The pure existence value is therefore independent of both the present and future utilisation by the individual – or others – of the good (Krutilla 1967). The reason for attributing an existence value to a good can be a feeling of responsibility or duty to preserve species and ecosystems (Bateman *et al.* 2002). The anthropocentric focus in economic valuation does not rule out a concern for the survival or wellbeing of other beings (Freeman 2003). However, it is important to notice that it is value to humans and thus still an anthropocentric approach, and not value for nature's own sake as in a *biocentric* framework. This is discussed in more detail in section 2.4.2, in relation to inherent value.

- **Testamentary value** Testamentary value falls into the category of non-use value (Freeman 2003). The concept originates from the individual's desire to preserve and protect natural goods out of concern for the opportunities of future generations. The concept can be extended to also include consideration for the current generation's utilisation of the good (Bateman *et al.* 2002).

2.4.2 Value categories outside the welfare economic framework

As mentioned at the beginning of this chapter, the analyses in this report solely build on welfare economics. Therefore, only the values within an anthropocentric approach will be included. But, as noted in section 2.3, there can be values outside the scope of welfare economics. These values have been described as the non-anthropocentric values. Something these values have in common is that it is not possible to determine their value from the perspective of a trade-off against other goods.

In the following sections, the non-anthropocentric values are described and it is discussed which consequences such values can cause when economists estimate the value of nature.

2.4.2.1 Inherent value

Inherent value is independent of human value. The concept is linked to the biocentric or ecocentric view of nature, according to which 'inherent value' is ascribed to everything in nature, but can also be limited to all *living* things or apply to a subcategory such as fauna (Bateman *et al.* 2002).

Since inherent value can be described as a value embodied in the good itself, it is outside of human preferences. Hence, the anthropocentric economic approach cannot address inherent values. As previously mentioned, the anthropocentric part of the inherent values can, to some extent, be included in an economic value concept. An individual can believe that nature has a right in itself to exist, and attempt to safeguard this through his/her willingness to pay (the *anthropocentric inner value* as described by *Turner et al. (2003)*). That is to say, humans can express worry on behalf of nature (Bateman *et al.* 2002).

When value is ascribed to nature for nature's own sake, there are certain qualities of nature to which high values are ascribed. In the introduction to the report *Nature Quality – Criteria and Methodology Development* by the Danish National Environmental Research Institute (DMU), it says that:

> *It is hardly possible to find untouched nature in today's Denmark, but despite this it is still meaningful to define criteria for the quality of nature that regards the untouched, original and wild nature as the expression of the highest quality of nature. Based on biological criteria, nature must be considered as being the best at creating good nature (Nygaard 1999).*

Here, the ideal is thus a wild and original nature, with as little influence from humans as possible. This view of nature can lead to conclusions quite the opposite from those drawn by an economic analysis. For instance, the Danish urban forest *Vestskoven* has a low biological value since it is a young and planted forest considered to contain no unique animals or plants. But the forest is well-attended by visitors who gain utility from the forest. Therefore, the forest has a high economic value from a welfare economic perspective. This is an example of a schism between different views of nature and values, which plays a role in forming the debate about the economic approach to value nature.

2.4.2.2 Symbolic value

Symbolic values resemble the inherent value, since a good with a symbolic value has a value of its own (Turner *et al.* 2000). This means that the good with a symbolic value

cannot be substituted for other goods. Symbolic values can be anything from a culturally or historically significant item, such as the Danish flag, to unique natural values. For instance, the Gudenå valley near Silkeborg could contain unique values by virtue of being Denmark's largest melt water valley. By definition, unique values are irreplaceable values that cannot be substituted.

Therefore, if society ascribes symbolic values to nature or parts of nature, it will not be possible to determine its welfare economic value (Turner *et al.* 2003). From a project point of view, these values must be addressed differently, for instance by means of a qualitative description of the consequences of the symbolic values.

2.4.3 Discussion of values

From the above sections, it is apparent that the question regarding the value of nature is complicated, and that there is no clear-cut answer to what contains value and how this value can be determined. With a biocentric and ecocentric approach, nature or its elements have an inherent value that is independent of humans, and therefore does not contain the possibility of having human values ascribed to it.

The debate on inherent value is particularly concerned with the protection of biodiversity. Hanley & Spash (1995) have showed that some people refuse to substitute between environmental goods, since they believe that nature cannot be replaced by any amount of money (or other goods). The idea of prioritising and trading biodiversity as a good is therefore unacceptable. Within economic terms this is known as *lexicographical preferences* and prioritisation via economic valuation is therefore impossible. In valuation studies the lexicographical preferences show when respondents refuse to state a willingness to pay (therefore called protest bids) for preserving e.g. nature from motorways. This might be the case if respondents believe that nature has an inherent or symbolic value. This can cause problems for the results since protest bids do not count in the calculations of value in valuation surveys. Hanley & Spash (1995) indicate that lexicographical preferences might exist when unique nature goods are being valued. But if people *always* believe that nature contains values outside the welfare economic approach, nature will be raised above all other goods in society and does not enter in the prioritisation considerations. This could result in high opportunity costs. At the extreme, the inviolability of nature will lead to a principle where considerations to humans must be ignored for the good of nature (Dubgaard *et al.* 1999). Planning of new motorways is not possible within such a framework.

In contrast, economists try to ascribe a value to nature or its elements, which puts it on a comparable basis to other societal goods. With an anthropocentric basis, this view therefore assumes that it is possible to estimate the value of changes in nature to a limited extent, based on the value people ascribe to these changes to nature. To some extent this might include natures own value, if people gain utility from preserving nature irrespective of their own utilisation of the areas (existing value and testamentary value).

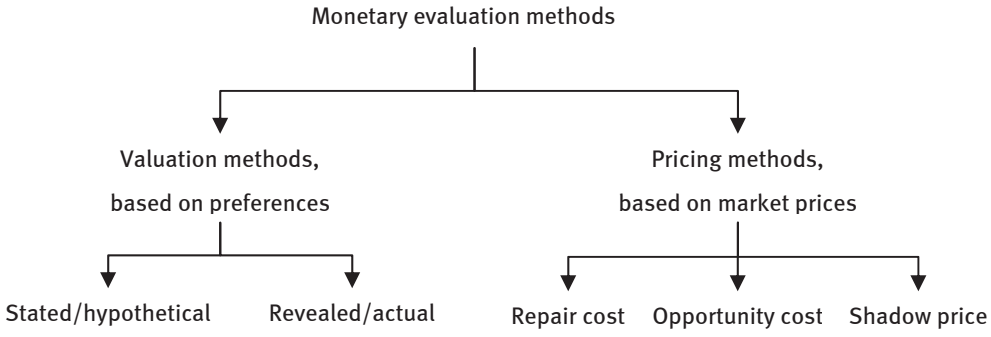
The specified ethical foundation and the exclusion of certain types of values from the welfare economic analysis imply that the welfare economic analysis cannot be used in isolation as a decision-making tool. In order to make the final prioritising of actual projects, these analyses must be complemented with other additional considerations that can be included.

This report builds solely on the welfare economic approach to valuing nature, and for this reason it does not deal with questions regarding possible symbolic and inherent values in relation to nature during the planning phase of motorways. In the following chapter, a summary will be given of available methods to estimate the economic value of the impacts on nature caused by motorways, e.g. the final stretch between Århus and Herning around Silkeborg.

3 Monetary evaluation methods

In the previous chapter, it was explained that nature has value for individuals and therefore to society. Since the impacts on nature have a value, they should be included in cost-benefit analyses. This implies that a *monetarisation* of the impacts on nature has to be carried out; thus, the impacts will be comparable to other goods. Within the area of environmental economics methods have been developed to facilitate such monetarisation of impacts on nature and changes in environmental goods. Figure 3.1 presents some of the methods within the two main categories – valuation and pricing.

Figure 3.1 Monetary evaluation methods



Adapted from Garrod & Willis (1999)

3.1 Pricing methods

Pricing methods use observable market prices to estimate the value of environmental goods. Usually this valuation of the environmental goods is done by cost calculation. However, there are no direct correlations between each individual's utility of the changes in the environmental good and the actual expenditures or costs that are linked to prevent or facilitate an environmental change. The result is that the pricing methods do not indicate the actual welfare value of the environmental change. Thus, pricing methods are not able to answer the fundamental question as to how society's scarce resources should be allocated based upon the preferences of the population. (Bateman *et al.* 2002; Dubgaard *et al.* 2002)

However, using a pricing method is often considerably less resource intensive than carrying out valuation studies. Therefore, the methods are used occasionally in economic analyses of the environment.

One approach to price the impacts on nature is the *repair cost* method, which is based on the idea of re-establishing nature sites. The method uses the calculated costs of restoration and compensation of nature areas affected by e.g. the motorway, if the areas, hypothetically, were restored. This repair cost approach has been used in a study by INFRAS/IWW (2000) and OECD (2003) to determine the external costs of the impacts of transport on nature and landscape in Europe.

As the method does not result in an actual welfare measurement it is difficult to interpret the result from a welfare economic perspective. The method can only show what the financial costs to society will be for regretting the construction of a motorway. This makes the method problematic for use in cost-benefit analyses.

3.2 Valuation methods

Valuation studies seek to reflect changes in society's welfare from a change in quality or quantity of environmental goods by, directly or indirectly, determining the value that individuals ascribe to environmental goods (Freeman 2003). Hence, valuation methods are, in contrast to the pricing methods, based upon people's preferences.

Their purpose is to reveal people's economic behavioural relationships between prices, and supply and demand for nature and environmental goods. It is these relationships which would be observable if nature were a regular good traded at a market. Valuation methods, therefore, try to identify people's preferences for environmental goods which do not have a market value, and, on the basis of these preferences, estimate monetary figures and establish indirect demand curves (Freeman 2003). Distinctions are made between methods based on actual behaviour, called revealed preference methods, and methods based on hypothetical behaviour, called stated preference methods. This will be explained in further detail in chapter 4.

3.2.1 Benefit transfer

Benefit transfer is another possibility for estimating the welfare economic values of a change in nature caused by motorways. Ideally, a thorough valuation study of the consequences for nature should be carried out for each new motorway. This will provide the best welfare economic measurements for further use in cost-benefit analyses.

However, valuation studies are characterised by a large demand on resources to conduct the surveys. Therefore, it is obvious to investigate the possibility of reusing and

transferring value estimates from existing valuation studies. This method is called *benefit transfer*.

Transferring value estimates is far from unproblematic. The technique is controversial and strict guidelines are needed in order to make a valid value transfer. As an example, the natural conditions of the survey site (the area where the valuation studies were conducted) and the target site (the area where the values are transferred to) has to be comparable in terms of ecology, scale and impacts on nature. Other important issues are socioeconomic and demographic conditions such as income, population size, etc. (Brouwer 2000; Desvouges *et al.* 1992)

Schou *et al.* (2003) have gathered a number of studies which analyse transfer errors in benefit transfer studies of nature resorts. The size of the errors depends on whether it is benefit functions or just crude average values that are transferred. According to Schou *et al.* (2003), the errors from benefit transfer can be very large. So, benefit transfer is not without problems and therefore often linked with uncertainty. While there are limitations in using benefit transfer to derive a precise monetary value for impacts on nature, it can – when suitable primary valuation studies exist and the transfer is carried out carefully – provide the likely magnitude of environmental values.

The size of an acceptable transfer error, both scientifically and politically, is open for discussion. From a technical basis, benefit transfer can be accused of being subject to huge uncertainty. However, the political relevance and time schedule of a project can mean that an estimate of the non-marketed goods, even though it is subject to great uncertainty, can be preferable to no estimate at all.

In Denmark, no studies have been carried out to estimate the loss of nature when motorways are being planned. Perhaps other existing Danish valuation studies could indicate the loss of nature values, but the overall number of valuation studies in Denmark are limited. Those who exist (Aakerlund 2000; Boiesen *et al.* 2005; Dubgaard 1998; Hansen 2005; Hasler *et al.* 2002; Ladenburg *et al.* 2005; Olsen & Lundhede 2005) are made in different contexts. Therefore, it is questionable whether the Danish studies can be used for benefit transfer when valuing loss of nature from motorways.

Instead of Danish studies, foreign studies can be investigated for potential use in benefit transfer. For this purpose *ENVALUE*[7] and *EVRI*[8] are useful databases. They have a systematic collection of environmental valuation studies presented online, which can produce an overview of potential estimates for use in benefit transfer.

Unfortunately it has only been possible to obtain two surveys where the value associated with loss of nature is estimated in connection with road projects. They will be discussed in section 9.1.2. The two studies are conducted in other countries and in other contexts, which is likely to cause problems when transferring benefit values.

3.2.2 Summary

In this chapter, two main approaches to evaluating the economic value of nature were presented –pricing methods and valuation methods. From a theoretical perspective, the pricing methods, such as the repair cost, can be problematic to apply, since it does not indicate the welfare economic loss of nature when constructing new motorways.

Benefit transfer is an alternative to the resource demanding primary valuation study. Reusing valuation estimates can be fully acceptable, but is dependent on the existence of well performed primary valuation studies and careful transfer of estimates. In the case of impacts on nature caused by new motorways, it is doubtful whether proper Danish or foreign valuation studies exist for an acceptable value transfer.

From a methodological point of view, there does not seem to be an easy way to measure the loss of nature during the planning process of new motorways. As a consequence this project conducts a thorough valuation study to measure the loss of nature associated with placing new motorways through nature.

[7] http://www.epa.nsw.gov.au/envalue/
[8] http://www.evri.ca/

4 Preference-based economic valuation methods

This chapter provides a more thorough description of the preference-based methods briefly mentioned in the previous chapter. Special attention is given to the 'stated preference' methods, as these are the most relevant methods in the present case.

4.1 From utility to monetary values

As previously mentioned, neoclassical welfare economic theory states that the purpose of economic activity is to increase the well-being of the individuals in the society. Furthermore, the individuals themselves are the best judge of how well off they are in any given situation. These premises are the basis for economic valuation of public goods and other non-market goods, such as environmental quality. It follows that the society's welfare can be measured through summing up the utilities of each individual. Equivalently, changes in the individual's welfare are measured as changes in the individual's utility.

This relates to another central concept in the neoclassical welfare economic theory, namely the utility maximising behaviour of the consumer. It is assumed that consumers have well-defined preferences among alternative bundles of both market and non-market goods, and that each consumer is able to rank a feasible set of goods and choose the one most preferred, i.e. the one that maximises his utility and, hence, welfare (Freeman 2003; Gravelle & Rees 1992; Varian 1992)[9].

However, utility functions and preference relations are ordinal and therefore not directly observable. Then how do we measure an individual's utility from a specific good or the change in utility when the good is changed?

Economic valuation solves this problem by looking at individuals' preferences for different bundles of goods, more specifically the trade-offs that individuals make when they choose one good over another, or when they substitute more of one good for less of another good. In other words, the choices that an individual makes between different bundles of goods reveal his or her preferences for these goods. Preference relations, like utility functions, are measured on an ordinal scale, but when the above-

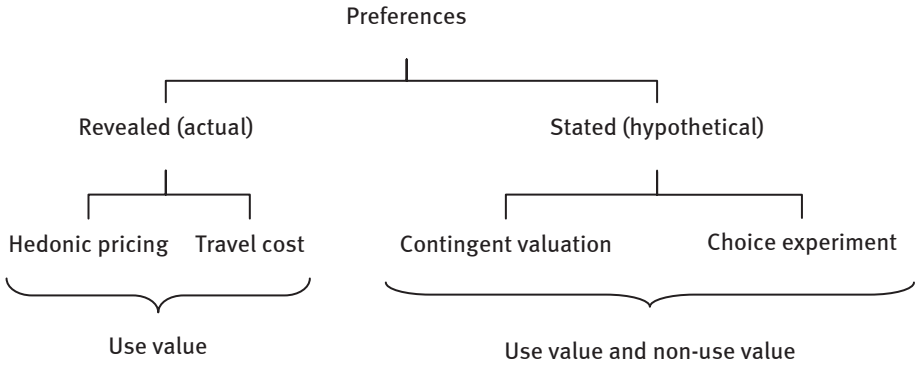
[9] For an in-depth treatment of consumer theory, see Varian (1992)

mentioned trade-offs include goods of monetary value, the revealed values are monetary values, measurable on a cardinal scale. This enables us to estimate latent demand functions for non-market goods, making it possible to measure the change in welfare associated with a change in the available bundles of goods (Freeman 2003; Hanemann 1995).

The monetary value measured in relation to either an increase or a decrease in the welfare of an individual is the individual's willingness to pay (WTP) to achieve the welfare gain, respectively willingness to accept (WTA) the welfare loss. In this study, the relevant measure is the respondents' WTP for a given positive change in the good. This will be an estimate of the so-called compensating surplus[10], which is the amount of money that makes the individual indifferent between the new and the old situation. In other words, this will be a measure of the change in welfare resulting from a marginal change in the non-market good.

A number of preference based methods have been developed for economic valuation of non-marketed goods. We generally distinguish between those based on revealed preferences (actual behaviour) and those based on stated preferences (hypothetical behaviour).

Figure 4.1 Classification of preference-based economic valuation methods



Adapted from Garrod & Willis (1999)

[10] For a thorough discussion of the five different measures of welfare, see Freeman (2003)

Figure 4.1 illustrates how some of the most popular methods for economic valuation are characterised in terms of revealed or stated preferences and what types of value the methods are capable of measuring.

As one of the aims of this study is to explore both use and non-use values in relation to different types of nature, only stated preference methods have been used in the study. Besides this, the study was intended to analyse the effects of motorways not yet built. In other words, *ex ante* analyses were needed. Stated preference methods are capable of handling both *ex ante* and *ex post* analyses. Revealed preference methods on the other hand are limited to *ex post* analyses, adding to the irrelevance of these methods in the present study. Thus, further explanation of revealed preference methods will be disregarded here[11].

4.1.1 The Contingent Valuation Method

Within the class of stated preference methods, the Contingent Valuation Method (CVM) has been the most widely applied. In CVM the aggregate value of a change in a non-marketed good is estimated holistically. This is achieved by setting up a hypothetical market for the good in question and then asking the individuals directly about their WTP (or WTA) for the relevant change in the good. Presenting a realistic scenario which describes the good in its present state as well as the relevant new state of the good and a credible method of payment, is a key element in CVM[12].

Within the frame of CVM, several mechanisms for elicitation of the individual's WTP (or WTA) have developed over the years. The *open ended* (OE) format is based on asking the individuals to state their maximum WTP for a given change. This approach has been subject to much criticism as it places a difficult cognitive burden on the individual. Stating a WTP for a good that you have never associated with monetary values is difficult and might yield unrealistic responses (Hanley *et al.* 1997). The *Dichotomous Choice* (DC) format is thought to simplify the cognitive task placed on the individual. In this approach, the individual is asked whether or not he or she would be willing to pay a specific amount for the proposed change. This resembles an everyday situation where a commodity has a fixed price, which you can either accept or reject (buy or not buy). The National Oceanic and Athmospheric Administration recommends using the DC format (Arrow *et al.* 1993).

[11] For a detailed description of these methods, see Garrod & Willis (1999).
[12] For comprehensive accounts of the method, see Mitchell & Carson (1989).

A much used and more efficient variant of the DC format is the *Double Bounded Dichotomous Choice* format (DBDC). Here the first DC question is followed by another DC question where the specified amount depends on the answer to the first DC question. Other available formats are the *Payment Card*, where the individual is presented a range of values and then has to identify the most preferred amount, or the *bidding game*, where higher and higher amounts are suggested to the individual until the maximum WTP is reached (Bateman *et al.* 2002; Hanley *et al.* 1997).

4.1.2 The Choice Experiment

An increasingly popular stated preference method is the Choice Experiment (CE). CE belongs to a group of methods known as *Choice Modelling Methods* (CMM) or *Conjoint Analysis* (CA)[13]. One of the cornerstones in CA is to make the individual consider different characteristics of a good jointly, hence the name. CA is based on economic theory considering the structure of utility functions and the influence of randomness.

CA methods other than CE are *contingent ranking* and *contingent rating* but as these are not used in this study, they will be disregarded here.

In CE, individuals are asked to choose repeatedly between alternative substitutable compositions of a good. The alternatives describe the good in terms of its *attributes* and differing *levels* of these attributes. The set of alternatives that the individual has to choose from, called the *choice set*, must comply with three conditions (Train 2003):

- The alternatives in each choice set must be *mutually exclusive*. Choosing one alternative necessarily implies not choosing one of the other alternatives.
- The choice set must be *exhaustive*. All possible alternatives are included and the individual necessarily chooses one of the alternatives.
- The number of alternatives must be *finite*.

Thus, when conducting a CE, it is important to describe both the good and its attributes as well as design the choice sets carefully, and as far as possible take into account all factors that might influence the individual's choice.

[13] In the literature different names have been used. The term conjoint analysis was proposed by Green & Srinivasan (1978).

4.1.2.1 Lancaster's Consumer Theory

A main part of the theoretical basis in CE is Lancaster's consumer theory suggesting that the individual derives utility not from a good *per se*, but rather from the attributes or characteristics of the good. Consequently, the demand for a good is derived from the demand for the attributes which constitute the good (Lancaster 1966).

For example this would mean, that a forest does not yield utility in itself (in a recreational and biological sense), but instead utility is derived from the attributes of the forest, such as noise level, visual expression, roads and paths, biotopes and habitats, etc. The theory is expressed in the following individual utility function:

$$U_{in} = U(Z_{in}, S_n) \qquad (4.1)$$

A representative individual, *n*, derives utility, *U*, from a good, *i,* depending on a vector of attributes of the good, *Z*, and a vector, *S*, describing the socioeconomic characteristics of the individual.

Faced with the choice between two goods *i* and *j*, the individuals will maximise their utility by comparing the two goods and choosing the one that yields the higher utility. In other words, if

$$U_i > U_j \quad , \forall\, i \neq j \qquad (4.2)$$

then good *i* is chosen over good *j*.

4.1.2.2 Random Utility Theory

Another central theoretical foundation of CE is Random Utility Theory (RUT) which recognises that no two individuals are identical[14] (Manski 1977). Thus, attributes of a good can be viewed and valued differently from individual to individual due to personal tastes, and only the individual itself knows their own true utility function, *U*. However, it is not possible to fully observe the set of influencing factors and the com-

[14] RUT is also the theoretical framework in DC CVM (Hanemann & Kanninen 1999). CE is thus closely related to DC CVM.

plete decision process when observing choices between two alternatives (Louviere *et al.* 2000). What is actually observed is an indirect utility, *V*, function:

$$V_{in} = V(Z_{in}, S_n) \tag{4.3}$$

As it is not possible to observe the true utility function, it is assumed that $V_{in} \neq U_{in}$. In other words, the analyst is supposed to have incomplete information and, therefore, uncertainty must be taken into account. To reflect this uncertainty, utility is modelled as a random variable:

$$U_{in} = V(Z_{in}, S_n) + \varepsilon(Z_{in}, S_n) \tag{4.4}$$

This splits the true utility function, *U*, into a deterministic (observable) part, *V*, and a stochastic (unobservable) part, ε. This error term reflects researcher uncertainty about the decision process behind the individual's choice (Ben-Akiva & Lerman 1985). The basic assumption about utility maximisation expressed in equation (4.2), can now be rewritten based on the equation above. Good *i* will be chosen over good *j* if:

$$(V_{in} + \varepsilon_{in}) > (V_{jn} + \varepsilon_{jn}) \tag{4.5}$$

Rearranging to place observables and unobservables together yields

$$(V_{in} - V_{jn}) > (\varepsilon_{jn} - \varepsilon_{in}) \tag{4.6}$$

As it is not possible for the analyst to observe the stochastic side of the equation, it cannot be determined exactly whether the equation holds. It follows that including the stochastic term makes certain prediction of the individual's choice between two alternatives impossible.

The utility function is now probabilistic and it is only possible to explain the choice between alternatives up to a probability of occurrence. The analyst, therefore, has to calculate the probability that equation (4.6) holds (Louviere *et al.* 2000; Train 2003). The probability of an individual, *n*, choosing good *i* over good *j* can thus be described as:

$$P_{in} = P(V_{in} + \varepsilon_{in} > V_{jn} + \varepsilon_{jn}) \\ = P(V_{in} - V_{jn} > \varepsilon_{jn} - \varepsilon_{in}) \,, \forall \; i \neq j \tag{4.7}$$

To estimate the above probability of choosing *i* over *j*, certain assumptions have to be made concerning the functional form of V and the distribution of ε. The indirect utility function, V, is generally assumed to be additively linear in terms of the relationship between decision attributes and observed choices (Garrod & Willis 1999). The linear additive function, describing the indirect utility derived from good *i*, is denoted by:

$$V_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} \ldots + \beta_m x_{im} \tag{4.8}$$

where x_{im} are the attributes of good *i*, and β_m are the coefficients of the attributes[15]. The β-coefficients represent the value of a marginal change in the attributes. Dividing one β-coefficient with another will yield the marginal rate of substitution between the two attributes. Usually in CE, one of the attributes is the price of the good. If an estimated β-coefficient for one of the attributes, x, is divided by the β-coefficient for the price attribute, β_{price}[16], and multiplied by -1, the result is known as the implicit price or the WTP for that specific attribute:

$$WTP_x = \frac{-\beta_x}{\beta_{price}} \tag{4.9}$$

Due to the assumption of a linear additive functional form, the attribute-specific WTP estimates can be summed to yield the total WTP for the good composed of these attributes. Louviere *et al.* (2000) state that even though the specification of the functional form will influence the significance of the attributes, the loss of generality in assuming a linear, additive form will be relatively small. Thus, the linear additive form is used throughout this study.

As for the distribution of the random term, ε, in equation (4.7), a number of different assumptions can be made. Assuming normality leads to the probit model, whereas assumption of a Gumbel distribution means that the logit model can be employed to examine the factors explaining the choice of one alternative over another. For further

[15] For simplicity the socioeconomic characteristics of the individual are disregarded in this equation.
[16] As a higher price is assumed to cause the individual disutility, the β_{price}-coefficient is negative.

explanation of available models and modifications of these, see e.g. Garrod & Willis (1999), Louviere *et al.* (2000), Ben-Akiva & Lerman (1985) or Train (2003). The multinomial logit model has been used extensively in CE. However, certain assumptions apply and one of these has proved to be potentially problematic. This is the Independence of Irrelevant Alternatives assumption, which is described below.

4.1.2.3 Independence of Irrelevant Alternatives

An important theoretical limitation of the above specification of a random utility model, which often arises in practice, is that selections from the choice set must obey the Independence of Irrelevant Alternatives (IIA) property. This implies that an individual's choice between two alternatives will only depend on the attributes of these two alternatives and not on the attributes of any other alternative. In other words, the probability of choosing one of the two alternatives must not be affected by an introduction of a third alternative. The problem is illustrated in the much cited *red bus – blue bus* example provided by Ben-Akiva & Lerman (1985). It is important to test for violations of the IIA assumption as it often does not hold in practice (Garrod & Willis 1999; Hausman & McFadden 1984). A readily available test is developed by Hausman & McFadden (1984). If a violation of the IIA assumption is observed, then more complex statistical models that relax this assumption are necessary (Hanley *et al.* 2002; Louviere *et al.* 2000; Train 2003).

4.1.2.4 Maximum Likelihood Estimation

There are several alternative statistical approaches to estimating the parameters in the utility expression specified in equation (4.8). The most commonly used estimation method is Maximum Likelihood Estimation (MLE) (Grafton *et al.* 2004; Louviere *et al.* 2000). MLE is based on the idea that an observed choice behaviour could be generated by different sets of parameters and is more likely to come from one set than another.

Stated simply, MLE identifies the set of parameters that generate the observed choice behaviour most often. For further explanation of the theory underpinning MLE, see Greene (2003).

4.1.3 CVM versus CE

The basic difference between CE and CVM is the way in which the good in question is described. Compared to CVM, where goods are described holistically, CE describes goods in terms of their attributes, or characteristics, and the levels that these take.

According to Boxall *et al.* (1996) and Hanley *et al.* (1998a) this is an advantage from a manager's or policy maker's point of view. This of course is dependent on the specific policy context. Most environmental management decisions are concerned with changing attribute levels, rather than losing or gaining the environmental good as a whole.

Often, the consequences of decisions concerning environmental goods are quite uncertain. In other words, the final state of the good after the change is not known exactly. CVM typically involves describing precise changes in the environmental good with no possibility to adjust the results according to new information gained or errors discovered after the data collection. CE is more flexible. Information about the value of attributes provides the opportunity to valuate a range of possible outcomes from a certain political/management decision.

If for some reason, a management decision is reconsidered or adjusted and the expected end state of the good thus changes, results from a CVM survey regarding the initial decision (and the initially expected end state) will be useless, whereas knowledge about attribute values from a CE survey will still be viable. Further, knowledge of attribute values could be an advantage when considering benefit transfer (Hanley *et al.* 1998a; Hanley *et al.* 1998b; Willis & Garrod 1995)

CVM has been widely criticised because of a range of potential estimation biases that it may generate. Most notably, CVM studies have been criticised because of the potential for *strategic bias* whereby respondents deliberately misrepresent their WTP in order to influence the decision-making process in their favour (Adamowicz 1995; Garrod & Willis 1999). This problem will supposedly be less in CE, as it is more difficult for the respondent to find out how each alternative in the choice set will influence the results of the survey.

Another major critique of CVM has been the so-called *embedding bias*[17] (Kahneman & Knetsch 1992). Embedding arises for example when different quantities of a good are assigned the same WTP values, see for instance Desvousges *et al.* (1992). An example could be access to forests. Two Danish valuation studies find almost similar WTP for

[17] The terminology considering embedding is not clearly defined in the literature. In this report the term 'embedding' is used as an expression covering a range of similar biases known as nesting bias, part-whole bias, scope effect, scale effect and sequencing.

access to one specific forest and to all Danish forests, respectively (Bjørner *et al.* 2000; Dubgaard 1998).

Another example implying embedding is when the same good is assigned a lower value if the WTP for it is inferred from WTP for a more inclusive good compared with when the particular good is evaluated on its own. Hanley *et al.* (1998a), Adamowicz *et al.* (1998) and Foster & Mourato (2003) report that CE to some extent avoids the embedding problem, as respondents are evaluating different levels/amounts/quantities of the attributes in the choice sets.

Yet a problem relating to DC CVM is *yea-saying*. Yea-saying describes the phenomenon of subjects agreeing to a proposal in the form of a direct question that they would reject under other conditions (Adamowicz 1995; Mitchell & Carson 1989). If a DC bid is above respondents' maximum WTP, they may still respond positively because they would like to demonstrate a positive preference for the goods in question[18]. Another explanation could be, that when faced with an interviewer or a questionnaire from an official institution, such as KVL[19], respondents might respond positively to questions, only because they wrongly believe that such a response is exactly what the interviewer, who is in a position of perceived authority, wishes to hear. In CE the yea-saying problem is to a large part avoided due to the fact that respondents are not required to answer a yes/no question but instead have to choose between two or more alternatives (Hanley *et al.* 1998a; Ready *et al.* 1996).

Another point is that the choice situations constructed in CE studies often correspond more closely to real life choices and thus perhaps are relatively familiar to the respondent. In contrast, the scenarios described in CVM studies are often unfamiliar with the risk of being downright unrealistic.

[18] This is also known as the *warm glow* effect or *moral satisfaction*.
[19] The Royal Danish Veterinary and Agricultural University

4.1.4 Methods used in this study

Due to the above-mentioned flaws of CVM and the advantages of CE, it might seem that CE would be the superior method for economic valuation. However, the choice of method is very much dependent on the specific context. If the goods being supplied and/or the change in the goods can be completely described with precision, CVM is an appropriate method. If this is not the case, CE is more appropriate.

In this study, it has been chosen to use both CVM and CE. One of the aims of the study has been to illuminate the welfare economic consequences of the decision concerning where exactly to locate the future motorway in or around the city of Silkeborg. As described in chapter 1, there are two possible layouts for the motorway[20].

Both of these locations have been subject to a thorough EIA, so detailed and precise descriptions of the layouts and their environmental consequences are possible. The two layouts have been identified from a wide range of locations through a long political and public process, so it is assumed here that one of these two *will* be realised. This pretty much meets the conditions for conducting a CVM survey, so this method was chosen for assessing the welfare economic consequences of the specific placement of the Silkeborg motorway.

As this motorway placement issue is apparent in other parts of Denmark, another aim of the study was, with benefit transfer in mind, to generate benefit estimates concerning different types of nature and the welfare economic consequences of encroaching these areas with new motorways. The nature surrounding Silkeborg is quite unique in Denmark, so the results from the CVM were not expected to be very suitable for benefit transfer, as they would probably overstate the value when transferred to more average areas in Denmark. Thus, it was decided to conduct a national CE survey concerning the welfare economic consequences of placing a stretch of motorway through a generic area of Denmark.

[20] Not building a motorway is *not* considered an option, at it is connecting two existing motorways and this political decision has already been taken. A third potential layout, the Combi layout, has been left out for reasons explained in chapter 1 and in the following chapter.

5 The survey

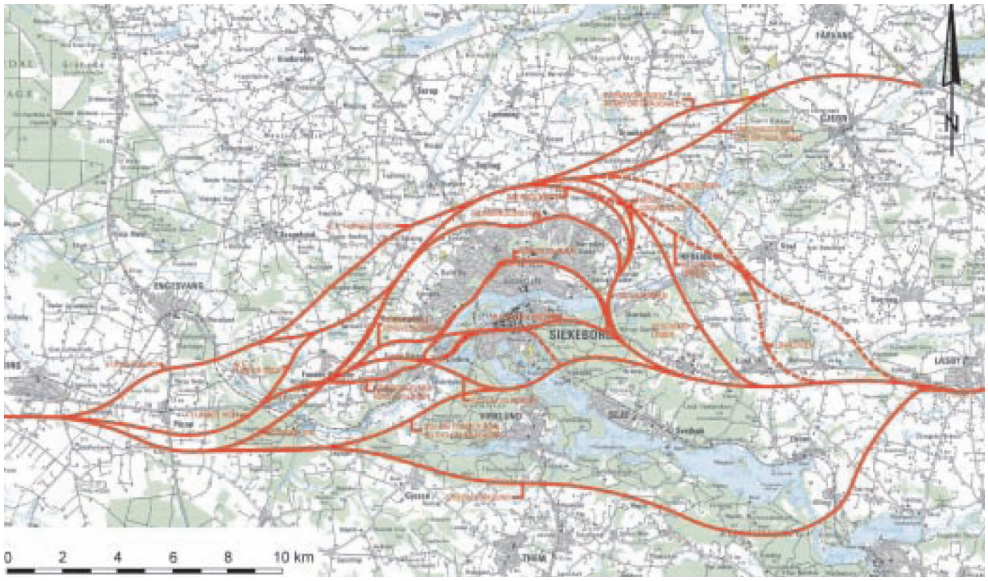
This chapter provides a detailed description of how the contingent valuation and the choice experiment were carried out.

5.1 The CVM study

The focus of the CVM study was the planned new motorway in or around the city of Silkeborg. As this is an *ex ante* analysis, i.e. the motorway has not been built yet, one might expect the main issue to be whether people in Silkeborg and the surrounding area want the motorway to be built or not. However, as far back as in 1993 the Danish Government decided that a new motorway was to be built between Aarhus in the east of Jutland and Herning in the middle of Jutland. Silkeborg lies between these two cities, so the policy relevant issue in the Silkeborg area is not whether to build the motorway or not, but where to place it.

The decision process concerning the placement of the new motorway has come a long way since 1993. As can be seen in figure 5.1, many different specific layouts for the coming motorway have been suggested.

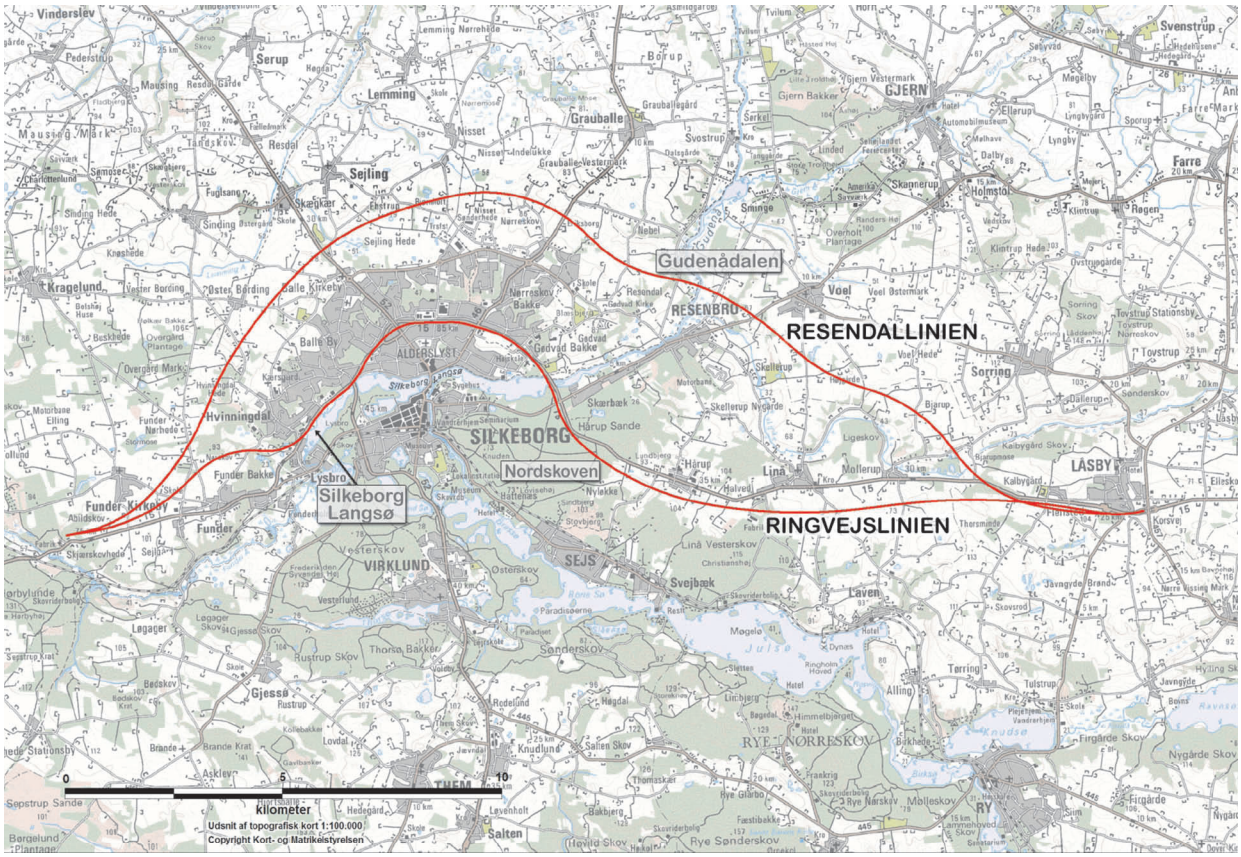
Figure 5.1 Suggested layouts for the future motorway through the Silkeborg area



Source: Vejdirektoratet (2002)

The suggested layouts have all been considered and debated, and two have been identified as the best and most practicable possibilities (Vejdirektoratet 2002). These two layouts are known respectively as the Resendal layout and the Ringvej layout.

Figure 5.2 The Resendal layout (in Danish: Resendallinien) and the Ringvej layout (in Danish: Ringvejslinien)



These two layouts are the only ones used in the CVM, as they are the only ones considered policy relevant[21]. Hence, the central question is, which of the two layouts is preferred and what is the value associated with choosing one over the other.

A detailed description of the two layouts and the areas affected is provided in Appendix 1.

[21] As mentioned, a third layout, called the Combi layout, is currently undergoing an EIA. This layout has deliberately been omitted from the current study as the EIA is not yet finished, and detailed information, as was available for the two other layouts, was not available for this third layout. This might pose a problem in the evaluation if respondents are very aware of this third layout and thus wonder why it is not mentioned. However, as will be explained later, results indicated that this was not a considerable problem, as only few respondents commented upon the lack of the Combi alternative.

In 1993, the NOAA panel issued a set of guidelines relating to the design of CVM studies (Arrow *et al.* 1993). One important recommendation was that in-person interviews should be used for collecting data. However, this approach is very costly and interviewer bias might occur. An alternative is self-administered questionnaires sent by post. This approach has been used with success in previous Danish valuation studies (Boiesen *et al.* 2005; Ladenburg & Martinsen 2004; Olsen & Lundhede 2005). Hanley *et al.* (1998a) state that well-designed postal surveys may well offer advantages over in-person interviews. Thus, in this survey it was decided to use self-administered questionnaires for data collection.

5.1.1 Questionnaire construction

As the questionnaire works as a data-generating tool for the survey analysis, the quality of the final results is, to a large part, determined by the quality of the applied questionnaire.

The questionnaire used in the CVM survey was constructed according to the guidelines of Dillman (1978), Dillman (1983), Rossi *et al.* (1983) and Schuman &Presser (1996). Among other things this implied keeping it short, precise and simple, using neutral wording in a personal and direct tone, making it appear manageable and inviting, and stressing the importance and relevance of the survey. These precautions are supposed to affect the response rate in a positive manner. Another way to improve the response rate is to offer the respondents some kind of reward for filling out the questionnaire (Dillman 1983; Jensen & Koch 1997). Thus, respondents were offered a lottery ticket with the chance to win a gift voucher.

Table 5.1 Internal structure of the questionnaire

Type of information	Topic
Introduction:	• How to fill in the questionnaire
Behavioural questions:	• Behaviour in nature, 'use' of nature • Means of transportation
Valuation questions:	• Description of the scenario • WTP question(s) • Elaborating questions on WTP answer
Attitudinal questions:	• Attitudes towards nature • Attitudes towards motorways
Personal background:	• Age, sex, income etc.
Closing questions:	• Participation In lottery • Further comments

The internal structure of the questionnaire is outlined in table 5.1. This setup is roughly in accordance with the Total Design Method (Dillman 1978). Bateman *et al.* (2002) state that this is a typical setup in economic valuation questionnaires. See Appendix 2 for a full copy of the CVM questionnaire that was employed.

5.1.1.1 Introduction

The introduction part informs respondents that the questionnaire should be filled in by the person intended, i.e. the recipient of the letter, and that questions should be answered honestly and in chronological sequence. Furthermore, respondents are assured that their answers will be treated confidentially.

5.1.1.2 Behavioural questions

The behavioural questions are intended to provide information about respondents' recreational behaviour in relation to their use of nature, and about respondents' daily means of transport. It was expected that an individual's behaviour regarding nature and transport could be determining for the individual's preferences and, hence, the stated answers to the following valuation questions. Besides, behavioural questions are relatively easy to answer. Respondents' first impression of the questions will often determine whether or not they decide to continue answering the questionnaire. So, it is important that the first questions are interesting, easy to understand and easy to answer (Dillman 1978). Another central purpose of the behavioural questions is to set up an appropriate mental frame for the following valuation questions (Mitchell & Carson 1989).

5.1.1.3 Valuation questions

The purpose of the scenario is to provide the respondent with a detailed description of the goods being valued and the hypothetical market under which they are made available to the respondent. The hypothetical market must be designed as plausible as possible, and it ought to describe the baseline level of provision, the structure under which the good is to be provided, and the method of payment (Bateman *et al.* 2002; Mitchell & Carson 1989).

Firstly, the political decision to build the motorway is presented followed by a description of the two alternative layouts focusing on their influence on and consequences for areas of nature around Silkeborg. This information is based on the EIAs that have been carried out. A map of the area and the two layouts (figure 5.2) are enclosed in the envelope with the questionnaire in order to help respondents imagine the consequences. Then, a (hypothetical) public referendum is put forward and the respondent is asked which of the two layouts he/she would vote for. This reveals which layout the respondent prefers.

Secondly, the hypothetical referendum is extended, by stating that the preferred layout is more costly than originally budgeted. It is then hypothesised, that to realise the preferred layout, the extra cost has to be financed by additional yearly income taxes. Then, a second public referendum is put forward concerning a proposal to raise income taxes to realise the preferred motorway layout. Only if the proposal is passed will the preferred layout be realised; if not, the other layout will be realised.

This second referendum leads to the actual WTP questions. However, before answering the WTP questions, the respondent is presented with *cheap talk*[22], a *budget reminder*[23], and a *substitute reminder*[24] to minimise hypothetical bias (Diamond & Hausman 1994).

For the actual WTP elicitation, it was decided to use both an ordinary Open Ended (OE) format and a slightly modified Double Bounded Dichotomous Choice (DBDC) format; the modification of the DBDC being an OE follow-up question placed right after the DC

[22] Informing the respondent that similar surveys have found that people tend to overstate their WTP is known as 'Cheap talk' (Aadland & Caplan 2004; Cummings & Taylor 1999).
[23] Reminding the respondent that he/she must consider his/her own budget constraint (Arrow *et al.* 1993).
[24] Reminding the respondent that even though some areas are affected by the motorway, there are still other areas left unaffected, is known as a substitute reminder (Arrow *et al.* 1993; Rolfe & Bennett 2001).

questions. Thus, the CVM experimental design actually consists of two splits; an OE split and a DBDC split. Apart from the WTP questions, the two versions of the questionnaire were identical. Appendix 2 supplies a copy of the OE version of the questionnaire, and Appendix 3 contains an example of the four DBDC WTP questions (Q15-18) that replace the single WTP question (Q15) from the OE version in the DBDC version.

The applied bid design in the DBDC split is presented in table 5.2. Respondents were divided into eight groups receiving different bid sets, so each respondent was only asked to consider one initial bid and one follow-up bid depending on the answer to the initial bid.

Table 5.2 Applied bid design in the DBDC split

Bid set	Initial bid (Bid 1)	Follow-up bid if 'yes' to bid 1	Follow-up bid if 'no' to bid 1
1	100	200	50
2	200	350	100
3	350	550	200
4	550	800	350
5	800	1100	550
6	1100	1500	800
7	1500	2500	1100
8	2500	5000	1500

Note: All bids are in Danish Crowns (DKK), 1 DKK ~ 0.13 EUR

The bids range from 50 DKK to 5000 DKK. The bid range was identified via focus group interviews and an OE pilot test (described below). The lowest bid was chosen so as to be almost universally acceptable whereas the highest bid was chosen so as to be rejected by almost all respondents. The distribution of the bids is skewed towards the lower end of the range based on the observed distribution in the pilot test. The bid offers are, thus, set at roughly equal log-linear intervals.

The number of bid level categories was fixed at eight groups to allow for reasonable sample sizes within each group facilitating robust within-group analysis. This approach to bid design largely follows Bateman *et al.* (1995). For further discussions on bid design see e.g. Cooper (1993), Alberini (1995), Duffield & Patterson (1991) or Boyle *et al.* (1998).

Having answered the WTP questions, respondents were then asked a series of questions elaborating on the stated WTP. These questions were designed to identify protest bidders and to reveal determining factors of the stated WTP.

5.1.1.4 Attitudinal questions

It was expected that respondents with different attitudes towards nature and motorways might answer the valuation questions differently. To be able to test this in the analysis, a series of questions concerning attitudes towards nature and motorways were included.

5.1.1.5 Personal background

Likewise, it was expected that respondents' socioeconomic and demographic characteristics to a certain extent would be predictive of respondents' preferences, so personal background questions were also included.

5.1.1.6 Closing questions

In the last part of the questionnaire respondents were offered the opportunity to take part in a lottery with a chance to win gift vouchers. However, in the introductory part respondents were promised anonymity, so to enter this lottery respondents were asked to state name and telephone number.

Finally, there is room for additional comments, so respondents have a chance to finish the questionnaire without feeling that they have more important information regarding their stated answers or the issue in general. Respondents are then urged to return the completed questionnaire in the enclosed return envelope.

5.1.2 Testing the questionnaire

As Sheatsley (1983) points out, generating a questionnaire is an iterative process which ultimately has the sole purpose of assuring the highest possible quality and applicability of the questionnaire. Thus, it is extremely important to test the questionnaire properly on intended recipients during this process prior to actual posting.

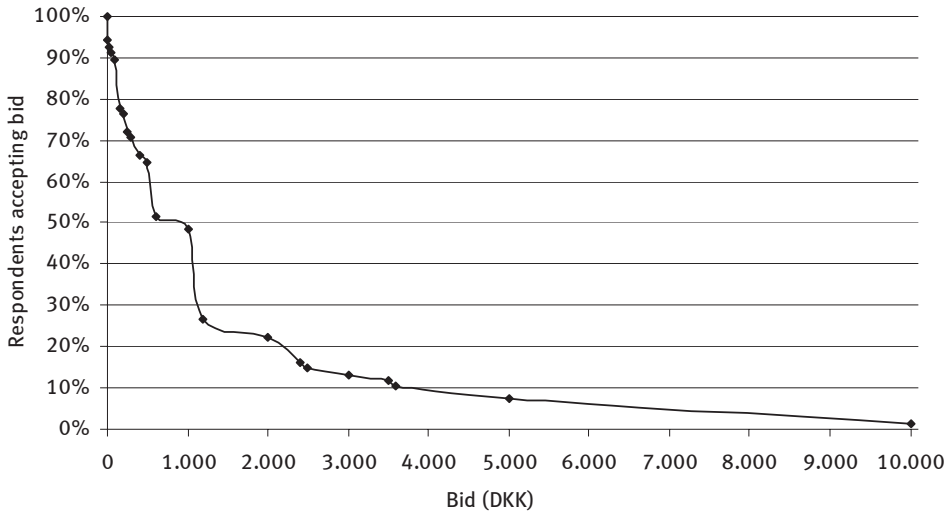
After having set up the first version of the CVM questionnaire, it was tested in two *focus group interviews*, each group consisting of ten people living in or around Copenhagen. These first focus groups produced several changes to the questionnaire in general, but the fact that these respondents were not from the Silkeborg area made their responses to, and comments on, the specific scenario of limited use.

Therefore, eleven informal, semi-structured *telephone interviews* were conducted with people living in the Silkeborg area. This yielded more useful information on the applicability of the scenario. A more structured focus group interview with 12 people was then carried out in Silkeborg. This interview created only minor changes to the questionnaire.

The telephone interviews and the last focus group interview, in particular, yielded useful information on the relevant bid range for the bid design in the DBDC split. However, the number of observations in these interviews was not sufficient to identify the entire response curve (or the probability density function).

A *pilot test* of the OE questionnaire was then posted to 200 randomly chosen people in the Silkeborg area. The purpose was to gain information on the applicability of the questionnaire in general and especially to achieve greater knowledge of the WTP response curve (with the DBDC bid design in mind). 119 respondents chose to answer, and their answers gave rise to no major changes to the questionnaire. Figure 5.3 illustrates the stated WTP bids in the pilot test. These bids provided the basis for the bid design in the DBDC described in table 5.2.

Figure 5.3 Cumulative bid function from open ended pilot test



With the pilot test resulting in no major changes, it was decided that the questionnaire was ready for its final deployment.

5.1.3 Population and sample

As the impact of the new motorway on natural areas is presumed mainly to affect locals in the Silkeborg area, it was decided that the relevant population to sample from would be citizens in the two municipalities Silkeborg and Gjern.

In the data collection period during early summer 2005, a total of 63,641citizens was registered in the two municipalities[25]. A sample of 2,000 people between the ages of 18 and 70 was randomly drawn from this population proportionate to the population in each municipality[26].

Half the sample were sent the OE questionnaire and the other half were sent the DBDC questionnaire. According to the bid design in table 5.2, the 1,000 people in the DBDC sample were divided further into eight equal-sized groups, i.e. 125 people in each group.

5.1.4 Collection procedure

The CVM questionnaires were sent to respondents on 3 June 2005. Besides the questionnaire and the map, a postage paid return envelope and an introductory letter (Appendix 4) were enclosed in the envelope. One week later, a short reminder notice was sent to those that had not yet responded (Appendix 5). After one more week, a final reminder notice (Appendix 6) was sent to non-responders, this time with the questionnaire enclosed once again. Two weeks later, at the end of June, the CVM questionnaires were finally collated.

5.2 The CE study

The aim of the CE survey was to generate benefit estimates transferable to principally any location in Denmark where placement of a new motorway is being considered. Thus, it was decided to use a generic stretch of new motorway as the basis for the scenario so as not to associate the CE study with any particular motorway planning process, e.g. the future motorway through the Silkeborg area. The generic approach ascertains a high degree of flexibility with regard to subsequent benefit transfer.

5.2.1 Questionnaire construction

[25] 55,460 citizens in Silkeborg municipality and 8,181 citizens in Gjern municipality (Danmarks Statistik 2005a)
[26] The actual sampling was performed by the Central Office of Civil Registration and the sample was drawn from the centralised civil register (CPR) where the entire population of Denmark is registered.

The general principles mentioned in section 5.1.1 regarding the construction of a questionnaire were applied in constructing the CE questionnaire as well. A version of the CE questionnaire that was employed can be found in Appendix 7. As for the internal structure of the questionnaire, this too resembles the structure used in the CVM questionnaire (see table 5.1). The main difference is found in the valuation questions, which in the CE consists of a series of choice sets for the respondent to choose from.

5.2.1.1 Defining the scenario

The scenario was defined on the basis of the past ten years of motorway building in Denmark. According to the Danish Road Directorate, 187 kilometres[27] of new motorways were built during the last 10 years (Vejdirektoratet 2005). Based on the current plans regarding future new motorways, it was loosely estimated that the next ten years will not produce as many new kilometres of motorway as the past ten.

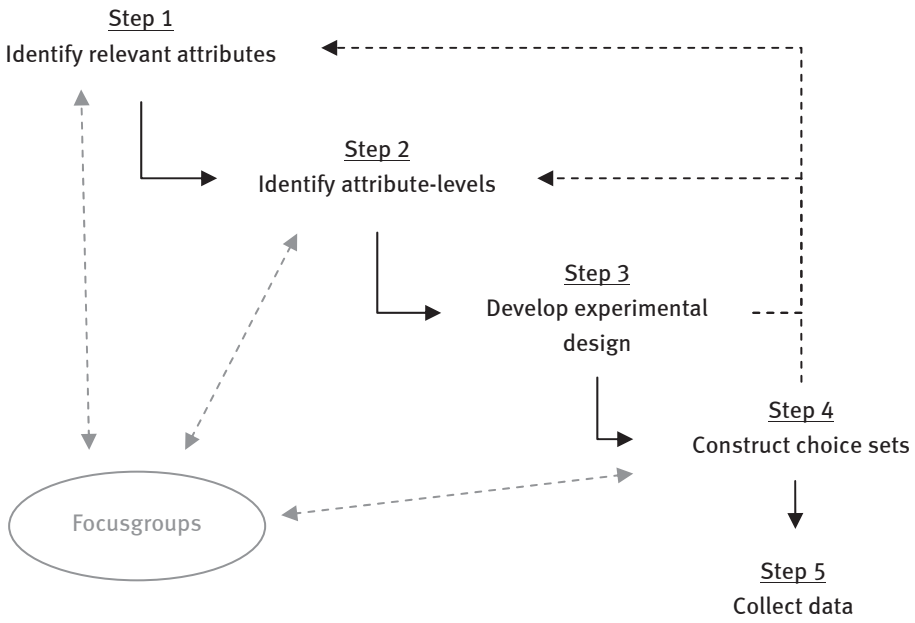
It was, therefore, decided to base the scenario on the assumption that 100 kilometres of new motorways will be built over the next ten years. The question is then, given that these new motorways are to be placed through the open landscape, how should they more specifically be placed through areas of nature (from a welfare economic point of view)? The answer to this question is determined by asking respondents to choose preferred alternatives in a series of choice sets.

5.2.1.2 Designing the choice sets

The design of the choice sets is extremely important, as this determines which and how much information can be extracted in the subsequent analysis of the answers. Following Bateman *et al.* (2002) the process of designing choice sets can be divided into a series of sequential steps as illustrated in figure 5.4.

[27] Excluding the Øresund Bridge.

Figure 5.4 The process of designing choice sets



Adapted from Olsen & Lundhede (2005)

Step 1

The first step was to identify attributes describing the good.

In this study, the good in question comprises areas of nature that are affected by new motorways. Three different types of nature that could describe natural areas were identified and chosen as attributes in the study. The three attributes were 'forest', 'wetland', and 'heath/common'. Focus groups revealed that respondents had much similar mental images of these types of nature.

From a biological point of view a more refined breakdown of types of nature would be desirable but this would necessitate many more attributes, thus adding to the cognitive burden which again is undesirable (Mazzotta & Opaluch 1995; Swait & Adamowicz 2001). Furthermore, focus groups showed that some of the more morphologically correct types of nature were lesser known to respondents, which could cause some respondents to make their own subjective assumptions concerning attributes. These assumptions will be unobservable to the analyst and the modelling of the respondent's preferences will, thus, be less precise (Bennett & Adamowicz 2001).

As described in section 5.2.1.1, the scenario defined that a total of 100 kilometres of new motorways are to be built over the next ten years, so reducing this number is not an option. This means that it was necessary to make sure that each of the alternatives in the choice sets summed to 100 kilometres. In order to do so, a fourth supplementary attribute, 'arable land', was introduced. This attribute functioned as a sort of an accumulation attribute dependent on the other attributes, the idea being that if the respondent wanted to protect the other types of nature, then a larger part of the motorway would be placed through arable land[28].

Step 2

The next step was to assign levels to the attributes. A base case scenario was used which stated that the 100 kilometres of new motorways would be located through the open landscape with no special concern for nature areas. In principle this is equal to locating the new motorways randomly across the open landscape. The base case levels of the attributes were thus assigned on the basis of the area distribution of the four nature types in Denmark in general[29] (Danmarks Statistik 2004). This yielded the base case scenario stating that 10 kilometres of new motorway would go through forest, 5 kilometres through wetlands, 5 kilometres through heath/common, and finally the remaining 80 kilometres through arable land. This composition also worked as a status quo alternative in the choice sets.

The number of levels of each attribute should generally be kept as low as possible to reduce complexity in the choice sets.

For each of the three main attributes, three levels were used. These were kept quantitative for ease of modelling and estimation (Bennett 1999; Blamey *et al.* 2001). The three levels ranged from the base case level, i.e. no protection of the affected areas, to protecting half of the affected areas, and finally to protecting the entire area. Focus groups revealed that this level range was suitable, as several respondents indicated that more levels would cause the interval between levels to become too small to be

[28] This carries an assumption that people prefer forest, wetlands and heaths/commons over cultivated field when considering 'types of nature'. This assumption was to a large degree confirmed by the stated answers to question 1 in the questionnaire. More rigorous ly this carries the assumption, that building motorways through arable land does not cause any loss of nature. This assumption is necessary in order to use the value estimates in cost-benefit analyses of motorway projects, which normally focus es on the costs and benefits of building a motorway as opposed to not building a motorway – somewhat different from the case in the present study, which focuses on the benefits of placing a motorway in different locations.

[29] Some rounding off towards category values was applied as technically precise amounts were considered likely to cause uncertainty and confusion among respondents.

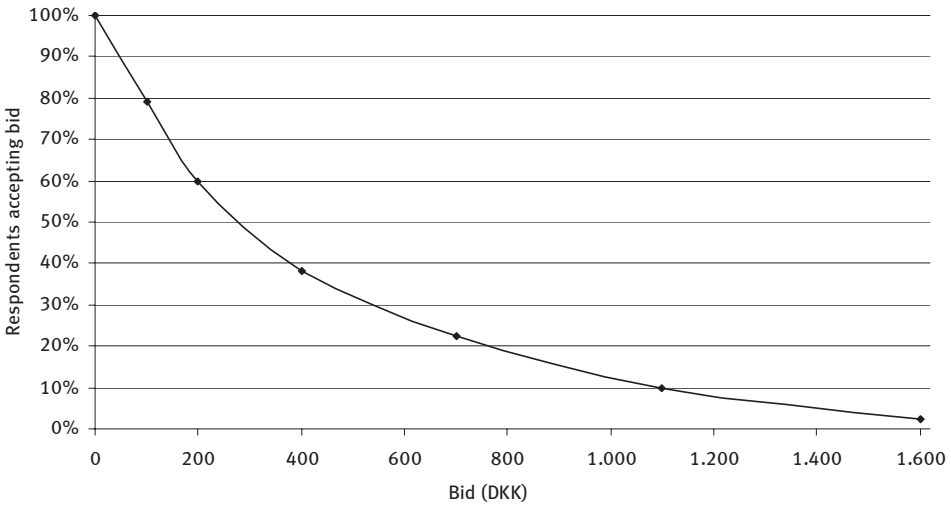
considered a real difference. This could lead to respondents not trading off between combinations of the attributes which might result in insignificant estimates.

Besides the above mentioned attributes and levels, a cost attribute was included to enable estimation of WTP. Choosing the most appropriate payment vehicle is extremely important (Bateman *et al.* 2002; Bennett 1999; Mitchell & Carson 1989).

In this study, an additional yearly income tax was used as the payment vehicle. In choosing this payment vehicle, it was initially considered that tax might be an inappropriate payment vehicle, as it is a well-known policy of the Danish government not to increase taxation. However, another possible payment vehicle, namely toll road pricing, was rejected by the focus groups. The prominent reason for this being that road pricing is not used anywhere else in Denmark, besides on the Storebælt Bridge and the Øresund Bridge. Furthermore, road pricing would only constitute an extra cost to those actually driving on the motorway. This would enable respondents with no intention of driving on the motorway to freeride in terms of gaining benefits from protecting nature without paying for it. Motorways in Denmark are in general financed by the taxpayers, so taxation was considered the most credible payment vehicle.

The cost attribute was set at six levels ranging from 100 to 1,600 DKK. The base case cost at 0 DKK could be seen as a seventh level, but this level was only used in the status quo alternative. The appropriateness of the cost range was supported by two focus group interviews and a pilot test.

Figure 5.5 Cumulative bid curve from the pilot test survey



NOTE: BASED ON THE LEVEL OF THE COST ATTRIBUTE IN THE POSITIVELY CHOSEN ALTERNATIVES

Figure 5.5 illustrates the stated bids in the pilot test. As can be seen, the highest cost at 1,600 DKK works as a choke price. The bids are distributed with a bias towards the lower end; the same arguments as in section 5.1.1.3 apply.

The attributes and their assigned levels are summed up in table 5.3.

Step 3

Having identified the attributes and attribute levels, an experimental design is required, which structures the attribute levels and the different alternatives into choice sets. The experimental design is crucially important to the subsequent analysis as the design determines the effects to be estimated from the data (Louviere *et al.* 2000). Thus, it is important to identify an efficient design for the choice sets.

Table 5.3 Attributes and levels in the CE study

Attribute	Level
Forest	10 km
	5 km
	0 km
Wetland	5 km
	2.5 km
	0 km
Heath/common	5 km
	2.5 km
	0 km
Arable land	80 km
	82.5 km
	85 km
	87.5 km
	90 km
	92.5 km
	95 km
	97.5 km
	100 km
Annual extra tax	(0 DKK)
	100 DKK
	200 DKK
	400 DKK
	700 DKK
	1100 DKK
	1600 DKK

It was decided to make use of a so-called *fractional factorial design*. This term covers the fact that the design only contains a subset of all possible alternatives. With three attributes each with three levels and one attribute with six levels[30], a total of 162 alternatives[31] were possible. With two alternatives per choice set, 81 choice sets would have to be evaluated (known as a *full factorial design*), thus requiring a very large sample (Louviere *et al.* 2000). The full factorial design has attractive statistical properties in that each level of each attribute is combined with all levels of all attributes, allowing for estimation of both main effects and interaction effects between attributes.

Depending on how the subset of alternatives is chosen from the full fractional design, using a fractional factorial design means that the possibility of estimating higher order interaction effects to some extent is lost. It is implicitly assumed in fractional factorial

[30] The cultivated field attribute only served as a pseudo-attribute to remind respondents that the total length of road was 100 km in all alternatives, which is why it was not included in the actual experimental design.
[31] From the calculation: $3^3 \times 6^1 = 162$

designs that respondents' preferences for one attribute do not depend on another attribute, i.e. no interaction effects are significant (Bennett & Adamowicz 2001; Hanley *et al.* 2001; Louviere *et al.* 2000). As Zwerina *et al.* (1996) note this might lead to biased results if omitted interaction effects in fact are significant. However, this might not be a big problem. Empirical evidence suggests that main effects typically account for 70-90% of the explained variance of choice, whereas interactions account for the remaining 10-30% with two-way interactions accounting for half of this (Louviere *et al.* 2000).

Step 4

The selection of alternatives and pairing of these into choice sets should be done systematically in order to ensure the statistical properties of the design. In this context, Huber & Zwerina (1996) have put forward four criteria for identifying efficient designs:

- **Level Balance** Each level of an attribute occurs with equal frequencies, and combinations of different levels also occur with equal frequency. This ensures equal representation of each level in the choice sets.
- **Orthogonality** Occurrence of an attribute level is independent of the levels of other attributes, thus minimising correlation between the attributes in the choice sets.
- **Minimal Overlap** Attribute levels differ within each attribute of the alternatives in a choice set. If the level of an attribute is the same in two alternatives, then the choice between these alternatives yield no information about the respondent's preferences regarding this attribute.
- **Utility Balance** The utility of each alternative in a choice set should be of similar magnitude to ensure that when choosing, respondents have to make actual trade-offs between attributes and levels.

Fulfilling these four criteria indicates that the design is efficient in that as much information as possible about respondents' preferences are exposed by their choices between alternatives in choice sets. However, the utility balance criterion is rarely met in practice as detailed *a priori* knowledge of respondents' preferences is required. Still, fulfilling the other criteria is advisable in order to obtain as efficient a design as possible.

Instead of finding an efficient design manually by time-consuming trial and error, computer software for this purpose is readily available (Kuhfeld 2004). The software is not actually based on fulfilling the four criteria, but seeks to maximise statistical efficiency, which then again results in three of the criteria being fulfilled if possible at all (Zwerina *et al.* 1996). The utility balance criterion is however not fulfilled in this way, but as described above this criterion is rarely met anyway. In this study, a series of procedures and macros in SAS was employed in order to find an efficient design.

The construction of the design used in this study was carried out in SAS using the macros '%mktruns', '%mktdes', '%choiceff' and '%mktblock'. For further explanation of these macros see Kuhfeld (2004).

Firstly, the selection of an efficient subset of alternatives from the possible 162 alternatives was made (%mktruns and %mktdes). An efficient design was found using 36 alternative compositions of the 100 km motorway. Next, the alternatives were paired, yielding 18 choice sets (%choiceff). Having each respondent choose 18 times was considered too big a cognitive burden on the respondents, so the choice sets were blocked into three blocks each consisting of six choice sets (%mktblock). As it was assumed that protecting more forest, wetland or heath/common would be associated with a higher WTP, some of the choice sets contained dominating alternatives[32].

One way to deal with this, would be to remove dominated choices. This, however, compromises the statistical efficiency of the design, so another approach was used. To minimise the number of dominated choice sets, more than 2,000 different (but all efficient) designs were run through in SAS. This way, a design was identified which only had one perfectly dominated choice set and two that were almost dominated.

[32] A dominating alternative is an alternative which in all attributes performs better than the alternative it is compared to. *Ceteris paribus,* all respondents would choose this alternative so the observed choices in this choice set would actually reveal no additional information.

These three dominated choice sets were assigned separately to the three blocks, so each respondent was only presented with one dominated choice set (out of the six). This was acceptable, as these choice sets would serve as a control of respondents actually answering rationally and not just randomly ticking off boxes.

The applicability of the design was then tested in a pilot test. The pilot test revealed that some respondents found it difficult to answer the first couple of choice sets. So, the sequence of the choice sets was adjusted in two of the blocks in order to avoid a high degree of difficulty in the first couple of choice sets.

The idea was that this would minimise a possible learning effect. This resulted in the final design of the choice sets, shown in table 5.4.

Table 5.4 The employed design

		Kilometres of motorway through type of nature				
Block	Choice set no.	Forest	Wetland	Heath/common	Arable land	Price (DKK)
1	1	0	0	5	95	200
		10	5	2.5	82.5	100
	2	0	2.5	2.5	95	1100
		5	5	0	90	200
	3	5	2.5	5	87.5	100
		0	0	2.5	97.5	400
	4	10	0	2.5	87.5	700
		0	5	5	90	1600
	5	5	5	0	90	400
		10	0	5	85	1600
	6	0	0	2.5	97.5	100
		10	2.5	0	87.5	1100
2	1	5	2.5	2.5	90	700
		10	5	0	85	100
	2	0	5	5	90	400
		10	2.5	0	87.5	200
	3	5	0	5	90	100
		0	2.5	0	97.5	1600
	4	5	0	0	95	700
		10	2.5	2.5	85	400
	5	0	5	0	95	700
		5	0	5	90	1100
	6	10	2.5	5	82.5	1600
		5	5	2.5	87.5	1100
3	1	10	0	2.5	87.5	200
		0	2.5	5	92.5	700
	2	5	0	0	95	400
		0	5	2.5	92.5	200
	3	5	2.5	5	87.5	200
		10	0	0	90	1600
	4	10	2.5	5	82.5	400
		5	5	2.5	87.5	1100
	5	0	5	0	95	1100
		10	0	5	85	700
	6	0	2.5	0	97.5	100
		5	5	2.5	87.5	1600

5.2.2 Overall experimental design of the CE study

To test for some of the known biases in CE and this way enhancing the validity of the study, an overall experimental design with seven different splits was used. The first five splits are much alike; the only difference is in the valuation part of the questionnaire. The differences are explained below.

The first split represents the main design that would have been employed if for some reason it would not have been possible to carry out the remaining splits. As such, it serves as a benchmark for the other splits. In this split respondents are explicitly asked to imagine that the new motorways will affect the areas of nature that they themselves visit most frequently. This is to ensure that the respondents' valuation of the types of nature cover both use values and non-use values.

The aim of the second split is to focus solely on non-use values. This is accomplished by asking respondents to imagine that the new motorways will *not* affect the areas of nature they visit. The levels of the price attribute are set at the levels from split number one multiplied by a factor of 0.5 (except from the choke price which is set at 1,200 DKK) to take into account the anticipated lower aggregate WTP[33]. The levels of the other attributes are the same as in split one.

Split number three is designed to enable a test of starting point bias or anchoring. Before answering the actual choice sets, respondents are presented in the scenario with an example of a choice set. The purpose of the example is to minimise a possible learning effect. But, in introducing the respondent to this example, the respondent is also presented with two levels of the price attribute which might introduce starting point bias or anchoring, as it has been recognised in dichotomous choice CVM (Herriges & Shogren 1996; Mitchell & Carson 1989).

Cognitive psychologists argue that when faced with an unfamiliar situation, as is the case in this study, people construct estimates by starting from an initial value, which may be suggested by the formulation of the problem, and then adjust that value to yield the final answer (Kahneman *et al.* 1982). In split number one the price levels used in the example were 400 DKK and 1,100 DKK. In split three a lower set of prices was used in the example, namely 100 DKK and 200 DKK. If respondents' WTP are influenced by the amounts in the example, then lower aggregate WTP would be expected in split three (Bateman *et al.* 1995).

Another built-in test in split number three concerns a possible sequencing bias relating to the ordering of the attributes. In split one the attributes are listed in the following order: forest, wetland, heath/common, arable land. In split three this order is re-

[33] Theoretically speaking, non-use value plus use value will be equal to or bigger than just the non-use value, *ceteris paribus*.

versed. If the ordering does affect peoples' preferences, a difference in attribute parameter estimates is expected.

It might be argued that changing two aspects in one split would cause problems with regards to separating the effects afterwards. It is however assessed that it indeed *will* be possible to keep the two effects separated in split 3. The first test, concerning anchoring due to the price levels in the introductory choice set example, only affects the price attribute. The second test, concerning a possible influence of the sequence of attributes, only affects the other attributes, but not the price attribute. Thus the two aspects are not entangled in each other.

The purpose of split number four is to examine whether or not an embedding effect exists. This is done by multiplying attribute levels of the four types of nature in split number one by a factor of 0.4 while leaving the levels of the price attribute unchanged.

0.4 was chosen so as to generate easily understandable category values instead of odd numbers. Consequently, the total length of the motorway in the scenario was 40 km. If an embedding effect is present, the parameter estimates in split 4 will yield different WTP per km than in split one.

Split number five is similar to split number two. The only difference is an additional, very explicit, reminder in the scenario. The reminder instructs respondents to consider carefully, that they are deciding on an annual payment and not just a one-off payment. Theoretically, this should not change estimates. However, if parameter estimates actually turn out to be different from split two, it would indicate, that respondents tend to forget the fact that they are deciding upon annual payments.

Splits number six and seven are identical to the first two splits. The difference is in the sampling procedure. As for the first five splits, a nationwide sample representing the entire population is used, whereas for splits six and seven a sample representing people in the Silkeborg area is used.

This enables a test of the hypothesis that people affected by an ongoing motorway planning process (people in the Silkeborg area) have different preferences than people in general (the general population in Denmark). Furthermore, split seven serves as an experiment as to whether or not it is possible to make people, who are affected di-

rectly by an ongoing motorway planning process, imagine a situation in which they are not affected directly.

With seven splits each consisting of three blocks, a total of 21 different versions of the questionnaire make up the final design setup. The split setup is summarised in table 5.5.

Table 5.5 Overall design of the CE study

Split	Purpose	Sample
1	Expose use and non-use values	National
2	Expose non-use values	National
3	Test for starting point bias and sequencing	National
4	Test for embedding	National
5	Test for awareness of annual payment	National
6	Test for preference differences in affected areas	Silkeborg
7	Test for preference differences in affected areas	Silkeborg

5.2.3 Population and sample

The aim of the CE study was to obtain WTP estimates principally transferable to any location in Denmark and the relevant target population was considered to be the entire Danish population. A sample totalling 5,354 people[34] was used to represent the population in the survey.

As mentioned above, a sample of people from the Silkeborg area[35] was used as well. This sample consisted of 405 people. To test for possible effects of the employed mode of data collection (Internet versus ordinary post, see below) an additional sample in the Silkeborg area was used, consisting of 589 respondents. This sample was constructed in a way that ensured that the distribution of people in this additional sample with regard to postal codes was similar to the first sample.

5.2.4 Data collection

The collection of data based on the CE questionnaire was carried out as an online Internet survey by ACNielsen AIM A/S (ACNielsen). The collection of data took place from 3-20 June. The procedure was the following: 5,759 people (between 18 and 70

[34] Between 18 and 70 years of age.

[35] Due to technical sampling restrictions this is defined as the area covering postal codes 8600 to 8699.

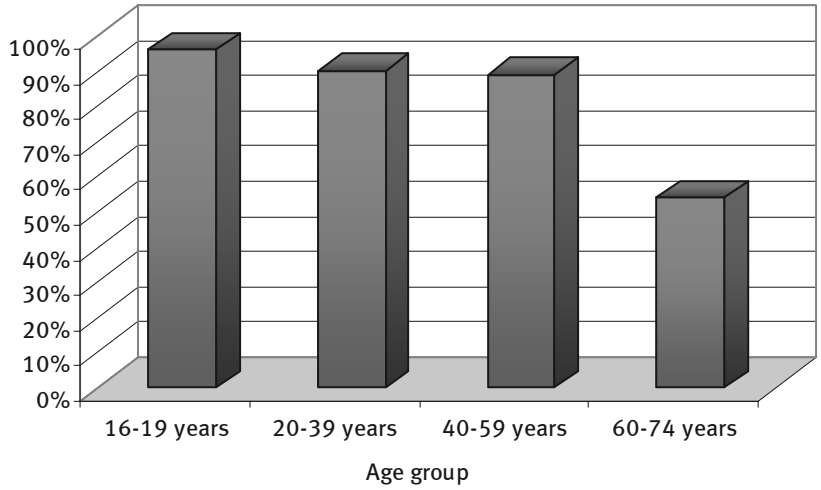
years of age) in ACNielsen's online panel, called Panel.online[36], were sent an e-mail containing both information about the survey and a personalised link to the website where the questionnaire was located. Respondents not answering within a week were sent an e-mail reminder with the link to the website. The 5,759 participants were picked from the entire panel of approximately 17,000 people on the basis of quotas regarding gender and age, based on the amount of people with Internet access in the given target group. This is to adjust for a large overrepresentation of younger people in the distribution of people with Internet access.

Experience with Internet panels for this kind of survey in Denmark is minimal. This meant several questions regarding the applicability of Internet panels could not be answered beforehand. The advantages of the Internet panel as compared to ordinary post were known; a larger degree of cost-effectiveness, less time-consuming, lower risk of errors owing to the computerised input of answers. Another advantage would be knowledge of the personal background of both respondents and non-respondents, as participants on the Internet panel are required to state this information upon recruitment.

The major concern was the extent to which the sample from the Internet panel would be representative of the Danish population. ACNielsen could only guarantee that the sample would be representative of 'Web-Denmark' which is not a representative part of the entire Danish population. Three-quarters of Danish households have Internet access, but the distribution is far from representative. For instance, as illustrated in figure 5.6, the proportion of people between the ages of 60 to 74 with Internet access is far below the proportion in younger age groups. As mentioned previously, some of this imbalance is rectified by stratified sampling during recruitment to the Internet panel.

[36] Panel.online has approximately 17,000 participants who were all recruited by telephone or personal interview. Thus, participants joined the panel voluntarily. Self-selection bias is minimised as it is not possible to join the panel without having been contacted by ACNielsen first. Panel.onlines 'universe' comprises people of age 15 years and older, living in households with computer and Internet access. More than 74 percent of the 2.4 million Danish households have Internet access (Danmarks Statistik 2005c).

Figure 5.6 Percentage of the population with Internet access



Source: Danmarks Statistik (2005b)

Another central concern was the potential risk of a selection bias relating to the fact that participants on the Internet panel all agreed to participate. People who said no to joining the Internet panel are not represented. However, it could be argued that people declining to participate on the Internet panel would also decline to fill in a postal questionnaire, so this difference might not be considerable.

In anticipation of potential problems with the samples' ability to represent the general population it was decided to carry out an additional experiment. A printed version of splits number six and seven was prepared and posted to a randomly selected sample of people in the Silkeborg area. This would enable a comparison to be made of the two modes of questionnaire employed, Internet and postal, and hopefully answer some of the unanswered questions regarding the applicability of Internet panels for this type of survey.

6 Results of the Contingent Valuation Method study

This chapter looks at the analysis and results of the CVM study, where respondents have been asked to state their WTP to avoid the motorway being realised in their least preferred layout and instead moved to the most preferred layout. Hence, it is *not* the question of building a motorway or not, but *where* exactly to locate it.

In the following, response rates are presented and the ability of the respondent sample to represent the target population is examined. A model of the preferences is then constructed and estimations of WTP are made.

6.1 Response rates

Of the 1,000 questionnaires sent out in each of the two CVM formats, 740 were returned in the Open Ended sample and 748 were returned in the Double Bounded Dichotomous Choice sample, see table 6.1. Adjusting for undelivered post and a few questionnaires returned with central questions left unanswered, effective samples of 711 and 716 respondents respectively were observed. This corresponds to an effective rate of response of 71.1% in the OE sample and 71.6% in the DBDC sample. These response rates are quite acceptable compared to previous Danish CVM studies (Bjørner *et al.* 2000; Boiesen *et al.* 2005; Hasler *et al.* 2005).

Table 6.1 Response rates and effective samples

	OE		DBDC	
	No.	%	No.	%
Questionnaires sent out	1000	100	1000	100
Returned	740	74.0	748	74.8
- Undelivered, returned to sender	6	0.6	7	0.7
Initial sample	734	73.4	741	74.1
- Layout question not answered	9	(1.2)	16	(2.2)
- WTP questions not answered	14	(1.9)	9	(1.2)
Effective sample	**711**	**71.1**	**716**	**71.6**
- Identified protest bidders	227	(31.9)	126	(17.6)
Trimmed sample, used for analyses	484	48.4	590	59.0

Note: Parentheses indicate percentage values related to the above subtotal.

6.1.1 Identification of protesters

Of the respondents expressing a zero bid in the WTP questions, a large group were identified as protest bidders. These bidders were identified based on their answers given to the follow-up questions concerning the respondent's reason for a zero bid[37]. Statements such as "I'm not willing to pay more taxes" or "I'm against the new motorway" are classified as protest answers, as these statements reveal that the respondent has not really made the required trade-offs. This means that the expressed zero bid does not genuinely reflect the respondent's true preferences and values. Statements such as "I don't care about the motorway layout" or "I can't afford to pay any more taxes" indicate a genuine zero bid.

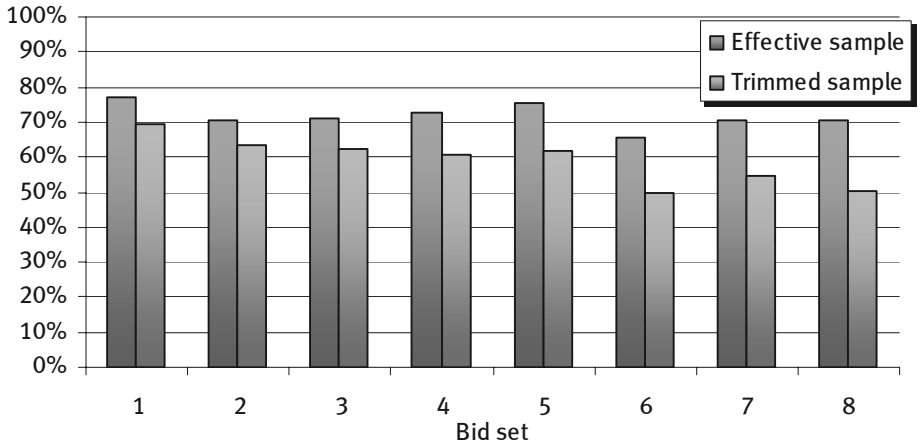
Besides this positive identification, respondents expressing a zero bid, but not stating a reason for doing so, where defined as protesters. It could be argued that some of these might be genuine zero bids and removal would lead to an overestimation of the WTP. However, this cannot be known for certain, so a cautious approach should be taken when excluding these respondents from further analyses.

As can be seen in table 6.1, almost a third of the effective OE sample were identified as protesters whereas less than one in five respondents in the effective DBDC sample were identified as protesters. It is generally recognised that open ended questions are more difficult to answer than referendum format questions (Arrow *et al.* 1993). The difference in the number of protesters in the two versions probably reflects this, as expressing a zero protest is an easy way out of a difficult open ended question.

A closer look at the distribution of respondents in the DBDC sample with regard to the internal bid design reveals that the number of protesters is dependent on the bid set presented. As explained in table 5.2, bid set 1 contained the lowest bids and bid set 8 the highest bids in the bid design. According to figure 6.1, it appears that there is a tendency towards lower response rates in the higher bid sets in both the effective and trimmed samples. However, the tendency is more evident in the trimmed sample. Since the only difference between the two samples is the removal of protesters, this indicates a higher number of protesters in the higher bid sets. By testing the difference between the two samples against its own mean value, it can be confirmed with statistical significance[38] that higher prices in the bid set result in more protesters.

[37] Question 17 in the OE version and question 20 in the DBDC version.
[38] Using a χ^2-test: P=0.034*

Figure 6.1 Response rates in the eight different bid sets comprising the DBDC bid design



The initial analysis examines the extent to which the samples are representative of the population in the Silkeborg area.

6.2 Representativeness of the samples

The ability of the CVM samples to represent the population in the area of Silkeborg is presented in table 6.2. This analysis is based on four key sociodemographic variables; gender, age, household income and education. These variables were chosen, since previous valuation studies in Denmark have shown that representativeness can be a problem when considering these variables (Boiesen *et al.* 2005; Ladenburg & Martinsen 2004; Olsen & Lundhede 2005).

Furthermore, these variables often turn out to be significantly important when determining preferences and estimating WTP. In this case, analysing representativeness is essential for determining the appropriateness of extending conclusions from the samples to the target population. In addition, the geographical location of respondents in terms of municipality and number of cars per household is also analysed. It was expected *a priori* that people living in Gjern municipality[39] might exhibit stronger preferences for the Ringvej layout, as they would probably be less affected by this layout

[39] Gjern municipality is located northeast of Silkeborg municipality, and as such it is only encroached by the Resendal layout.

than people living in Silkeborg. Likewise, it was expected that car owners may have different preferences from people without a car.

Of most interest in table 6.2 are the analyses of the trimmed samples, as they form the basis for the actual estimation of WTP. The analysis of the postal format and effective samples serve more as explanatory elements, highlighting some of the differences between the expected and the actual distribution in the trimmed sample.

Differences between the distributions in the postal sample and the effective sample can reveal certain subgroups of people who tend to be less inclined to participate in the survey, i.e. a possible *non-response bias* affecting representativeness.

Similarly, differences between the effective sample and the trimmed sample can expose subgroups with a stronger tendency to express a protest bid.

6.2.1 Gender

The OE trimmed sample is not significantly different from the expected gender distribution. However, it seems that there is a tendency for women to be less likely to respond to the questionnaire, and if they do respond, they are more likely to express a protest bid than men. This tendency is confirmed in the DBDC sample which, furthermore, has a significant overrepresentation of men in the trimmed sample.

6.2.2 Age

Both the OE and the DBDC trimmed samples show significantly different age distributions compared to the population. This is partly explained by the fact that distributions in both of the initial postal samples were slightly distorted. This results in a slight overrepresentation of respondents aged 45 and over and an underrepresentation of age groups 18 – 34.

Table 6.2 The distribution of respondents in the OE and DBDC samples across key sociodemographic variables compared to the actual distribution of the population in the municipalities of Silkeborg and Gjern

	Silkeborg & Gjern[40]	OE samples %			DBDC samples %		
		Postal	Effective	Trimmed	Postal	Effective	Trimmed
Gender		ns	ns	ns	Ns	***	***
Male	49.4	49.2	51.1	52.2	51.4	55.8	56.6
Female	50.6	50.8	48.9	47.8	48.6	44.2	43.4
Age		*	***	**	**	**	*
18 - 24	10.8	10.0	7.1	8.2	8.7	6.6	7.2
25 - 34	19.7	16.9	15.4	16.0	17.7	18.5	18.9
35 - 44	22.5	21.8	22.0	19.8	23.7	22.9	22.8
45 - 54	20.5	20.7	24.1	24.8	20.8	22.1	22.2
55 - 64	19.2	22.2	23.3	24.0	19.3	20.6	19.4
65 - 70	7.2	8.4	8.0	7.4	9.8	9.2	9.5
Household income (DKK)[41]			***	***		***	***
‹ 150,000	14.6		5.8	5.9		7.5	7.3
150,000 – 299,999	28.1		20.1	20.0		19.3	18.7
300,000 – 499,999	22.1		27.6	29.1		25.3	24.1
500,000 – 799,999	23.1		37.4	35.9		37.6	39.0
› 800,000	12.1		9.1	9.1		10.3	10.9
Education			***	***		***	***
Primary school	32.1		16.1	16.8		17.6	16.8
Vocational	37.1		24.6	24.7		22.8	23.3
High school	7.4		9.0	8.2		10.5	11.0
Short academic (‹3 years)	4.8		13.6	13.4		11.0	11.4
Middle academic (3-4 years)	14.6		27.3	28.1		26.8	26.9
Long academic (›4 years)	4.0		9.4	8.8		11.3	10.7
Municipality		ns	ns	ns	Ns	ns	ns
Silkeborg	87.1	87.5	88.6	87.6	86.2	86.2	86.3
Gjern	12.9	12.5	11.4	12.4	13.8	13.8	13.7
Cars per household			***	***		***	***
0 car	31.9		8.7	8.4		8.5	9.0
1 car	53.4		60.9	61.3		58.2	56.7
›1 car	14.7		30.4	30.3		33.3	34.3

Note: All values are percentage values of the total sample/population excluding respondents who failed to answer the given questions. Above each distribution of each sample it is indicated whether or not the distribution in the sample is significantly different from that of the target population. A χ^2-test was conducted on the basis of the actual numbers behind the percentages. (ns) indicates no significant difference, (*) indicates significant difference on a 95% level, (**) indicates significant difference on a 99% level, (***) indicates significant difference on a 99.9% level.

[40] The Silkeborg and Gjern distributions are based on the following statistics from Statistics Denmark: FU2, HFU2, BIL3, and BEF1A – all available from www.statistikbanken.dk.

[41] The representative distribution of household income and education is based on the *national* distribution as it was not possible to obtain a local distribution. Household gross income is used.

6.2.3 Household gross income

The household income in the effective and the trimmed samples is analysed simply because this information was not available for the postal sample[42]. The expected distribution of household income is based on the national distribution, as it was not possible to obtain a local distribution. However, the average *family* income in Silkeborg and Gjern is slightly higher than the national average, indicating that the household income distribution in Silkeborg and Gjern is likely to be somewhat displaced towards the higher income bracket when compared to the national distribution (Danmarks Statistik 2004).

Nevertheless, it is evident that the distribution in the trimmed samples is far from the actual household income distribution. People with relatively high household income are strongly overrepresented. This may be important when extending conclusions, especially WTP estimates, from the sample to the target population. Economic theory predicts that an individual with high income will have a higher WTP for a good than an individual with low income, *ceteris paribus*. In effect, this means that WTP estimates based on the samples used will probably be overestimates of the true WTP of the population in the Silkeborg area. Whether this is so, is examined in the parametric analyses of the stated WTP bids in sections 6.3.2 and 6.4.3.

The overrepresentation of the higher income levels is however, partly, due to the fact that the expected distribution is slightly outdated, since it is based on the average income of households from 2001 to 2003. A more up-to-date distribution would supposedly move towards somewhat higher income levels, thus reducing the difference between the samples and the actual distribution in the population.

Another difference is that the samples are only based on people in the 18 to 70 age bracket. People outside this bracket are typically found in lower income groups, e.g. pensioners. Such groups are incorporated in the basis forming the expected distribution but they have not been sampled, which undoubtedly contributes to the large difference.

[42] The sample from the Central Office of Civil Registration only provided information of each individual's name, address and date of birth.

6.2.4 Education

Table 6.2 reveals a significant overrepresentation of people with relatively high levels of education. It can be assumed that this is a reason behind the observed overrepresentation of high income households as highly educated people are generally well paid.

A possible explanation of this tendency could be that academically trained people are more likely to, or feel more obliged to, answer a questionnaire which is intended for academic research. This argument would also explain some of the overrepresentation of higher income households.

6.2.5 Municipality

As can be seen from table 6.2, none of the samples have distributions significantly different from the expected distribution with regard to geographical location.

6.2.6 Cars per household

In terms of cars per household in the samples, there is a clear and significant overrepresentation of people living in households with one car or more. Again, this probably reflects the overrepresentation of higher income households. This can lead to an underestimation of the true WTP in the population if respondents with no car have stronger preferences, i.e. a higher WTP for the protection of nature. Another argument leading to the same expectation could be that it is easier for carowners to visit other areas, i.e. it is easier for them to find substitutes.

6.2.7 Summing up on analysis of representativeness

In summing up the samples' ability to represent people living in the municipalities of Silkeborg and Gjern, a number of problems has emerged regarding certain sociodemographic variables. Age distributions are generally skewed towards the 'older' end of the scale, while income distributions are skewed towards the 'richer' end of the scale and the education distribution is skewed towards the 'academic' end of the scale. Furthermore, the proportion of men is a bit too high in the DBDC sample, but not in the OE sample. The proportion of households in the samples without a car is lower than expected, whereas no problems are apparent with the geographical location of respondents.

The importance of the skews identified in the samples with regard to estimating WTP depends on whether or not the specific sociodemographic variables turn out to have

significant influence on expressed WTP. Thus, it is necessary to include these variables in the following analyses in order to determine their significance with respect to the respondents' preferences.

6.3 Open ended

Of the 484 respondents in the trimmed OE sample, 79.6% stated that they would vote for the Resendal layout if the matter were to be decided by a vote. The remaining 20.5% would vote for the Ringvej layout. The two layouts are illustrated in figure 5.2.

Even though the questionnaire focuses on how the two layouts affect nature, and seeks to identify respondents' preferences regarding this matter, it seems logical that other factors may determine respondents' choice of layout in question 14 (see Appendix 2). One important factor expected was whether or not the layouts were in close vicinity of the respondents' home. A probit analysis was undertaken to identify significant determinants of choice. The probit regressions are based on each respondent's choice of layout and the distance from dwelling to each layout stated in question 20. The results are given in table 6.3.

Table 6.3 Parameter estimates from the probit model on choice of layout

Parameter	Coefficient	Std. error	P value
Distance to Resendal layout (Q20_1)	-0.2244*	0.0996	0.024
Distance to Ringvej layout (Q20_2)	0.3607***	0.0756	‹0.001
Constant	-1.2214**	0.4358	0.005
N	437		
Log likelihood	-211.82		
Pseudo R^2	0.058		

Note: The dependent variable, question 14 regarding layout choice, is coded as Resendal=0 and Ringvej=1. Explanatory variables are coded according to the sequence of answer categories in the questionnaire. Respondents who responded "Don't know" to question 20 are excluded. (*) indicates significant difference on a 95% level, (**) indicates significant difference on a 99% level, (***) indicates significant difference on a 99.9% level.

The distance between the household and motorway layout is, as expected, a significant determinant in the choice of layout. Both factors in question 20 are significant and the positive and negative signs in the coefficient estimates are as expected; e.g. the further the respondent lives from the Resendal layout, the greater the chance of the respondent choosing the Resendal layout (indicated by the negative sign of the first coefficient), and vice versa.

The model in table 6.3 is very simple and, as the relatively low pseudo R^2 indicates, the model is not a very good fit[43]. This is probably due to the fact that question 20 is quite vague, in that it does not explain *why* distance matters. Question 21 poses a series of more detailed questions concerning different effects of which several are correlated with the distance between layout and household. Inclusion of this information offers a more detailed analysis of the determinants of respondents' choices with respect to layout. The results are presented in table 6.4.

The more detailed model exhibits a much better fit with a pseudo R^2 of 0.359. Significant parameters affecting choice of layout are the perceived influence of each layout on the respondent's opportunities for recreational and nature experiences, the noise level at the place of residence, and the impact on the appearance of the landscape and the specific, affected areas of nature. Again, signs are as expected. A positive sign indicates a propensity towards choosing the Ringvej layout. For instance, the more the Resendal layout is perceived by a respondent to affect his opportunities to experience nature (Q21a_1), the higher the propensity for that respondent to choose the Ringvej layout in question 14 (coding key: Resendal=0 and Ringvej=1).

Table 6.4 Probit model on choice of layout based on respondents' expectations of each layout's effect on various factors

Parameter	Coefficient	Std. error	P value
Resendal layout - perceived influence on:			
- nature experiences (Q21a_1)	0.6610***	0.1401	‹0.001
- noise level at residence (Q21a_3)	0.3698**	0.1421	0.009
- landscape appearance (Q21a_4)	0.3624*	0.1503	0.016
- specific areas of nature(Q21a_6)	0.6180**	0.1890	0.001
Ringvej layout - perceived influence on:			
- recreational opportunities (Q21b_2)	-0.4337**	0.1477	0.003
- noise level at residence (Q21b_3)	-0.3839**	0.1277	0.003
- landscape appearance (Q21b_4)	-0.3823**	0.1468	0.009
- specific areas of nature (Q21b_6)	-0.3895*	0.1798	0.030
Constant	-1.6049***	0.4066	‹0.001
N	441		
Log likelihood	-144.78		
Pseudo R^2	0.359		

Note: The dependent variable, question 14 regarding layout choice, is coded as Resendal=0 and Ringvej=1. Explanatory variables are coded according to the sequence of answer categories in the questionnaire. (*) indicates significant difference on a 95% level, (**) indicates significant difference on a 99% level, (***) indicates significant difference on a 99.9% level.

[43] A pseudo R^2 of 0.10 to 0.20 is considered a good fit; above 0.20 is considered an extremely good fit (Louviere *et al.* 2000).

From this analysis, it can be concluded that the preferences stated in the answers to the OE questionnaire cover more than just preferences concerning impacts on nature and recreational opportunities. Thus, when estimating WTP and drawing general conclusions, it is deemed very important to remember that WTP will express not only values regarding nature and recreation, as was the intention of the survey, but also values concerning other factors such as noise level at the place of residence.

In addition to this, several respondents mentioned (in the additional comments field) that the Ringvej layout was deemed unacceptable as it would separate the city into two physically divided parts. When question 18 item 6, concerning the influence of the motorway on Silkeborg city, shown in the model in table 6.4, is included, it reveals that this is in fact a strongly significant determinant of layout choice (coefficient estimate = -0.5006***, pseudo R^2 = 0.403). The more a respondent considers the effect on the city when choosing layout, the greater the chance of the Resendal layout being chosen.

In relation to the identified problems concerning the representativeness of the sample identified in table 6.2, it is interesting to determine whether or not respondents' choice of layout is dependent on their socio-demographic background. In table 6.5 a probit model based on socio-demographic variables is presented.

Table 6.5 Probit model on choice of layout based on the socio-demographic characteristics of the respondents

Parameter	Coefficient	Std. error	P value
Gender (Q27)	-0.1357	0.1442	0.347
Age (Q26)	0.0096	0.0053	0.071
Household income (Q34)	-0.0594	0.0327	0.070
Education (Q31)	0.0630	0.0454	0.165
Municipality	0.7923***	0.1908	‹0.001
Car ownership (Q8a)	0.1034	0.2723	0.704
Constant	-1.2220*	0.5619	0.030
N	426		
Log likelihood	-208.39		
Pseudo R^2	0.057		

NOTE: THE DEPENDENT VARIABLE, QUESTION 14 REGARDING LAYOUT CHOICE, IS CODED AS RESENDAL=0 AND RINGVEJ=1. EXPLANATORY VARIABLES ARE CODED ACCORDING TO THE SEQUENCE OF CATEGORIES IN TABLE 6.2. (*) INDICATES SIGNIFICANT DIFFERENCE ON A 95% LEVEL, (**) INDICATES SIGNIFICANT DIFFERENCE ON A 99% LEVEL, (***) INDICATES SIGNIFICANT DIFFERENCE ON A 99.9% LEVEL.

As the table shows, the only significant determinant of choice is the municipality of the respondent. In effect this means that respondents living in Gjern municipality have a

larger propensity of choosing the Ringvej layout, which is not surprising as the Ringvej layout does not pass through this municipality, whereas the Resendal layout does. A closer look reveals that 40% of the respondents from Gjern municipality prefer the Ringvej layout, whereas only 18% of the respondents from Silkeborg municipality preferred this layout.

There are some indications that increasing age leads to increased propensity of choosing the Ringvej layout, whereas increasing household income leads to a larger propensity to choose the Resendal layout. This is however not significant.

Overall, table 6.5 suggests that the results concerning choice of layout in the sample in general can be directly extended to the population in Gjern and Silkeborg municipalities, as the skewness of the sample does not affect choice of layout.

6.3.1 Non-parametric analysis

A simple, non-parametric analysis of the responses to the open ended WTP question (question 15) is presented in table 6.6.

Table 6.6 Non-parametric analysis of OE CVM

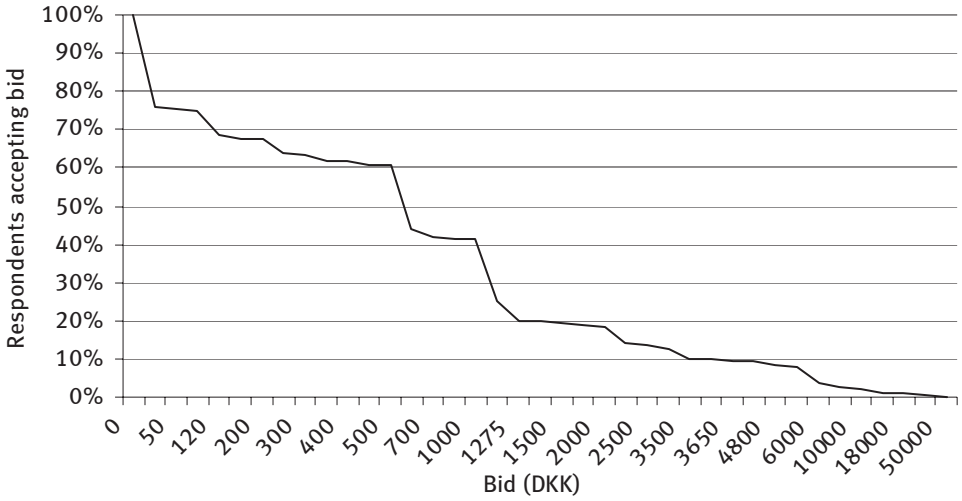
Layout	Respondents choosing layout	Mean WTP (DKK)	Median WTP (DKK)	95% CL for mean (DKK)
Resendal	385	1318	500	987 – 1648
Ringvej	99	1428	500	851 – 2004

Note: The WTP figures are per household per year.

Respondents preferring the Resendal layout stated that they were willing to pay a mean value of 1,318 DKK per year in extra taxes to ensure the realisation of this layout instead of the Ringvej layout. The mean WTP of respondents preferring the Ringvej layout is 110 DKK higher, at 1,428 DKK. However, the 95% confidence limits reveal that the mean WTP of the two groups are not significantly different from each other.

The median WTP of 500 DKK is identical for the two groups. The fact that the median WTP is less than half of the mean WTP, and that it is not even within the range of the 95% confidence limits, indicates that the distribution of bids is far from normally distributed. Upon closer inspection, it is apparent that the bids exhibit a lognormal distribution, thus the mean WTP is strongly influenced by a few very large bids. Figure 6.2 shows that the highest bid is 50,000 DKK.

Figure 6.2 Cumulative bid curve from the open ended CVM



Note: The intervals between the ranges on the x-axis are not equal. Dividing the bid curve into respondents choosing the Resendal layout and those choosing the Ringvej layout does not change the picture notably.

It could be argued that some of the very large bids might represent a strategic answer. Setting a top-end spike[44] at 5,000 DKK, which is the 95 percentile of the bids offered, i.e. only 5% of the bids are over 5,000 DKK, results in a lower mean WTP estimates as illustrated in table 6.7.

Table 6.7 WTP spiked at 5,000 DKK at the top end

Layout	Respondents choosing layout	Mean WTP (DKK)	Median WTP (DKK)	95% CL for mean (DKK)
Resendal	385	1040	500	898 – 1181
Ringvej	99	1104	500	808 – 1401

Note: The WTP figures are per household per year.

However, a closer look at each of the respondents offering bids over 5,000 DKK reveals that their bids cannot be ruled out as entirely strategic. In general, most of these respondents live very close (less than 500 metres) to one of the motorway layouts, and most of them have a relatively high household income. So, the bids made by these respondents are actually both possible and credible.

[44] Bids over 5,000 DKK are adjusted to 5,000 DKK exactly.

The primary focus of this report is investigation of values associated with nature. Another approach to estimating the respondents' preferences for the two layouts, is to adjust the stated WTP bids in accordance with question 19, in which the respondent is asked to state the share of their WTP assigned to protectionof nature and recreational opportunities. Table 6.8 shows the adjusted mean WTP values.

Table 6.8 Share of WTP related exclusively to protection nature and recreational opportunities

Layout	Respondents choosing layout	Mean WTP (DKK)	Median WTP (DKK)	95% CL for mean (DKK)
Resendal	293	660	250	491 – 830
Ringvej	84	1023	425	590 – 1455

Note: Respondents not answering question 19 or answering "Don't know" are excluded. The WTP figures are per household per year.

The results of the WTP breakdown are interesting in that they introduce a larger difference between WTP values for the two layouts. The WTP attributed to nature and recreation protection by respondents choosing the Ringvej layout is significantly larger than for those choosing the Resendal layout (using a simple t-test on the differences in the means at a 5% level). This indicates that the WTP expressed by respondents choosing the Resendal layout is motivated to a greater extent by other considerations than simply protection of nature and recreational opportunities, than is the case for respondents choosing the Ringvej layout.

These findings concur with the results in table 6.4 concerning the determinants of layout choice. Furthermore, it seems logical that respondents living in Silkeborg city perceive the Ringvej layout to affect them more directly in terms of noise, pollution and barrier effects. Thus, they base their WTP for the Resendal layout mainly on these reasons and less so on the more indirect effects such as the consequences for nature and recreation. People choosing the Ringvej layout are probably less directly affected by the layout and, thus, they therefore put more weight on the consequences for nature and recreational possibilities when stating their WTP. This conclusion is in accordance with comments from several respondents; comments such as:

> *"I would like to show more consideration for the Gudenå valley, but the negative consequences of the Ringvej layout are just too high. The city will be divided in two! And what about the noise? I live only 300 metres from the Ringvej layout! We*

can't have that much noise and pollution in the city. So, I'm compelled to choose the Resendal layout".

This represents a classic example of the *Not-In-My-BackYard (NIMBY) phenomenon*. People do want the motorway[45], but they don't want the associated negative effects to affect themselves.

6.3.2 Parametric analysis

In this section. a parametric analysis of the open ended bids is undertaken. A maximum likelihood Tobit model[46] approach is employed to address the fact that ordinary OLS regression is not able to censor lowest estimated bids at zero. In other words, an OLS regression model would permit the estimated WTP to become negative, and this is not considered viable in the scenario put forward.

The estimated Tobit models for the Resendal and Ringvej layouts are presented in table 6.9. The explanatory parameters included in the models were identified by testing a series of potentially significant parameters. For reasons of comparison between the two layouts, each of the models contains a few non-significant parameters which are significant only in the other model. As explained in section 6.3.1, the stated WTP bids exhibit a lognormal distribution. Thus a lognormal distribution is utilised in the Tobit models in table 6.9.

A number of parameters turn out to be significant determinants of WTP. Some of these will be commented upon in the following.

6.3.2.1 The Ringvej layout

It is apparent that bids expressed by respondents choosing the Ringvej layout are determined by several socioeconomic parameters. As economic theory would suggest,

[45] Respondents are not directly asked whether or not they actually want the new stretch of motorway. However, almost 8% have commented in the additional comments field on the last page of the questionnaire that they really want the motorway to be realised soon, because they have been waiting for it for more than 12 years. It was also the impression from focus group interviews that people in Silkeborg are generally so tired of the long and tedious governmental process regarding the location of the motorway that they would like to have the motorway realised as soon as possible. Another explanation of this is what several respondents called the growing traffic chaos on the ring road in Silkeborg caused by the completed stretches of motorway on both sides of Silkeborg.

[46] A Tobit model is an econometric model in which the dependent variable is censored; in the original model of Tobin (1958), for example, the dependent variable was expenditures on durables, and the censoring occurs because values below zero are not observed.

WTP increases with increasing household income (Q34). Further WTP increases with age and educational level (Q31).

Table 6.9 Specification of Tobit models describing WTP in the OE sample

	Parameter estimates	
Parameter	Resendal	Ringvej
Socioeconomic characteristics		
- Household income (Q34)	0.175***	0.116**
- Age (Q26)	0.005	0.026***
- Gender (Q27)	0.166	-0.787***
- Size of city (Q30)	0.030	0.284***
- Education (Q31)	0.013	0.139*
When choosing layout and stating WTP, respondent considered…		
- Animals and plants (Q18_1)	-0.105	0.803***
- Landscape (Q18_5)	0.191*	-0.437***
- Influence on Silkeborg city (Q18_6)	0.396***	0.567***
- Influence on own property value (Q18_8)	-0.105	0.398***
Other		
- Distance to Resendal layout (Q20_1)	0.232**	0.243*
- Effect of Ringvej layout on daily transportation (Q21b_5)	0.028	-0.274*
- Living in household with car (Q8a)	0.640*	0.163
- Number of visits to Nordskoven in the past year (Q6_1)	0.186**	-0.229**
- Effect of Resendal layout on recreational opportunities (Q21a_2)	0.357**	0.246
- "Motorways destroy the appearance of nature" (Q25_4)	0.223***	0.088
Scale	1.272	0.834
N	250	66
Log likelihood	-414.88	-81.66
Pseudo R^2	0.151	0.248

Note: Variables are coded according to the sequence of categories within each question in the questionnaire. (*) indicates significance on a 90% level, (**) indicates significance on a 95% level, (***) indicates significance on a 99% level.

Women have significantly lower WTP than men (Q27), and respondents living in the countryside have higher WTP than those living in the city (Q30). This last finding seems reasonable, as a large part of those living in the countryside will probably be more directly affected if the Resendal layout is realised. Thus, their preferences for the Ringvej layout are stronger than those living in areas of the city which will not be directly affected by either layout.

This could be supported by the fact that respondents paying much consideration to a possible influence on their own property values have stronger preferences than those not considering this aspect. It is quite possible that respondents choosing the Ringvej layout due to property value considerations (among others), are those living in the countryside close to the Resendal layout. This is, however, somewhat contradicted by

the fact that the greater the distance to the Resendal layout (Q20_1), the greater the WTP for the Ringvej layout.

A significant determinant of WTP is the degree to which respondents have taken consequences for animals and plants into consideration (Q18_1). The fact that respondents, who give high consideration to the importance of animals and plants, exhibit high WTP values to ensure the Ringvej layout, indicates that these respondents believe that the Resendal layout will affect animals and plants much more than the Ringvej layout. As concern for animals and plants is mainly associated with non-use values, a further interpretation would be that respondents generally attach larger non-use values to the areas affected by the Resendal layout than those affected by the Ringvej layout.

6.3.2.2 The Resendal layout

Of the socioeconomic parameters in table 6.9, only household income is significant. Instead, a major determinant of WTP for this layout is the extent to which respondents took the influence of the motorway on Silkeborg city into consideration (Q18_6). Those doing so have significantly larger WTP than others. This corresponds to the previously mentioned large number of comments concerning the negative effects for the city as such, if the Ringvej layout is realised. Furthermore, WTP increases as the distance to the Resendal layout increases (Q20_1), which might be ascribed to an 'out of sight – out of mind' effect. In this relation, it is noteworthy that the WTP for the Ringvej layout is positively influenced by the "impact on Silkeborg city".

This suggests that respondents choosing the Ringvej layout associate impacts on the city with positive effects. Based on comments in the additional comments field in the questionnaire, these include industrial development of the city and lower unemployment.

It is interesting to note that WTP increases with the number of visits to the 'Nordskoven' forest (Q6_1). As this recreational area is only affected by the Ringvej layout, it was anticipated that this group of people who use 'Nordskoven' a lot would exhibit very strong preferences for the Resendal layout. Likewise, the number of visits to Nordskoven has a significant influence on the preferences of those respondents that actually *do* choose the Ringvej layout, but with an opposite sign. This, too, is not surprising. People choosing the Ringvej layout mainly do so to protect the Gudenå valley from the Resendal layout. With all things being equal, this is accomplished by paying

(WTP) for protection of the area. However, respondents, presently using the 'Nordskoven' a lot, further sacrifice some of their present recreational opportunities in this trade-off involving acceptance of the Ringvej layout, thus it seems logical for those to state a lower monetary WTP.

It is also interesting (and expected) that those *disagreeing* with the statement "Motorways destroy the appearance of nature" (Q25_4) have significantly higher WTP for the Resendal layout than those agreeing with the statement.

An oddity is the fact that respondents expecting the Resendal layout to affect their recreational opportunities (Q21a_2) actually state a higher WTP than others. A possible, but maybe not plausible, explanation could be that some respondents see the opportunity of driving on a large bridge across the Gudenå valley as a new recreational experience. Supporting this explanation is the fact that more than 50% of the respondents, when answering the WTP questions, took into consideration the opportunity of experiencing the specific areas by driving on the new motorway.

Table 6.10 Estimation of WTP based on the specified Tobit models

Layout	Respondents choosing layout	Mean WTP (DKK)	Median WTP (DKK)	95% CL for mean (DKK)
Resendal	385 (250)	707	599	652 – 762
Ringvej	99 (66)	1421	647	961 – 1881

Note: Numbers in parentheses indicate the actual number of respondents used in the modelling due to item non-response. The WTP figures are per household per year.

Table 6.10 lists estimates of mean and median WTP on the basis of the specified models. A striking feature is that the Resendal mean WTP is only just under half of that in the non-parametric analysis in table 6.6. This is due to the lognormal properties of the estimated model and the fact that the estimated model does not describe the upper end of the bid spectrum very well (the highest predicted bid is 3,560 DKK whilst the highest stated bid is 50.000 DKK). This is further underpinned by the quite narrow 95% confidence interval of the mean, and the fact that the median and the mean are much closer to each other than in the non-parametric analysis.

The Ringvej estimates seem more reasonable when compared to the non-parametric estimates. The estimated mean WTP and the 95% confidence interval around it are almost identical in the parametric and the non-parametric analysis. As in table 6.6, the

median is significantly lower than the mean. All this indicates that the parametric Ringvej model describes the observed data quite well.

An important implication of the above analysis is that the identified problem in section 6.2 concerning the samples' ability to represent the population with regard to central sociodemographic variables *does* in fact require more attention. As all of these variables (household income, age, education, and household with car) are significant determinants of WTP, the resulting WTP estimates cannot be extended from the sample to the population without further calibration.

In the case of the Ringvej layout, increasing household income, age and education leads to significantly higher WTP estimates. Combining this with the identified overrepresentation of respondents with high household income, in the older part of the age spectrum and with a high level of education, it is apparent that WTP estimates for the Ringvej layout need to be treated as overestimates of the true WTP of the general public in the Silkeborg area.

Likewise, WTP for the Resendal layout increase significantly with increasing household income and households with a car. Combined with the overrepresentation in the sample, this also leads to the conclusion that WTP estimates for the Resendal layout overestimate the true WTP of the Silkeborg population.

6.3.3 Subgroup analysis of the OE sample

With the above identified connection between WTP and certain background characteristics of the respondents, and the problems concerning representativeness of the samples in mind, a subgroup analysis is called for on order to achieve a clearer picture of the importance of the problem with representativeness.

Table 6.11 presents non-parametric WTP estimates for subgroups based on the sociodemographic background variables that were found not to be representative of the population. A parametric approach would have been preferable, but was not possible due to small numbers of respondents in several subgroups. For the same reason some of the WTP estimates should not be taken at face value without reservations.

The results in table 6.11 are in accordance with signs and significance levels identified in the parametric analysis in table 6.9. Men are generally willing to pay double as much as women to have their preferred layout realised. However, the sample *was* rep-

resentative with regards to gender, so this finding entails no need for reservations when extending conclusions from the sample to the people in the Silkeborg area.

Table 6.11 Subgroup non-parametric WTP analysis

	Resendal		Ringvej	
	N	Mean WTP	N	Mean WTP
Gender				
Male	194	1686	55	1979
Female	184	960	44	739
Education				
Low	161	1050	37	1168
Medium	80	843	23	1943
High	137	1951	39	1370
Household income (DKK)				
0 – 149,999	23	1413	5	780
150,000 – 299,999	74	623	21	485
300,000 – 499,999	106	1001	32	1308
500,000 – 799,999	135	1336	35	1869
800,000 or more	39	3553	4	4875
Age				
18 – 34	89	1435	26	986
35 – 54	162	1683	50	1440
55 – 70	124	834	23	1900
Household with car?				
No	30	882	10	410
Yes	353	1359	89	1542

Note: Education levels are aggregated; 'low' covers primary school and vocational, 'medium' covers high school and short academic, and 'high' covers middle and long academic education. The WTP figures are per household per year.

WTP increases with increasing level of education though this tendency is not as unequivocal as expected. Combining this with the fact that people with long educations are overrepresented in the sample, the overall mean WTP estimates must be considered overestimates of the true WTP of the population.

Higher household income leads to higher WTP estimates, which is in accordance with economic theory regarding diminishing marginal utility of money. The fact that WTP in the lowest income group is higher than the following group is somewhat disturbing. One explanation could be the relatively low number of respondents in the lowest income group rendering these estimates uncertain. Another explanation could be that respondents in the lowest income group do not consider their budget restrictions in a realistic way, implying a larger extent of strategic bidding and/or warm glow in their bids as compared to other income groups. As table 6.2 displayed, people with high

household income is overrepresented in the sample, which further adds to the above notion of estimated WTP overestimating the true WTP.

Looking at respondents choosing the Ringvej layout, WTP increases with increasing age, and the WTP of those above 55 years of age is double that of respondents below 35 years of age. The effect of age is different for respondents choosing the Resendal layout, where respondents in the middle age group from 35 to 54 years show the highest WTP, while the older age group have a much lower WTP. Due to this ambiguity it is difficult to determine the importance of the age effect on the overall WTP estimates' ability to describe the true WTP.

Finally, a tendency of respondents living in a household with car stating higher WTP than those without a car, is revealed. Remembering the overrepresentation of respondents in the sample living in a household with car, this also adds to the conclusion that the WTP estimates from the OE CVM generally must be regarded as overestimates of the true WTP of the people in the Silkeborg area.

6.4 Double Bounded Dichotomous Choice

The trimmed DBDC sample consists of 590 respondents. 73.9% of the respondents state that they would vote for the Resendal layout, and the remaining 26.1% would vote for the Ringvej layout.

As was the case for the OE sample (table 6.3), the choice of layout is significantly influenced by the proximity of each layout to the respondents' place of residence. This is illustrated in table 6.12.

Table 6.12 Parameter estimates from probit model on choice of layout

Parameter	Coefficient	Std. error	P value
Distance to Resendal layout (Q20_1)	-0.2503**	0.0756	0.001
Distance to Ringvej layout (Q20_2)	0.3643***	0.0668	‹0.001
Constant	-0.9875**	0.3489	0.005
N	531		
Log likelihood	-285.19		
Pseudo R^2	0.059		

Note: The dependent variable, question 14 regarding layout choice, is coded as Resendal=0 and Ringvej=1. Explanatory variables are coded according to the sequence of categories in the questionnaire. Respondents answering "Don't know" to question 23 are excluded. (*) indicates a significant difference on a 95% level, (**) indicates a significant difference on a 99% level, (***) indicates a significant difference on a 99.9% level.

The signs are as expected, cf. the reasoning in section 6.3, and the model is almost identical to the model in table 6.3. A more elaborate model on determinants of choice is presented in table 6.13.

Table 6.13 Probit model on choice of layout based on respondents' expectations of each layout's effect on various factors (DBDC model)

Parameter	Coefficient	Std. error	P value
Resendal layout - perceived influence on:			
- recreational opportunities (Q24a_2)	0.6782***	0.1226	‹0.001
- noise level at place of residence (Q24a_3)	0.3218**	0.1194	0.007
- specific areas of nature (Q24a_6)	0.5092***	0.1144	‹0.001
Ringvej layout – perceived influence on:			
- nature experiences (Q24b_1)	-0.4201***	0.1156	‹0.001
- noise level at place of residence (Q24b_3)	-0.2657*	0.1062	0.012
- landscape appearance (Q24b_4)	-0.4943***	0.1091	‹0.001
- nature in Denmark in general (Q24b_7)	0.3766**	0.1162	0.001
Constant	-1.7486***	0.2924	‹0.001
N	565		
Log likelihood	-223.25		
Pseudo R^2	0.306		

Note: The dependent variable, question 14 regarding layout choice, is coded as Resendal=0 and Ringvej=1. Explanatory variables are coded according to the sequence of categories in the questionnaire. (*) indicates significant difference on a 95% level, (**) indicates significant difference on a 99% level, (***) indicates significant difference on a 99.9% level.

Again, this model is similar to the one in table 6.4, but a few parameters have been replaced by others. However, the general conclusion does not change; the elicited WTP bids clearly cover more than just preferences concerning nature and recreation.

For instance, the expected noise level at respondents' own residence is clearly significant. Furthermore, as explained in section 6.3, a major determinant of layout choice is the extent to which the respondent considered the influence of the motorway on Silkeborg city (Q21_6). This parameter is not included in the model in table 6.13, as it is correlated with the expected noise level.

As was done for the OE sample in table 6.5, a probit model analysing the influence of socio-demographic varibles on respondents' choice of layout is presented in table 6.14.

Table 6.14 Probit model on choice of layout based on the socio-demographic characteristics of the respondents

Parameter	Coefficient	Std. error	P value
Gender (Q30)	-0.0065	0.1237	0.958
Age (Q29)	0.0057	0.0046	0.206
Household income (Q37)	-0.0435	0.0275	0.113
Education (Q34)	0.0226	0.0378	0.560
Municipality	1.0570***	0.1631	‹0.001
Car ownership (Q8a)	-0.0565	0.2504	0.822
Constant	-0.8841	0.4610	0.055
N	535		
Log likelihood	-279.90		
Pseudo R^2	0.080		

Note: The dependent variable, question 14 regarding layout choice, is coded as Resendal=0 and Ringvej=1. Explanatory variables are coded according to the sequence of categories in table 6.2. (*) indicates significant difference on a 95% level, (**) indicates significant difference on a 99% level, (***) indicates significant difference on a 99.9% level.

Similar to the findings in the OE sample, the only significant variable is municipality. Respondents living in Gjern municipality clearly more prone to choosing the Ringvej layout than respondents living in Silkeborg municipality. This is supported by the fact that 58% of the respondents from Gjern municipality prefer the Ringvej layout, whereas only 21% of those living in Silkeborg municipality prefer this layout.

None of the other variables are significant determinants of choice, which implies that the distribution of layout choice in the sample can be directly extended to the population even though the sample is not representative of the population.

6.4.1 Descriptive statistics of answers

The distribution of responses to the DBDC questions (see Appendix 3) is listed in table 6.15. As expected, the tendency is clear; the higher the bid levels, the more 'no' responses.

The share of respondents in bid set 8 accepting both bids is somewhat alarming. 30% acceptance of the highest bid would indicate that the bid range has not effectively reached the choke price. However, 5,000 DKK was found to be an effective choke price on the basis of an open ended pilot test, where less than 5% of the respondents bid 5,000 DKK or more. So the 30% accepting this amount in the DBDC sample is more likely to be a consequence of an anchoring effect, which will be elaborated on later.

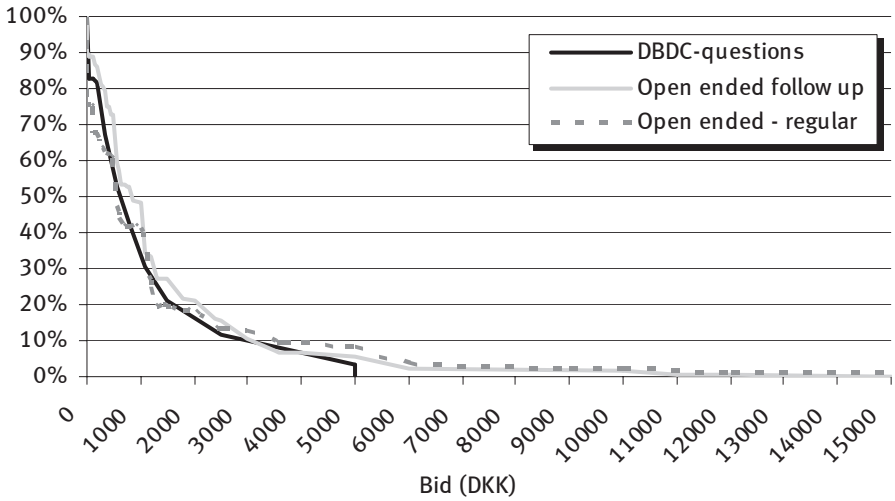
Table 6.15 Descriptive statistics of answers to the DBDC questions

Bid set	Threshold 1st (2nd) bid	n	YY %	YN %	NY %	NN %
1	100 (200/50)	87	86.2	8.1	1.1	4.6
2	200 (350/100)	79	84.8	3.8	1.3	10.1
3	350 (550/200)	77	61.0	16.9	7.8	14.3
4	550 (800/350)	76	72.4	9.2	6.6	11.8
5	800 (1100/550)	77	55.8	11.7	7.8	24.7
6	1100 (1500/800)	63	57.1	11.1	12.7	19.1
7	1500 (2500/1100)	68	50.0	22.1	7.4	20.5
8	2500 (5000/1500)	63	30.1	27.0	6.4	36.5

NOTE: YY = YES TO FIRST BID – YES TO SECOND BID, YN = YES – NO, NY = NO – YES, NN = NO – NO.

Based on the accepted bids, an approximate cumulative bid curve is constructed in figure 6.3. Respondents answering YY are assigned a bid value equal to the upper second bid in the bid set, while those answering YN are assigned the first bid. NY answers are assigned the lower second bid, and NN answers are assigned a zero bid value.

Figure 6.3 Cumulative bid curve based on DBDC answers and the open ended follow-up question compared with the bid curve from the regular open ended sample



The approximate cumulative bid curve is a quite conservative construct as YY answers are likely to represent a higher WTP than the upper second bid, and it cannot be ascertained that a NN answer equals a zero WTP and not just a WTP lower than the second bid. Nevertheless, the figure provides a raw, and conservative, picture of the stated bids.

For comparison, a bid curve based on the open ended follow-up in question 18 is constructed and illustrated in figure 6.3. Bids are generally slightly higher which was expected; cf. the above argument concerning conservativeness.

It could be argued that the open ended follow-up bids cannot be interpreted entirely as regular open ended bids due to heavy anchoring effects induced by the preceding DBDC questions. This difference is illustrated by incorporating the cumulative bid curve from the regular open ended sample in figure 6.2 into figure 6.3. The OE follow-up curve generally exhibits a larger percentage of bids below 3,000 DKK and a lower percentage of high bids than the regular OE curve. However, the difference does not seem to be very alarming.

6.4.2 Non-parametric analysis

A simple non-parametric analysis of the conservative bids based on the DBDC questions and of the OE follow-up bids is presented in table 6.16.

Table 6.16 Non-parametric analysis of DBDC CVM

Layout	Respondents choosing layout	Mean WTP (DKK)	Median WTP (DKK)	95% CL for mean (DKK)
Conservative bids				
Resendal	436	895	550	796 – 994
Ringvej	154	737	350	580 – 893
OE Follow-up				
Resendal	404	1383	1000	1201 – 1564
Ringvej	151	990	700	822 – 1159

Note: The WTP figures are per household per year. The conservative bids represent the construct described above, setting the bid of each respondent on the basis of answers to the DBDC questions. The number of respondents is lower in the OE follow-up, as not all have stated an OE bid.

The results support the expected findings from figure 6.3; the OE follow-up generally exhibits higher WTP than the conservative bids. Compared to the regular OE in table 6.6 it seems that mean WTP based on the conservative bids is generally lower. The mean WTP values from the OE follow-up resemble the findings in the regular OE more. However, the median WTP estimates are higher than in the regular OE, and the difference between the mean and the median is less striking.

This indicates that the OE follow-up is not as heavily influenced by a few very high bids as the regular OE. Furthermore, the confidence intervals are not as great as in the regular OE, indicating that the distribution of bids is not as widespread.

This could be interpreted to reflect the above mentioned anchoring of the OE follow-up in the DBDC-bids. However, a more elaborate test of whether or not the OE follow-up bids reflect the same preference function as the regular OE bids, is to employ the identified parametric model from the regular OE split in section 6.3.2 on the OE follow-up bids from the DBDC split .

6.4.3 Parametric analysis of OE follow-up bids

In table 6.17 below, the tobit model from the regular OE split is employed on the follow-up bids (denoted 'regular OE model' in the table). The general picture, when comparing table 6.17 to table 6.9, is that the model fits the follow-up bids quite well. A few of the significant variables from the regular OE-model in table 6.9 become insignificant and vice versa. Regarding respondents choosing the Resendal layout, the model actually shows a better fit for the follow-up bids than for the regular bids. The opposite goes for respondents choosing the Ringvej layout. The fact that the specified model fits both the regular and the follow-up OE bids quite well indicates that the preference function underlying respondents' bids is quite similar in the two cases.

In the rightmost columns of table 6.17, an extra variable describing the first bid-level introduced in the DC-questions into the model, is incorporated in the model to take into account a suspected anchoring effect. The variable is highly significant, revealing that an anchoring effect is indeed present in the follow-up bids. However, including the 'anchor'-variable does not markedly diminish the explanatory power of the remaining variables, it simply adds to the overall fit of the model. In other words, even though the OE follow-up bids are anchored in the initially presented DC bid levels, they still exhibit preference relations roughly similar to those exhibited in a regular OE.

This speaks in favour of the applicability and usefulness of an OE follow-up question when conducting a DC CVM.

Table 6.17 Specification of Tobit models describing WTP based on OE follow-up with and without anchoring

	Regular OE model		Anchored model	
Parameter	Resendal	Ringvej	Resendal	Ringvej
1st bid *(anchor)*	-	-	0.001 ***	0.001 ***
Socioeconomic characteristics				
- Household income (Q37)	0.161 ***	0.181 ***	0.143 ***	0.192 ***
- Age (Q29)	0.009 *	0.018 *	0.009 *	0.011
- Gender (Q30)	0.158	-0.133	0.144	-0.151
- Size of city (Q33)	0.111 *	0.068	0.078	0.128 *
- Education (Q34)	0.079 *	0.056	0.070 *	0.053
When choosing layout and stating WTP, respondent considered…				
- Animals and plants (Q21_1)	0.124	0.214	0.081	0.050
- Landscape (Q21_5)	-0.011	0.031	0.008	0.063
- Influence on Silkeborg city (Q21_6)	0.265 ***	0.037	0.228 ***	0.028
- Influence on own property value (Q21_8)	0.103 *	-0.080	0.079	-0.018
Other				
- Distance to Resendal layout (Q23_1)	0.177 **	0.205 *	0.0209 ***	0.174 *
- Effect of Ringvej layout on daily transportation (Q24b_5)	0.039	0.093	0.069	0.117
- Living in household with car (Q8a)	1.147 ***	0.866 *	0.998 ***	1.059 **
- Number of visits to Nordskoven in the past year (Q6_1)	0.049	0.133	0.022	0.208 *
- Effect of Resendal layout on recreational possibilities (Q24a_2)	0.285 **	0.278 *	0.226 *	0.241 *
- "Motorways destroy the appearance of nature" (Q28_4)	0.110 *	0.269 ***	0.137 ***	0.193 **
Scale	0.993	0.951	0.861	0.828
N	313	110	313	110
Log Likelihood	- 441.77	- 150.65	- 397.44	- 135.38
Pseudo R^2	0.165	0.081	0.249	0.174

NOTE: VARIABLES ARE CODED ACCORDING TO THE SEQUENCE OF CATEGORIES WITHIN EACH QUESTION IN THE QUESTIONNAIRE. (*) INDICATES SIGNIFICANCE ON A 90%-LEVEL, (**) INDICATES SIGNIFICANCE ON A 95%-LEVEL, (***) INDICATES SIGNIFICANCE ON A 99%-LEVEL.

In table 6.18, mean WTP values are estimated based on the OE follow-up bids and the specified model.

Table 6.18 Parametric analysis of OE follow-up bids

Layout	Respondents choosing layout	Mean WTP (DKK)	Median WTP (DKK)	95% CL for mean (DKK)
Regular OE model				
Resendal	360	903	784	847 – 960
Ringvej	126	799	621	682 – 917
Anchored model				
Resendal	360	1120	792	1015 – 1226
Ringvej	126	961	623	776 – 1146

NOTE: THE WTP FIGURES ARE PER HOUSEHOLD PER YEAR.

Comparing to the non-parametric estimates in table 6.16, the estimates based on the specified tobit model from the modelling of the regular OE split are generally lower.

Incorporation of a variable accounting for the anchor effect however raises the WTP estimates somewhat and brings them close to the non-parametric estimates.

The rationale for undertaking the DBDC study was, however, not just to facilitate a simple, non-parametric estimation of WTP or a parametric analysis of the follow-up bids, but to estimate WTP parametrically based on the actual DBDC questions.

6.4.4 Parametric analysis

Due to the random assignment of bids and respondents being unaware of the underlying design, it is possible to estimate WTP by double bounded interval data analysis (Cameron & Quiggin 1994). The DBDC questions provide for a division of respondents into four censoring WTP intervals, presented in table 6.19.

Table 6.19 Creation of censoring intervals

Answer to		
1st bid (BID1)	2nd bid (BID2)	Censoring WTP interval
Yes	Yes	$WTP_i \geq BID2_u$
Yes	No	$BID1 \leq WTP_i < BID2_U$
No	Yes	$BID1 > WTP_i \geq BID2_d$
No	No	$WTP_i < BID2_d$

Note: Subscript *i* refers to individuals in the sample. Subscripts *u* and *d* refer to an increase or a decrease in initial bid value respectively.

The respondent's answers to the two DBDC questions are assumed to have the following WTP structure:

$$WTP_i = \beta' x_i' + u_i \qquad (6.1)$$

where β' is a vector of parameters to be estimated and x' is a vector of variables determining a 'yes' or 'no' response. Furthermore, assuming that individual WTP is normally distributed with mean $\beta' x'$, the probabilities for ending up in each of the four intervals can be described as:

$$P_i^{YY} = 1 - \Phi\left(\frac{WTP_i - \beta' x_i}{\sigma} \leq \frac{BID2_u - \beta' x_i}{\sigma}\right),$$

$$P_i^{YN} = \Phi\left(\frac{WTP_i - \beta' x_i}{\sigma} \leq \frac{BID2_u - \beta' x_i}{\sigma}\right) - \Phi\left(\frac{WTP_i - \beta' x_i}{\sigma} \leq \frac{BID1 - \beta' x_i}{\sigma}\right),$$

$$P_i^{NY} = \Phi\left(\frac{WTP_i - \beta' x_i}{\sigma} \leq \frac{BID1 - \beta' x_i}{\sigma}\right) - \Phi\left(\frac{WTP_i - \beta' x_i}{\sigma} \leq \frac{BID2_d - \beta' x_i}{\sigma}\right),$$

$$P_i^{NN} = \Phi\left(\frac{WTP_i - \beta' x_i}{\sigma} \leq \frac{BID2_d - \beta' x_i}{\sigma}\right).$$

The probabilities for all respondents can then be totalled to obtain the likelihood and, thus, enabling statistical analysis in the form of maximum likelihood estimation. The statistical analysis is conducted using the LIFEREG procedure in SAS which allows for interval-based maximum likelihood estimation (SAS 1999). The resulting models are presented in table 6.20:

Table 6.20 WTP models analysed by maximum likelihood estimation of the DBDC sample

	Resendal layout		Ringvej layout	
Parameter	Coefficient	Std. error	Coefficient	Std. error
Income (Q37)	0.2396 ***	0.0411	0.2510 ***	0.0607
Ringvej_property value (Q24b_8)	0.2865 **	0.1352		
Resendal_ areas (Q24a_6)	-0.4986 ***	0.1746		
Recreation (Q21_2)	0.3604 ***	0.1058		
Resendal distance (Q23_1)			-0.2906 *	0.1742
Property values (Q21_8)			-0.3381 **	0.1420
Resendal_exp. nature (Q24a_1)			0.4383 **	0.1963
Interest in nature (Q25)			0.6612 **	0.2602
Constant	5.5231 ***	0.5306	4.8271 ***	1.1750
Scale	1.4825	0.1226	1.2038	0.1505
N	391		132	
Log Likelihood	- 325.76		- 124.11	
Pseudo R^2	0.205		0.282	

Note: Explanatory variables are coded according to the sequence of categories in the questionnaire. (*) indicates significance on a 90% level, (**) indicates significance on a 95% level, (***) indicates significance on a 99% level.

Both models exhibit an acceptable fit with pseudo R^2 values above 0.20. Household income is the only significant, common parameter in the two models. The fact that

higher household income results in a significantly higher WTP, is an important result when considering the identified overrepresentation of respondents with high household income in the samples. These findings indicate that the WTP estimates based on the samples *will* be overestimates of the true WTP of the population in the Silkeborg area. Consequently, calibration is required, when estimates are to be used in policy analysis.

A few selected parameters are commented upon below. As was the case for the OE sample, parameters other than those associated with the value of nature significantly affect the elicited WTP. Thus, the more respondents, choosing the Resendal layout, deem the Ringvej layout to affect their property values (Q24b_8), the more they are willing to pay.

The expectation of changing property values significantly effects WTP for the Ringvej layout too. The more the respondents have considered their property values (Q21_8) when answering the WTP questions, the lower the WTP for this layout.

Nevertheless, nature plays a role; the higher the perceived impact by the Resendal layout on the affected areas of nature (Q24a_6), the lower the WTP for the Resendal layout. And the more the respondents deem the Resendal layout to affect their opportunities to experience nature (Q24a_1), the greater the WTP for ensuring realisation of the Ringvej layout.

Respondents living far from the Resendal layout exhibit a lower WTP for the Ringvej layout than those living closer to the Resendal layout. This could be explained by the fact that respondents living close to the Gudenå valley, and consequently the Resendal layout, are more concerned about this area and, thus, have a higher WTP to protect it, i.e. a high WTP for the Ringvej layout.

On the basis of the models put forward, WTP from the DBDC study is calculated and presented in table 6.21:

Table 6.21 Estimation of WTP based on the specified ML models

Layout	Respondents choosing layout	Mean WTP (DKK)	Median WTP (DKK)	95% CL for mean (DKK)
Resendal	391	3202	2466	2963 – 3441
Ringvej	132	2213	1656	1786 – 2640

Note: The WTP figures are per household per year.

The estimated WTP values are strikingly higher than those found in the OE study. This is caused by the fact that the 'yes – yes' responses in the modelling principally have no upper limit. This effect is further enhanced by an assumption of a lognormal distribution of the bids[47] which, compared to the normal distribution, solves the problem of non-negative WTP but, at the same time, introduces an overrepresented section at the tail end of the findings.

To deal with this problem, an upper spike is introduced in the model. The spike is set at 5,000 DKK based on the bids from the OE study where this amount was the 95% quantile, i.e. only 5% of the respondents stated a bid higher than this amount. The spiked WTP estimates are presented in table 6.22:

Table 6.22 WTP spiked at 5,000 DKK

Layout	Respondents choosing layout	Mean WTP (DKK)	Median WTP (DKK)	95% CL for mean (DKK)
Resendal	391	1388	1296	1334 – 1442
Ringvej	132	1233	1107	1113 – 1352

Note: The WTP figures are per household per year.

Introducing the spike more or less halves the estimated WTP values which now seem more reasonable compared to the results from the OE study. However, the spike at 5,000 DKK is somewhat arbitrary. As explained in section 6.3.1, some respondents could very well have perfectly viable, and true, WTP values exceeding 5,000 DKK. Another approach to setting the upper spike would be to make use of the open ended follow-up in question 18. This way, the spike is set from the respondents' own answers, so each respondent would have an individual spike value. The results of employing this personalised spike are presented in table 6.23:

[47] The distribution of bids is specified as lognormal due to the findings from the OE study. This slightly changes the specification of probabilities presented on page 92, but the basic idea is the same.

Table 6.23 WTP spiked at the open ended follow-up bid (Q18)

Layout	Respondents choosing layout	Mean WTP (DKK)	Median WTP (DKK)	95% CL for mean (DKK)
Resendal	391	838	798	811 – 865
Ringvej	132	735	679	681 – 788

Note: The WTP figures are per household per year.

Once again, the estimated WTP values are roughly halved by introducing this personalised spike. However, it could be argued that the open ended follow-up is anchored by the DBDC questions. As mentioned in section 6.4.1, this seems, to some extent, to be the case when drawing a comparison with the regular OE bid curve which exhibited a larger share of bids above 3,000 DKK. The existence of such an anchoring effect was further supported by the parametric analysis of the OE follow-up in section 6.4.3. Consequently, the WTP estimates based on the personalised spike could be interpreted as a slight underestimate of the true WTP, *ceteris paribus*.

table 6.24 presents results from an analysis similar to the one performed in table 6.8. Stated bids are adjusted according to question 22 which concerns the proportion of the stated bid attributed to the protection of nature and recreational opportunities.

Table 6.24 WTP related exclusively to the protection of nature and recreational opportunities

Layout	Respondents choosing layout	Mean WTP (DKK)	Median WTP (DKK)	95% CL for mean (DKK)
Resendal	391	1551	1176	1437 – 1665
Ringvej	132	1887	1145	1398 – 2377

Note: No spike employed. Relevant comparison is table 6.21. The WTP figures are per household per year.

As is the case in table 6.8, this approach reduces estimated WTP values, although, interestingly, WTP for the Resendal layout is reduced a lot more than WTP for the Ringvej layout.

Combining the self-reported share of WTP attributed to nature and recreational possibilities with the employment of the OE follow-up as a spike, naturally combines the tendencies from table 6.23 and table 6.24, thus yielding the lowest WTP estimates of the DBDC analyses. These are reported in table 6.25.

Table 6.25 WTP related exclusively to the protection of nature and recreational opportunities, spiked at the OE follow-up

Layout	Respondents choosing layout	Mean WTP (DKK)	Median WTP (DKK)	95% CL for mean (DKK)
Resendal	391	477	447	453 – 502
Ringvej	132	542	511	496 – 588

Note: The WTP figures are per household per year.

6.4.5 Subgroup analysis of the DBDC sample

In table 6.20 and table 6.17 it was ascertained that the socio-demographic variables, which in table 6.2 were identified as causing problems with the samples ability to represent the people in the Silkeborg area, did have a significant effect on the WTP estimates. Thus, a subgroup analysis concerning these variables is conducted in table 6.26.

Table 6.26 Subgroup non-parametric WTP analysis (based on OE follow-up)

	Resendal		Ringvej	
	N	Mean WTP	N	Mean WTP
Gender				
Male	224	1445	83	1022
Female	169	1332	62	837
Education				
Low	150	1087	64	891
Medium	90	1550	32	952
High	153	1610	49	1009
Household gross income (DKK)				
0 – 149,999	30	483	12	1083
150,000 – 299,999	67	1080	33	505
300,000 – 499,999	98	950	34	1010
500,000 – 799,999	157	1721	55	1196
800,000 or more	44	2326	13	1423
Age				
18 – 34	102	1414	43	835
35 – 54	177	1618	64	1123
55 – 70	113	1038	38	762
Household with car?				
No	39	1079	13	1096
Yes	364	1417	137	966

Note: Education levels are aggregated; 'low' covers primary school and vocational, 'medium' covers high school and short academic, and 'high' covers middle and long academic education. The WTP figures are per household per year.

As some of the subgroups contained too few respondents to estimate WTP parametrically, the subgroup analysis is based on the OE follow-up bids. The revealed tendencies are roughly similar to the subgroup analysis of the regular OE bids (table 6.11).

Men are overrepresented in the sample and they are seemingly WTP more than women. This would suggest that estimates of WTP are overestimates of the true WTP, but as table 6.20 and table 6.17 demonstrated, gender was not a significant determinant of WTP, so this tendency cannot entirely be determined.

Rising levels of education and household income leads to higher WTP. In conjunction with the overrepresentation of highly educated respondents and respondents with relative high household income, the suspicion of estimated WTP being an overestimate of the true WTP of the people in the Silkeborg area is confirmed.

The middle age class (35 – 54) apparently state higher WTP than both the younger and the older age classes. The older age class has the lowest WTP of the three groups. In table 6.2 it was established that the sample had a slight overrepresentation of the middle and the older age classes. The fact that both the group with the highest WTP as well as the group with the lowest WTP are overrepresented, pulls in opposite directions and makes it impossible to draw a conclusion concerning the suspected overestimation.

Respondents living in a household with car, state higher WTP for the Resendal layout than those without a car, whereas the opposite tendency goes for respondents choosing the Ringvej layout. With the overrepresentation of households with car in mind, this would indicate that WTP estimates overestimate the true WTP for the Resendal layout whereas the true WTP for the Ringvej layout is underestimated. However, as the WTP for the Ringvej layout is only slightly higher for the group with no car as compared to the group with car, this is not likely to change the overall conclusion of WTP estimates being overestimates of the true WTP of people in the Silkeborg area.

6.5 Summary of WTP estimation based on the CVM

In the above sections, it is found that approximately 76% of the respondents prefer the Resendal layout whereas the remaining 24% would prefer to have the Ringvej layout realised. This finding can be directly extended to the population in Silkeborg and Gjern municipalities.

WTP values have been estimated in several different ways based on both open ended data and double bounded dichotomous choice data, resulting in a series of differing WTP values. It is not easy to determine which estimate is closest to the true WTP. How-

ever, the general picture is that the mean WTP for the Resendal layout and the Ringvej layout can be found in an interval ranging from around 500 DKK to 3,200 DKK and 500 DKK to 2,200 DKK respectively, depending on the calculation approach used. Median WTP values are generally slightly lower due to the 'fat tail' properties of the log-normal distributed bids.

Interestingly, adjusting bids to represent only values concerning the protection of nature and recreational opportunities lowers WTP values for the Resendal layout a lot more than for the Ringvej layout. This means that respondents choosing the Resendal layout, more so than respondents choosing the Ringvej layout, motivate their stated WTP on concerns for the direct effects on the city and its residents, and not so much on concerns for the influence on nature and recreation. This finding is further supported by a closer look at the answers to the question regarding the proportion of WTP assigned to the protection of nature and recreation. Respondents choosing the Resendal layout state an average percentage of 45% to 49% of expressed WTP attributed to the protection of nature and recreational opportunities, whereas respondents choosing the Ringvej layout state an average of 61% to 67%.

This uncertainty, regarding which WTP estimates are most realistic, calls for caution when using the estimates in further calculations. Sensitivity analyses are essential for drawing conclusions. Furthermore, the analyses revealed that the estimated WTP values must be deemed overestimates of the true WTP of the population in the municipalities of Silkeborg and Gjern.

7 Results of the Choice Experiment study

This chapter covers the analysis and results of the CE study. Response rates and the ability of the respondent sample to represent the intended target population are examined. Models are then applies to the preferences, an estimation of the WTP made and the hypothesis tested.

7.1 Response rates

As table 7.1 shows, an effective rate of response of 48.7% was achieved in the national sample. Bateman *et al.* (2002) state as a rule of thumb that a response rate of 50% is a suitable minimum for this kind of study, so the achieved rate is considered only just acceptable. At 65.8%, the response rate in the Silkeborg Internet sample was quite a bit higher. This is due to the fact that an additional reminder was sent to the Silkeborg Internet sample. The Silkeborg postal sample yielded an effective response rate at 60.0%. As in the Silkeborg Internet sample, a total of two reminders were used.

Table 7.1 Response rates in the samples

			Silkeborg			
	National		Internet		Postal	
	No.	%	No.	%	No.	%
E-mails/Questionnaires sent out	5354	100	476	100	600	100
Answered / returned	2610	48.7	313	65.8	374	62.3
- Undelivered / refused to answer	-	-	-	-	11	1.8
Initial sample	2610	48.7	313	65.8	363	60.5
- CE questions not answered	-	-	-	-	3	(0.8)
Effective sample	**2610**	**48.7**	**313**	**65.8**	**360**	**60.0**
- Identified protest bidders	205	(7.9)	25	(8.0)	46	(12.8)
- Identified irrational respondents	48	(1.8)	1	(0.3)	0	(0.0)
- Identified 'non-traders'	885	(33.9)	117	(37.4)	166	(46.1)
Trimmed sample (analysed)	1472	27.5	170	35.7	148	24.7

Note: Parentheses indicate percentage values related to the above subtotal. It was not possible to determine how many respondents refused to answer or only partially answered the Internet questionnaire, as the datasets supplied by ACNielsen did not contain this information.

The rates of response achieved in the three samples are comparable to response rates achieved in previous Danish CE studies concerning non-marketed goods (Boiesen *et al.* 2005; Hasler *et al.* 2005; Ladenburg & Martinsen 2004; Olsen & Lundhede 2005). However, the samples are reduced by more than a third when protesters, irrational respondents and so-called 'non-traders' are excluded.

7.1.1 Protesters, irrational respondents and 'non-traders'

Protesters are identified in question 25, which only has to be answered by respondents choosing the status quo alternative in all six choice sets. Protest answers were defined as described in table 7.2.

Table 7.2 Definition of protest and genuine zero bids

Primary cause for choosing status quo in all six choice sets	**P**rotest/**G**enuine
"The alternatives were too expensive when considering the benefits for nature"	G
"I can't afford to pay any more taxes"	G
"I pay enough taxes as it is"	P
"The questions were too difficult"	P
"No more motorways should be built in Denmark"	P
"It is unnecessary to consider nature especially, when building motorways"	G
"I would like to be able to see as much nature as possible when driving my car"	G
"Don't know"	P
"Other"	G/P

Irrational respondents are those who have chosen a perfectly dominated alternative in the CE question, as mentioned in chapter 5. The last choice set in all but blocks 2, 5, 8, 11 and 14 contains a perfectly dominating alternative (though not compared to the status quo alternative). Respondents not choosing this alternative (or the status quo alternative) in this particular choice set are excluded from further analysis. Only a few respondents are excluded due to irrational behaviour.

Non-traders are respondents who have not made any trade-offs between attributes in their choices. Non-traders were defined as respondents who stated in question 22 that none of the attributes affected their choices, and respondents who stated in question 23 that their choices were based entirely on the most important attribute (known as a 'rule of thumb' strategy). In order to be certain that all respondents in the analysis were actually respondents who had made real trade-offs, respondents answering 'Don't know' in question 23 were excluded[48].

[48] Models including these protesters and non-traders could have been applied to gain detailed information on the effect of these respondents on WTP estimates. However, this has been omitted as it is not considered to be within the scope of this study.

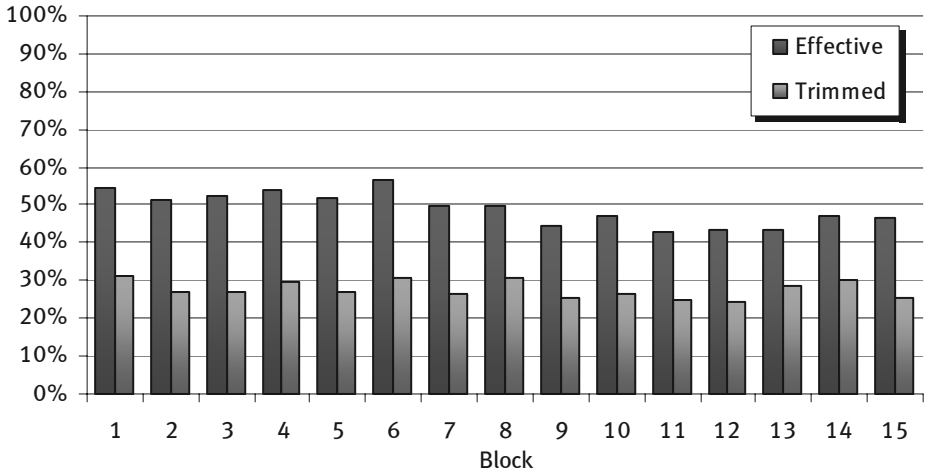
Quite a lot of respondents are found to be non-traders, and the trimmed sample response rates in table 7.1 might seem disturbingly low. However, the actual number of respondents in the trimme samples is sufficient for the parametric analysis of WTP, and, as section 7.2. will show, this reduction of the response rates due to exclusion of protesters, irrational and non-trading respondents does not affect the representativeness of the sample significantly. Hence, the seemingly low trimmed sample response rates does not cause major problems in the following analyses.

7.1.2 Response rates in blocks

As explained in chapter 5, the CE design employs a blocked design. If the response rate varies considerably within blocks, it might cause erroneous estimates when applying models. This is due to the fact that, in this case, some choice sets, and thus some attribute levels, would have more representation than others in the dataset. In other words, the orthogonality and level balance properties of the efficient design would be compromised.

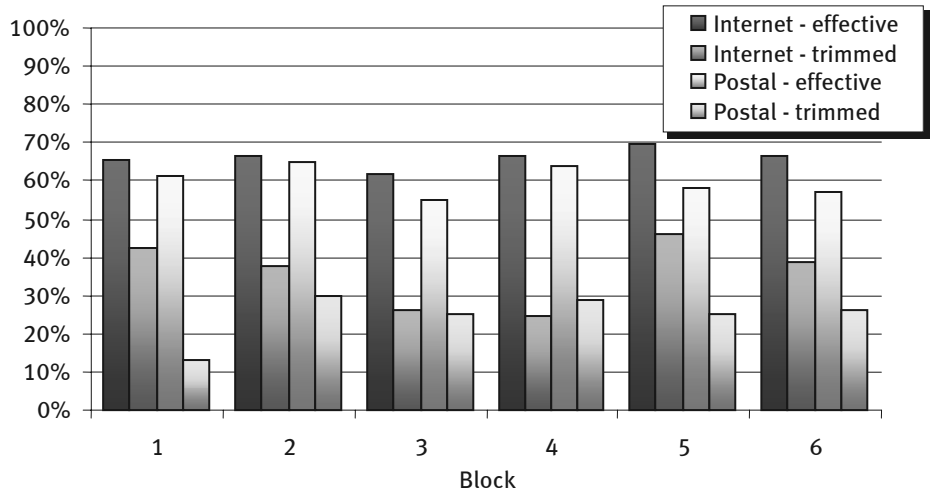
As can be seen in figure 7.1 and Figure 7.2, there is some variation in response rates between blocks. However, the actual number of respondents in each block is not significantly different[49] from the mean number of respondents per block. Likewise, looking at response rates within splits revealed no significant differences.

Figure 7.1 Comparison of response rates in the 15 blocks of the national sample



[49] Employing a χ^2-test at a 95% significance level.

Figure 7.2 Comparison of response rates in the six blocks of the Silkeborg Internet sample respectively the postal sample



7.2 Representativeness of the samples

Looking at table 7.3 and table 7.4, it is evident that none of the samples are entirely representative of the intended populations. The only variable that can be said to be representative is gender.

Table 7.3 Distribution of sociodemographic variables in the national samples

	National[50]	Sample %		
	%	E-mail	Effective	Trimmed
Gender		ns	ns	ns
Male	50.3	51.7	50.1	50.1
Female	49.7	48.3	49.9	49.9
Age		***	***	***
18 - 24	11.1	11.9	8.2	9.0
25 - 34	19.9	20.9	18.1	19.8
35 - 44	22.2	25.8	25.6	25.3
45 - 54	19.8	19.9	23.9	23.4
55 - 64	19.3	17.9	20.1	18.3
65 - 70	7.7	3.7	4.1	4.3
Household gross income (DKK)		***	***	***
‹ 150,000	14.6	7.0	5.6	6.5
150,000 - 299,999	28.1	18.5	18.4	17.8
300,000 - 499,999	22.1	31.1	30.8	29.8
› 500,000	35.2	43.5	45.2	46.0
Education		***	***	***
Primary school	32.1	7.8	5.6	4.8
Vocational	37.1	32.3	32.4	27.9
High school	7.4	4.7	3.8	4.7
Short academic (‹3 years)	4.8	13	13.3	12.3
Middle academic (3-4 years)	14.6	27.4	29.1	30.7
Long academic (›4 years)	4.0	14.8	15.9	19.0
Region		***	***	***
Jutland	45.0	40.8	41.6	40.9
Funen	8.8	8.4	7.4	7.3
Zealand	46.2	50.8	51.0	51.8

Note: All values are percentage values of the total sample/population excluding respondents who did not answer the given questions. Above each distribution of each sample, it is indicated whether or not the distribution in the sample is significantly different from that of the target population. A χ^2-test is employed on the basis of the actual numbers behind the percentages. (ns) indicates no significant difference, (*) indicates a significant difference on a 95% level, (**) indicates a significant difference on a 99% level, (***) indicates a significant difference on a 99.9% level.

[50] The national distributions are based on the following statistics from Statistics Denmark: FU2, HFU2, and BEF1A – all available from www.statistikbanken.dk.

Table 7.4 Distribution of sociodemographic variables in the Silkeborg samples

	Silkeborg area[51] %	Internet %			Postal %		
		E-mail	Effective	Trimmed	Postal	Effective	Trimmed
Gender		Ns	ns	ns	ns	ns	ns
Male	49.4	45.7	45.7	45.3	51.2	49.3	45.3
Female	50.6	54.3	54.3	54.7	48.8	50.7	54.7
Age		***	***	**	***	**	ns
18 - 24	10.8	8.0	5.5	6.5	8.2	7.6	10.1
25 - 34	19.7	20.3	17.6	18.9	13.3	13.5	17.6
35 - 44	22.5	32.4	34.0	34.3	21.0	23.9	24.3
45 - 54	20.5	22.4	24.7	23.1	22.8	24.5	26.4
55 - 64	19.2	14.6	15.4	14.2	20.7	19.4	14.9
65 - 70	7.2	2.3	2.9	3.0	14.0	11.0	6.8
Household gross income (DKK)		***	***	***		***	***
‹ 150,000	14.6	3.1	2.8	2.5		4.5	2.4
150,000 - 299,999	28.1	15.1	14.7	15.6		15.3	11.3
300,000 - 499,999	22.1	31.1	28.7	26.3		28.4	24.2
› 500,000	35.2	50.8	53.9	55.6		51.8	62.1
Education		***	***	***		***	***
Primary school	32.1	8.1	7.2	8.1		14.1	11.5
Vocational	37.1	32.3	31.6	23.0		35.0	25.0
High school	7.4	3.1	2.8	2.5		4.5	6.8
Short academic (‹3 years)	4.8	14.6	16.2	21.7		10.7	10.1
Middle academic (3-4 years)	14.6	30.7	30.9	29.8		25.4	29.7
Long academic (›4 years)	4.0	11.2	11.3	14.9		10.2	16.9

Note: All values are percentage values of the total sample/population excluding respondents who did not answer the given questions. Above each distribution of each sample, it is indicated whether or not the distribution in the sample is significantly different from that of the target population. A χ^2-test is employed on the basis of the actual numbers behind the percentages. (ns) indicates no significant difference, (*) indicates a significant difference on a 95% level, (**) indicates a significant difference on a 99% level, (***) indicates a significant difference on a 99.9% level.

7.2.1 Gender

In both the national sample and the two Silkeborg samples, there is no significant difference between the expected and the actual number of women and men in the sample.

7.2.2 Age

The distribution of age is significantly different from the expected in all of the samples. In the initial two e-mailed Internet samples (national and Silkeborg), the number of people over 54 years of age is less than expected. However, when comparing people in

[51] The Silkeborg distributions are identical to the 'Silkeborg & Gjern' distributions in table 6.2, even though the samples are different in that one is physically delimited by municipality borders and the other by post code borders. These borders are not exactly identical, but it was not possible to obtain a distribution based on post codes, so this minor inaccuracy was accepted.

the initially e-mailed samples to those actually responding, i.e. the effective samples, it seems that older people are more likely to answer the Internet questionnaire than younger people. Consequently, people under 35 years of age are underrepresented in the effective samples.

A striking difference between the initial e-mailed Internet sample and the postal sample in Silkeborg is the number of people over 54 years. As explained above, this group is heavily underrepresented in the Internet sample, but. in the initial postal sample. this group is heavily overrepresented. This is offset by a lower number of people aged 25 to 44. However, when looking at the trimmed postal sample, this misrepresentation has disappeared and the age distribution is actually representative of the population. This is caused by a lower rate of response and a higher rate of protest and irrational answers in the 54 and over age groups. Nevertheless, the trimmed postal sample is significantly different from the trimmed Internet sample, which is an important factor when comparing the results from the two modes of collection.

7.2.3 Household income

In both Internet samples, there is a clearly significant overrepresentation of people with a household income of 300,000 DKK or more. This tendency is intensified by the fact that these people are, apparently, more likely to answer than people with a lower household income. The tendencies are the same in the postal samples, and even though it seems that respondents in the trimmed postal samples are generally better off financially than respondents in the trimmed Internet samples, the difference is not significant.

7.2.4 Education

In the Internet samples, a misrepresentation in terms of too few people with short educational history is evident. This is offset by a much larger number of people with academic experience than expected. This is presumably correlated with the overrepresentation of high income households. The assumption is supported by the fact that people with a shorter educational history seem to be less likely to answer the questionnaire than people with a longer history. Furthermore, respondents with academic education tend to express a protest or irrational answer less than respondents with no academic experience.

In the postal samples, the proportion of respondents with no academic education is higher than in the Internet samples. Thus, the trimmed samples are significantly dif-

ferent. However, the postal distribution is still far from the expected with a large overrepresentation of academically educated respondents. As for the Internet samples, there is an evident tendency towards a higher rate of protest and irrational answers from the low education groups.

7.2.5 Region

Looking at the regional distribution of respondents in the national sample, a significant overrepresentation of people living on Zealand is apparent.

7.2.6 Summing up the analysis of representativeness

As in the case for the CVM samples, the CE samples' ability to represent the people of Denmark and the people living in the Silkeborg area is relatively poor. The proportion of older respondents is low in the Internet samples, whereas in the postal samples the age distribution is more representative.

The distribution of income is generally skewed towards the 'better off' end of the scale, and the educational distribution is skewed towards the 'academic' end of the scale. Furthermore, in the national samples, the proportion of respondents living in Zealand is higher than expected.

The samples' inability to represent the intended populations with regard to central sociodemographic variables calls for the inclusion of these variables in the subsequent modelling of the respondents' choices.

7.3 Modelling and estimation of WTP

A large number of different econometric models have been formulated over the years to analyse data based on discrete choices in a random utility framework, as presented in chapter 4, see for instance Maddala (1983) or Train (2003). In previous discrete choice studies in Denmark, binary or conditional logit models have been the most frequently used models in the analysis of preferences for environmental goods. Though the logit model is simple in its formulation and is relatively straightforward to use in practice, the model is limited by the restrictive assumption of proportional substitution across alternatives, also described as the IIA property in section 4.1.2.3.

7.3.1 The Independence of Irrelevant Alternatives

The IIA property and its consequences for the probabilities among the alternatives in the model were first discussed by Luce (1959). More specifically, IIA implies that the

ratio of choice probability between two alternatives is completely unaffected by the systematic utilities of other alternatives. In the present case, this means that the ratio of the probability of, for example, choosing the status quo option and alternative 1 is unaffected by the presence of alternative 2. More specifically, the axiom of IIA can be formulated as follows:

$$\frac{P_{ni}}{P_{nk}} = \frac{e^{V_{ni}} \Big/ \sum_j e^{V_{nj}}}{e^{V_{nk}} \Big/ \sum_j e^{V_{nj}}} = \frac{e^{V_{ni}}}{e^{V_{nk}}} = e^{V_{ni} - V_{nk}} \qquad (7.1)$$

Equation (7.1) illustrates that the ratio of choice probabilities only depends on *i* and *k*, even though a *j* alternative is present. In some respects, the IIA may seem reasonable. However, when the alternatives – or some of the alternatives – become close substitutes, implying that the respondent is more or less indifferent about the alternatives, the assumption of IIA is likely to be violated (Lareau & Rae 1989).

Following Brownstone & Train (1999), the IIA should be used when it reflects reality. However, the property only causes problems when individuals are faced with more than two alternatives in the choice sets (Freeman 2003; Train 1986), which is the case in this survey because of the inclusion of an opt-out alternative. It seems reasonable to assume that proportional substitution across alternatives is affected by the opt-out alternative because the opt-out alternative is very different from the two 'real' alternatives.

If IIA is violated, it implies that the logit model specification is inappropriate in the given context. Thus, violations of IIA imply that the introduction of new alternatives – or the exclusion of alternatives – would change the estimated model. Consequently, the estimated logit model cannot necessarily be used as a basis for making inferences to other situations. In this study, a test developed by Hausman & McFadden (1984) is used to test for violation of the IIA.

The test builds on the observation that if the logit model is correctly specified, parameter estimates from a model estimated on full choice sets should be consistent with parameter estimates from a model estimated on reduced choice sets. The test statistic, which tests the hypothesis that $\hat{\beta}_C = \hat{\beta}_{\tilde{C}}$, is given by Ben-Akiva & Lerman (1985):

$$\left(\hat{\beta}_{\tilde{C}} - \hat{\beta}_{C}\right)' \left(\Sigma_{\hat{\beta}_{\tilde{C}}} - \Sigma_{\hat{\beta}_{C}}\right)^{-1} \left(\hat{\beta}_{\tilde{C}} - \hat{\beta}_{C}\right) \qquad (7.2)$$

where $\hat{\beta}_{C}$ and $\hat{\beta}_{\tilde{C}}$ refer to the estimated coefficient vectors for the models estimated on the full, c, and the reduced, $\tilde{c}$, data sets respectively, and where $\Sigma_{\hat{\beta}_{C}}$ and $\Sigma_{\hat{\beta}_{\tilde{C}}}$ refer to the associated covariance matrices. The test statistic is asymptotically χ^2 distributed with $\tilde{K}$ degrees of freedom, where $\tilde{K}$ is equal to the dimension of $\hat{\beta}_{\tilde{C}}$. Basically, the test determines the extent to which the parameter estimates from the two models are the same (Hausman & McFadden 1984). If they are found to be approximately the same – i.e. if the hypothesis cannot be rejected – it is taken to indicate that the IIA assumption is not violated, and consequently, that the logit specification can be accepted. On the other hand, if the hypothesis is rejected, this indicates that the IIA assumption is violated, implying that another model specification should be used.

In this study, each respondent is presented with three alternatives, as described. The results of the IIA test across the 9 splits are presented in table 7.5.

Table 7.5 Test for violations of the IIA assumption

	Alternative added/removed			
	Alternative = Status quo* Pr<χ	Alternative = 1 Pr<χ	Alternative = 2 Pr<χ	Violation of IIA ?
Split 1	0.0002	0.1511	0.0024	YES
Split 2	0.0001	0.0520	0.1159	YES
Split 3	0.1636	0.0011	0.0275	YES
Split 4	0.0302	0.0153	0.0285	YES
Split 5	0.0859	0.0000	0.0164	YES
Split 6	0.4809	0.0602	0.6209	NO
Split 7	0.1354	0.0022	0.0000	YES
Split 8	0.4065	0.0804	0.5160	NO
Split 9	0.1201	0.0305	0.1045	YES

The result is that the IIA assumption is violated in splits 1-5 and splits 7 and 9. However, IIA is not violated in splits 6 and 8. Nevertheless, the test results in table 7.5 strongly indicate that a conditional logit model is not an appropriate model to use in the analysis of the discrete choice data in this study.

Violations of the IIA property have, as mentioned, been discussed since the late-1950s by Luce, and were, later on, proved to be a property of the logit model by McFadden (1974). Consequently, new types of logit models (Nested Logit, Mixed Logit) and other models (Multinomial Probit, HEV models) have been explored in an attempt to remedy the IIA problems of the logit model. It is not within the scope of this paper to discuss the pros and cons of the different models, or test the applicability of all the different models. For a more thorough presentation and discussion of the different models, see Greene (2003) and Train (2003).

With reference to the available literature, the sequences of choice assumed in the nested logit models (Train 1986) were assessed to be inappropriate in this choice experiment. The mixed logit and multinomial probit models have a relatively broad range of similar properties which eradicate the limitations of the logit model. Owing to its relatively less complex nature, the multinomial probit model has been chosen over the mixed logit model. The multinomial model is presented in the section below.

7.3.2 Multinomial Probit

The multinomial probit model (MNP) is an extension of the binary probit model (as applied in the CVM analyses), which can also handle multiple choice. The multinomial probit model allows for taste variations, the correlation of unobserved factors over time and, most importantly, relaxes the IIA property. The relaxation of the IIA property is brought about by the multinomial probit model's ability to allow for correlation between the error terms for the different choices (Alvarez & Nagler 1998).

This makes it a very attractive model. Train (2003) argues that the only limitation of the model is that all the unobserved components are assumed to have normal distribution. But, as mentioned above, there are some computational challenges as well. This is due to the fact that the choice probability is an integral with an open form, which has to be estimated through simulation.

The section below presents the theoretical properties of the model.

As in equation (4.5), it is assumed that the individual is confronted with a set of alternatives, but the number of alternatives is extended to include 3 alternatives (*i*, *j* and *k*). Following equation (4.7) the probability of choosing alternative *i* opposed to *j* and *k* is equal to:

$$P_{ni} = P(V_{ni} - V_{nj} > \varepsilon_{nj} - \varepsilon_{ni}, V_{ni} - V_{nk} > \varepsilon_{nk} - \varepsilon_{ni}) \qquad (7.3)$$

where ε_{ni}, ε_{nj} and ε_{nk} are assumed to have a trivariate normal distribution. Let $f(\varepsilon_{ni}, \varepsilon_{nj}, \varepsilon_{nk}) = f_n(\varepsilon)$, with a covariance matrix given by:

$$\Omega = \begin{bmatrix} \sigma_i^2 & \sigma_{ji}^2 & \sigma_{ik}^2 \\ \sigma_{ij}^2 & \sigma_j^2 & \sigma_{kj}^2 \\ \sigma_{ik}^2 & \sigma_{jk}^2 & \sigma_k^2 \end{bmatrix} \qquad (7.4)$$

Depending on the definition of the covariance matrix, the multinomial probit model will have different properties, (see Train 2003).

Based on equations (7.3) and (7.4), the probability of choosing alternative *i* is equal to:

$$P_{ni} = \int_{-\infty}^{\infty} \int_{-\infty}^{V_{nij}+\varepsilon_{ni}} \int_{-\infty}^{V_{nik}+\varepsilon_{ni}} f(\varepsilon_{ni}, \varepsilon_{nj}, \varepsilon_{nk}) d\varepsilon_{ni} d\varepsilon_{nj} d\varepsilon_{nk} \qquad (7.5)$$

where $V_{nij} = V_{ni} - V_{nj}$ and $V_{nik} = V_{ni} - V_{nk}$

The multinomial probit model is analysed in the statistical software package SAS by using the proc MDC procedure (SAS 2005). In proc MDC, the multinomial probit model is estimated using *simulations* of the trivariate distribution rather than solving the triple integral numerically, see Train (2003). The number of simulations can be specified in the program. By increasing the number of simulations, the specific distribution is described more accurately. But, the increase in precision has a cost, as the computation time similarly increases. In this study, 250 simulations are used per "choice" contained in the dataset.

The number of simulations was chosen by sequentially increasing the number of simulations and comparing the differences in the elicited models. In proc MDC, the multinomial probit model is fitted with regard to the definition of the structure of the covariance matrix. The structure is set by normalising with regard to one, two or all three variance elements in the covariance matrix (SAS 2005; Train 2003). In this study, different definitions of the covariance matrix were tested using the Likelihood Ratio Test.

In order to identify the most appropriate model specification, the test statistics for the main split (split 1) are presented in table 7.6.

The nomenclature used in equation (7.4) is adjusted to the choice sets used in this study, where the respondent is presented with a status quo alternative *(A-sq)* and the two other alternatives represent alternative motorway layouts *(A-1 and A-2)*. Table 7.6 tests whether a homoscedastic model (identical variance across the three alternatives ($\sigma^2_{A\text{-}sq} = \sigma^2_{A\text{-}1} = \sigma^2_{A\text{-}2}$)) is a better model compared to heteroscedastic models (heterogeneous variances across the three alternatives ($\sigma^2_{A\text{-}sq} = \sigma^2_{A\text{-}1} \neq \sigma^2_{A\text{-}2}$, $\sigma^2_{A\text{-}sq} = \sigma^2_{A\text{-}2} \neq \sigma^2_{A\text{-}1}$ and $\sigma^2_{A\text{-}1} = \sigma^2_{A\text{-}2} \neq \sigma^2_{A\text{-}sq}$)).

Table 7.6 Test of appropriateness of homoscedastic model versus heteroscedastic model

	Hypothesis on the structure of the covariance matrix			
	$\sigma^2_{A\text{-}sq} = \sigma^2_{A\text{-}1} = \sigma^2_{A\text{-}2}$	$\sigma^2_{A\text{-}sq} = \sigma^2_{A\text{-}1} \neq \sigma^2_{A\text{-}2}$	$\sigma^2_{A\text{-}sq} = \sigma^2_{A\text{-}2} \neq \sigma^2_{A\text{-}1}$	$\sigma^2_{A\text{-}1} = \sigma^2_{A\text{-}2} \neq \sigma^2_{A\text{-}sq}$
LL	-1659.26	-1652.89	-1659.12	-1650.94
DF	7	8	8	8
-2LL		12.75	0.29	16.66
Test (χ^2)		0.000356	0.592666	0.000045

Looking at the test statistics (chi-square distributed), the conclusion is quite clear. The models specifying identical variances for alternatives *A-sq* and *A-1* and *A-2* and *A-3* respectively are better models than the homoscedastic model, taking into account the higher degrees of freedom in the heteroscedastic models.

The hypothesis of homoscedasticity is consequently rejected. Of the two models, the latter model ($\sigma^2_{A\text{-}1} = \sigma^2_{A\text{-}2}$) has a superior fit. This strongly indicates that a model with identical variance of alternatives 1 (*A-1*) and 2 (*A-2*) is the best model for split 1. The tests presented in table 7.6 were also used in the analysis of the model specifications for the other splits. Across the splits, the conclusion is uniform; the heteroscedastic model with equal variance of alternatives 1 and 2 is the best model specification. From an intuitive point of view, this makes good sense.

The status quo alternative (*A-sq*) has zero cost and no improved protection of the different types of nature. Alternatives 2 and 3 represent generated alternatives. Both alternatives have a cost but also provide improved levels of protection of the different nature types. Given that the cost and protection levels are uncorrelated, due to the

design properties described in section 5.2.1.2, alternatives 1 and 2 must be perceived as close substitutes. From this point of view, it seems valid that the variances associated with two similar alternatives, which are close substitutes, are identical, and at the same time different from the variances of the less similar status quo alternative.

In the CE questionnaire, the respondents were asked to choose between substitute motorway construction plans with regard to the protection of forest, wetland and heath opposed to arable land. Based on the choice of the respondents and by applying the presented multinomial probit model, the preferences, and, hence, the WTP for the protection of different levels of the different nature types, can be estimated. This section presents the results of the multinomial probit regression for the data contained in split 1.

The analysis of the data is carried out in three steps. The first step includes a derivation of preferences and WTP estimates based only on the attributes of the alternatives – a main effect model. The second step entails subgroup analysis, assessment of heterogeneity in preferences within subgroups and estimation of WTP. The final step is a joint model, where the information obtained from the subgroup analysis is used to elicit a joint heterogeneous model.

7.3.3 Split 1 – The main effect model

The main effect model is solely estimated on the attributes of the alternatives evaluated by the respondents. As information regarding the characteristics of the respondents is not incorporated in the model, the model can be characterised as an average sample model. The model is presented in table 7.7 below.

Table 7.7 Parameter estimates and calculated WTP in split 1 – the main effects model

Parameter	Estimate	St. err.	P value	WTP
forest_min	1.1123	0.0964	‹0.0001	912
forest_med	0.5613	0.0728	‹0.0001	460
wetland_min	0.9548	0.0930	‹0.0001	783
wetland_med	0.5807	0.0840	‹0.0001	476
heath_min	0.4158	0.0780	‹0.0001	341
heath_med	0.0757	0.0729	0.2990	*62*
Price	-0.0012	0.0001	‹0.0001	
Std_1	1.7550	0.2065	‹0.0001	
N	1764			
Simulations	250			
LL(0)	1938.2			
LL(b)	1651.4			
Pseudo-R^2	0.148			

Note: Italicised WTP figures are non-significant at the 95% level. WTP figures are DKK per household per year.

The parameter estimates (coefficients) in the multinomial probit model in table 7.7 are all strongly significant (below 0.0001), excluding heath_med which is only significant on a 0.30 level. As explained, the variables representing the nature protection attributes are all dummy variables, that is, the coefficients represent the change in utility associated with the specified (_min or _med) protection level opposed to no protection at all. In this relation, it makes good theoretical sense that the nature protection attributes all are positive. Within each nature type (forest, wetland and heath), the numerical size of the parameter estimates are also as would be expected.

The variables representing the highest level of protection (_min), thus, have larger coefficients than the variables representing medium levels of protection (_med). This illustrates that, with all else being equal, the respondents prefer a high level of protection over a medium level or no protection. The price coefficient is negative, as would be expected. The estimated standard error for the status quo alternative (std_1) is significantly different from 0. The estimated covariance matrix in the model is, as presented, normalised with regard to the standard error of alternatives 1 and 2. Using the nomenclature from section 7.3.2, it can then be analysed whether the $\sigma_{A\text{-}sq}$ is significantly different from $\sigma_{A\text{-}1}$ and $\sigma_{A\text{-}2}$ by testing whether the coefficient of std_1 (the esti-

mate of $\sigma_{A\text{-}sq}$) in a two tailed t-test is significantly different from 1[52]. The t-test statistic is 3.656 which is significant on a 0.0005 level[53].

Returning to the coefficients of the main variables, the coefficients of the nature protection variables can be converted into WTP values by dividing them by the numerical value of the price coefficient, as explained in chapter 4. The WTP estimates are presented in the far right column. According to the model, the respondents in split 1 are willing to pay 912 DKK and 460 DKK for protecting 10 km of forest and 5 km of forest respectively from future motorway constructions. Similarly, the respondents are willing to pay 783 DKK and 476 DKK for protecting 5 km and 2.5 km of wetland respectively. Finally, the WTP for protecting 5 km and 2.5 km of heath is 342 DKK and 62 DKK respectively. However, as the coefficient of the heath_med is not significant, caution should be exercised when concluding a WTP of 62 DKK.

With reference to the WTP estimates, the internal rank of the nature types is presented in table 7.8.

Table 7.8 The implicit internal ranking of the three types of nature

Internal rank	WTP (DKK per household per year)	Nature type and protection level	Km of nature type protected	WTP (DKK per km per household per year)	Internal rank (WTP per km)
1	912	forest_min	10	91.2	4
2	783	wetland_min	5	156.6	2
3	476	wetland_med	2.5	190.4	1
4	460	forest_med	5	92.0	3
5	341	heath_min	5	68.2	5
6	*62*	heath_med	2.5	24.8	6

It is evident that the protection of 10 km of forest is ranked highest among the protection levels across the different types of nature. Protection of 5 km of wetland is clearly ranked second. However, protecting 2.5 km of wetland or 5 km of forest receives almost identical ranking, indicating that respondents are more or less indifferent to protecting 5 km of forest or 2.5 km of wetland.

[52] $\sigma_{A\text{-}sq} = \sigma_{A\text{-}sq\ (not\ normalised)} / \sigma_{A\text{-}1}=1$ if $\sigma_{A\text{-}sq} = \sigma_{A\text{-}1} = \sigma_{A\text{-}2}$

[53] The test statistics support the choice of covariance matrix, as the t-test is complementary to the rejection of the homoscedastic model ($\sigma_{A\text{-}sq} = \sigma_{A\text{-}1} = \sigma_{A\text{-}2}$) for the model chosen ($\sigma_{A\text{-}sq} \neq \sigma_{A\text{-}1} = \sigma_{A\text{-}2}$) using the likelihood ratio test.

The protection of heath is ranked the lowest, which suggests that the respondents find it more important to protect forest and wetland areas against the impact of motorway development than heath. However, in the interpretation of the WTP estimates and, hence, the internal ranking, it is important to look at the scale (km protected) of the protection levels, since the numerical amount of km protected in the three levels of protection is not identical across the different types of nature.

This difference in dimension makes it difficult to draw inferences with regard to the internal ranking of nature types based on preferences for the specific protection levels. This can be circumvented by expressing the preferences in unit values. One way to do this is to divide the estimated WTP values for the different levels by the number of km protected in each case and, thus, obtain estimates of WTP per km. For a similar approach, see Ladenburg *et al.* (2005). This is calculated in table 7.8. Depending on the WTP per km, the internal rank changes. These unit values imply that respondents find it more important to protect 2.5 km of wetland, opposed to 5 km of wetland, 5 km forest, 10 km of forest, 5 km of heath and 2.5 km of heath. In other words, if respondents are given the choice to protect only one km of nature, they would, according to the internal rank based on WTP per km, choose to protect wetland.

The rank based on WTP per km furthermore illustrates the economic concept of *diminishing marginal utility*. This means that the more an individual has of a good, the less worth that individual attaches to an extra unit of the good (Gravelle & Rees 1992).

More specifically, the rank shows that the first km of the nature type protected (_med) ranks higher than the subsequent km (_min). In other words, it is more important for the respondent to protect the first km of, for example, forest than the sixth km.

However, as will be discussed in chapter 9, it is questionable whether the respondents actually evaluate the levels of protection on a qualitative scale (no protection, medium protection or maximum protection) instead of the intended quantitative scale (0, 1, 2, ...,10 km protected). In the case of the former, the presented conversion of WTP into WTP per km must be deemed problematic.

7.3.4 Subgroup analysis of split 1

The previous section presented the main effects model representing the average preferences of the sample. Preferences are, however, seldom identical across individuals. Some respondents may have very strong preferences for protecting forests as opposed

to wetland, and vice versa. Such heterogeneity in preferences is not captured in the main model.

In this section, the respondents' preferences for protecting nature in split 1 is analysed with the aim of identifying heterogeneity in preferences in the sample. The perfect model in this relation would be a specific model for each individual. However, neither the design of alternatives nor the number of observations per individual permits such a model(s). The analysis of heterogeneity in preferences is, therefore, analysed by dividing the respondents into subgroups and subsequently estimating a model for each subgroup. By comparing the elicited models to the elements, potential heterogeneity can be assessed. The different subgroups are defined by the sociodemographic categories; gender, education, income, age and geographical affiliation.

To keep the analysis simple, only the WTP, together with information relating to the significance of the coefficients defining the WTP, the number of observations and the fit of the models are presented. The information on the fit of the models and the number of respondents will only be addressed when they appear to be markedly different within the subgroups. It should also be noted that the number of respondents in some of the subgroups is small, causing coefficients and, hence, WTP to be more frequently insignificant compared to the main effects model based on the entire split.

7.3.4.1 Gender

Previous surveys in Denmark using choice modelling methods have shown that preferences for environmental goods are significantly different between men and women, see for example Ladenburg & Martinsen (2004), Olsen & Lundhede (2005), Hasler *et al.* (2005), Lundhede *et al.* (2005) and Ladenburg *et al.* (2005). Although not completely uniformly determined, women commonly have stronger preferences for environmental goods than men.

Table 7.9 Differences across gender

Gender	Forest _min	Forest _med	Wetland _min	Wetland _med	Heath _min	Heath _med	N	Pseudo-R^2
Male	839	362	678	449	381	*41*	846	0.14
Female	972	548	869	495	287	*78*	918	0.16

Note: Italicised values indicate non-significance at the 95% level. WTP figures are DKK per household per year.

As illustrated in table 7.9, the preferences for protecting nature across gender are relatively identical. Female respondents seem to have stronger preferences for protecting forest areas, as the WTP for both forest protection levels are higher than for male respondents. Similarly, the WTP for protecting wetland areas is higher for female respondents. Men, on the other hand, show stronger preferences for protecting heath areas. The differences in the WTP estimates are, however, relatively small and insignificant.

7.3.4.2 Education

Like gender, the education level of the respondents has in previous choice modelling studies proved to be a significant determinant of heterogeneity in preferences. In Ladenburg & Martinsen (2004), respondents with a higher education level are willing to pay a higher price premium for eco-labelled wood products than people with a lower level of education.

Similarly, Lundhede & Olsen (2005) find that respondents with a higher education level in general have stronger preferences for forests characteristics than less educated respondents. However, the effect of education might not be as simple, as presented in the two samples. In Fardan *et al.* (2005), the preferences for increasing biodiversity in Lake Fure, located north of Copenhagen, was negatively correlated with the education level among swimmers, but was an insignificant choice among anglers and boat users. table 7.10 presents the subgroup analysis across education.

Table 7.10 Differences across education level

Education	Forest _min	Forest _med	Wetland _min	Wetland _med	Heath _min	Heath _med	N	Pseudo-R^2
Low	767	551	652	540	395	194	528	0.17
Medium	837	*142*	885	471	*130*	*51*	318	0.15
High	1070	565	928	446	464	*62*	756	0.15

Note: Italicised values indicate non-significance at the 95% level. WTP figures are DKK per household per year.

It appears that preferences vary across education levels with regard to the variables controlling the maximum protection of nature (Forest_min, Wetland_min and Heath_min). The WTP, thus, seems to increase as a function of the level of education. However, the trend is not uniform for the other variables. It is, consequently, difficult to say whether or not respondents with a higher level of education have stronger preferences for protecting forest and wetland. It can, however, be concluded that prefer-

ences for protecting maximum levels of forest and wetland seem to be an increasing function of the level of education.

7.3.4.3 Household income

The alternatives in the choice sets all include a price attribute. The price is an important attribute, as the coefficient of the price attribute is used to estimate the WTP for the other attributes. The price attribute represents the price that the household must pay for the chosen alternative. The disposable income of the respondent's household is, therefore, expected to have an influence on which alternative the respondent chooses. All else being equal, respondents with a lower income are expected to have a smaller amount available for consumption than respondents with a higher income.

The probability, with all else equal, of choosing an alternative with a high price might, therefore, be smaller for low income respondents than high income respondents. As a direct consequence, the coefficients representing the price variable are expected to be numerically higher for low income respondents than for high income respondents. This means that the estimated WTP values are higher for high income respondents than low income respondents, see for example Olsen & Lundhede (2005)[54].

Table 7.11 Differences across household gross income groups

Household income	Forest _min	Forest _med	Wetland _min	Wetland _med	Heath _min	Heath _med	N	Pseudo-R^2
0 - 149,999	1268	*224*	1047	537	359	*-148*	114	0.33
150,000 - 299,999	771	532	596	477	*297*	*213*	294	0.13
300,000 - 499,999	848	403	1093	560	429	*-3*	498	0.14
500,000 or more	978	536	646	440	330	*59*	720	0.15

Note: Italicised values indicate non-significance at the 95% level. WTP figures are DKK per household per year.

Assuming that the income level of households only affects the price attribute and not the protection attributes, the preferences in table 7.11 across income groups do not seem to follow a systematic path[55]. It is, however, noticeable that the respondents with the lowest income have a high WTP for protecting different nature types compared

[54] This income-price relationship may, however, depend on the price of the good. In Ladenburg & Martinsen (2004), the price coefficient and, hence, the WTP for eco-labelled wood products depends only on the income of the respondent for the most expensive type of wood product (table tops). The price parameter was unaffected by income in the case of toilet paper and cutting boards.

[55] Heterogeneity in price coefficients was also tested by defining a dummy for each income level. A new income specific price variable was then created by multiplying the dummies by the price coefficients. The income specific dummies did not have the theoretical expected properties.

to the higher income groups. The property is especially clear in the case of protecting the maximum amount of forest (Forest_min) and, to a certain extent, the protection of wetland (Wetland_min and Wetland_med).

In this case, it is worth mentioning that the fit of the model based on the lowest income group is as high as 0.33. This indicates that this group has more homogenous preferences than the other income groups.

7.3.4.4 Age

The age of the respondents is expected to have a potential influence on the choice in a number of ways, as preferences change with age.

In a study on preferences for wind power development in Denmark, see Ladenburg (2005), the preferences were found to be a function of age, with older respondents being more negative towards wind power development. However, in that specific example, the age effect was only identified in one dimension (preferences for future wind power development).

In choice modelling methods, preferences are typically measured in several dimensions (multiple substitute attributes). Differences in preferences across age in choice modelling studies might, therefore, be less straightforward than in the previous example.

In a CE study on preferences for protecting heath areas, preferences for protecting biodiversity in two dimensions (key species of butterflies and plants, also associated with the protection of the heath) was negatively correlated with age, whereas preferences for the price coefficient was positively correlated (Boiesen *et al.* 2005).

Table 7.12 Differences across age groups

Age	Forest _min	Forest _med	Wetland _min	Wetland _med	Heath _min	Heath _med	N	Pseudo-R^2
18-34	1063	444	571	253	339	*71*	492	0.20
35-54	947	469	884	541	349	*72*	882	0.14
55-70	614	461	802	651	324	*70*	390	0.14

Note: Italicised values indicate non-significance at the 95% level. WTP figures are DKK per household per year.

The preferences across age groups in table 7.12 seem to vary systematically across the age groups. The preferences for protecting the maximum level of forest appear to be a decreasing function of the age of the respondent. Younger respondents, accordingly, have stronger preferences for protecting as much forest as possible (Forest_min) than older respondents. Conversely, the preferences for protecting wetland increase with age. In conclusion, the respondents appear to substitute the protection of forest increasingly with the protection of wetland the older the respondents are.

As discussed in Ladenburg (2005), the essential question in this relation is, however, whether observed differences in attitude are age or generation dependent. That is, do preferences change in favour of the protection of wetlands as respondents become older or are the preferences fixed within each generation. In the case of the latter, the use of the WTP should, if possible, be adjusted in line with the development of the sociodemographic change in the representation of different generations. In the case of the former, the adjustment is most easily limited to the change in age distribution.

7.3.4.5 Geographical regions

Various studies have shown that the geographical affiliation of respondents[56] might help explain the respondents' choices. In a contingent ranking study on preferences for forest characteristics, respondents living in Jutland had significantly stronger preferences for increasing the regenerated forest area with conifers as opposed to respondents living on the islands (Aakerlund 2000). Similar preference structures (conifers vs. broadleaves) were found in Olsen & Lundhede (2005). In the two examples, the preferences for coniferous forest are most probably best explained by differences in the geographical representation of deciduous and coniferous forest. Even though this study elicits preferences on a larger scale, the preferences could, similarly, be expected to vary with regard to the representation of the different types of nature (forest, wetland, heath and arable land).

Table 7.13 Differences across geographical regions

Region	Forest _min	Forest _med	Wetland _min	Wetland _med	Heath _min	Heath _med	N	Pseudo-R^2
Zealand	819	400	796	464	338	*57*	1020	0.17
Funen	1276	658	*540*	*440*	736	524	78	0.18
Jutland	1112	601	834	531	348	*42*	666	0.13

Note: Italicised values indicate non-significance at the 95% level. WTP figures are DKK per household per year.

[56] Geographical affiliation is determined by the physical home address of the respondent.

According to table 7.13, respondents living in Jutland or on Funen seem to have stronger preferences for protecting forest areas than respondents living on Zealand. In the same respect, respondents on Funen have very strong preferences for protecting heath areas compared to respondents from Jutland or Zealand.

However, the Funen subgroup contains only 78 observations, hence the estimated coefficients must be interpreted cautiously.

7.3.4.6 Joint model

Based on the subgroup analysis, a joint model is produced to test for the significance of the observed differences in preference. Although the subgroup analysis points towards a relatively large level of heterogeneity, the joint model contains less heterogeneity than expected. Although some of the subgroup effects are significant individually, the variance of the subgroup variables increases with the introduction of age related variables. The final model is presented below.

Table 7.14 Joint model based on the subgroup analysis

Parameter	Estimate	St. err.	P value	WTP
forest_min	3.6037	0.6828	‹0.0001	2923
forest_min_ln(age)	-0.6705	0.1813	0.0002	-544
forest_med	0.5638	0.0729	‹0.0001	457
wetland_min_ln(age)	0.2550	0.0248	‹0.0001	207
wetland_med_ln(age)	0.1600	0.0225	‹0.0001	123
heath_min	0.4196	0.0781	‹0.0001	340
heath_med	0.0792	0.0732	0.2789	*64*
price	-0.0012	0.0001	‹0.0001	
Std_1	1.7504	0.2045	‹0.0001	
N	1764			
Simulations	250			
LL(0)	1938.2			
LL(b)	1642.8			
Pseudo-R^2	0.150			

Note: Italicised values indicate non-significance at the 95% level. WTP figures are DKK per household per year.

In the joint model in table 7.14, only the age of the respondent appeared to be a significant determinant of choice when the different sources of heterogeneity observed in the subgroup analysis were tested.

The age variables have been included by interacting them (ln-transformed) with the forest_min, wetland_min and wetland_med attributes. The preferences and, hence, the WTP estimates, therefore, become a nonlinear function of the respondents' age. Starting with the forest protection attributes, the forest_min variable represents the overall utility (grand mean) of protecting 10 km of forest. The forest_min_ln(age) is the age specific adjustment to the grand mean. The coefficient is negative, which denotes that the utility of protecting 10 km of forest is a decreasing nonlinear function of age.

Across the age distribution, the WTP for protecting 10 km of forest varies from 1,350 DKK (age=18) to 612 DKK (age=70) per household per year. The WTP for protecting 5 km of forest is found to vary insignificantly among the subgroups. The WTP in the model is 457 DKK. The preferences for protecting wetlands are only represented by the two wetland_ln(age) variables. Both coefficients are positive, indicating an increase in the utility related to protecting wetlands as a function of age. The WTP across the 18 – 70 age distribution is 598 – 879 DKK and 375 – 551 DKK for protecting 5 km and 2.5 km of wetland respectively. The WTP for protecting heath varies significantly within the subgroups. The WTP is, therefore, fixed at 340 DKK for protecting 5 km of heath. The coefficient for protecting 2.5 km opposed to 0 km is not significantly different from zero.

Subgroup analyses similar to the above have been performed for the remaining 8 splits. The results in terms of WTP estimates from the remaining subgroup analyses are shown in Appendix 8. However, it is considered to be too extensive to comment on all these analyses, and the results of these do not vary widely from the above findings, so further descriptions of subgroup analyses on splits 2 to 9 have been disregarded. Instead, the following analyses of the remaining splits concentrate on main effect models.

7.3.5 Split 2 – Non-use values

By informing respondents that the 100 kilometre stretch of motorway would *not* affect the specific areas of nature used by the individual respondents, split 2 was intended to assess only non-use values. The parameter estimates and resulting WTP estimates from the main effects multinomial probit model applied to the data from split 2 are shown in table 7.15 below.

Table 7.15 Parameter estimates and calculated WTP in split 2

Parameter	Estimate	St. err.	P value	WTP
forest_min	0.9316	0.0813	‹0.0001	587
forest_med	0.5118	0.0666	‹0.0001	322
wetland_min	0.7051	0.0804	‹0.0001	444
wetland_med	0.4313	0.0766	‹0.0001	272
heath_min	0.2861	0.0732	‹0.0001	180
heath_med	0.1624	0.0696	0.0196	102
price	-0.0016	0.0000	‹0.0001	
Std_1	1.3579	0.1723	‹0.0001	
N	1806			
Simulations	250			
LL(0)	1984.3			
LL(b)	1689.5			
Pseudo-R^2	0.149			

Note: Italicised values indicate non-significance at the 95% level. WTP figures are DKK per household per year.

Compared to the WTP estimates in split 1, split 2 clearly generates lower WTP estimates. This finding was anticipated, as economic theory would prescribe non-use values alone to be lower than the same non-use values plus additional use values. At a glance, WTP for heath_med seems to be higher in split 2, but as this attribute is not significant in split 1, such a conclusion cannot be drawn. The preference ordering of the attributes and of the internal levels of attributes is roughly the same in splits 1 and 2.

The WTP for each attribute in split 2 suggests that approximately 60% of the total value elicited in split 1 can be ascribed to non-use values. This would further imply that use values account for 40% of the total value in split 1. However, as will be discussed in chapter 9, this might be giving too much interpretation to the results.

7.3.6 Split 3 – Anchoring and sequencing

By reversing the sequence of attributes, split 3 was designed to test for possible sequencing effects internally in each choice set, the hypothesis being that the preference ordering of attributes might be influenced by the listing sequence of attributes. Consequentially, reversing the sequence would also reverse the preference ordering. Furthermore, the choice set example presented in the scenario was given a lower set of prices to test the hypothesis that these prices might anchor stated WTP. If so, this would cause lower WTP estimates in split 3 than in split 1. In all other aspects, split 3 was identical to split 1.

Table 7.16 Parameter estimates and calculated WTP in split 3

Parameter	Estimate	St. err.	P value	WTP
forest_min	0.9506	0.0928	‹0.0001	684
forest_med	0.5044	0.0714	‹0.0001	363
wetland_min	0.6626	0.0852	‹0.0001	477
wetland_med	0.4536	0.0785	‹0.0001	327
heath_min	0.2373	0.0745	0.0014	171
heath_med	0.0980	0.0710	0.1675	*71*
price	-0.0014	0.0001	‹0.0001	
Std_1	1.2846	0.1869	‹0.0001	
N	1710			
Simulations	250			
LL(0)	1879.0			
LL(b)	1584.5			
Pseudo-R^2	0.157			

Note: Italicised values indicate non-significance at the 95% level. WTP figures are DKK per household per year.

Table 7.16 shows the results of the main effects model applied to split 3.
Clearly, the preference ordering has not changed compared to split 1, and the hypothesis that an internal sequence effect exists can be rejected. The forest attributes still receive higher WTP estimates than the wetland attributes and the heath attributes respectively.

The level of the WTP estimates strongly indicates that an anchoring effect exists, as all WTP estimates in table 7.16 are lower than the corresponding estimates in split 1. In other words, estimated WTP depends on the level of prices introduced before the actual choice sets. The lower the prices in the choice set example, the lower the stated WTP.

The fact than an anchoring effect is established, speaks in favour of using an introductory choice set example in CE in general. If no example is used, the preference function underlying respondent choice in the first choice set will be different from that of the subsequent choice sets. This is similar to anchoring effects established in DC CVM (Herriges & Shogren 1996; Kahneman *et al.* 1982; Mitchell & Carson 1989). This poses a problem in relation to estimation of WTP, as it is normally assumed in the modelling procedure that the preference structure is constant within each respondent's choices. By incorporating an example, which is not included in estimations, it is likely that the preference function is more stable throughout the respondent's choices, thus leading

to more precise estimates. This, however, requires the recognition that the estimates *are* indeed anchored by the example. Further, this result underlines the importance of conducting focusgroups and pilot-tests to determine the best possible bid levels, and it is advisable to conduct split-samples in CE surveys in order to achieve a clearer picture of the influence of the anchoring effect on the WTP estimates.

7.3.7 Split 4 – Embedding

Split 4 was designed to verify the existence or not of a possible embedding bias in terms of respondents not contemplating the actual amount of kilometres of motorway in a rational way.

In CVM, it has been shown that respondents sometimes exhibit the same WTP for different amounts of the same good. As mentioned in chapter 2, CE claims to avoid such embedding problems. In accordance with rational choice theory, analysis of the preceding splits shows that protecting nature from intrusion from a larger stretch of motorway is associated with higher WTP estimates than when protecting nature from a smaller stretch.

This supports the theoretical background in terms of an increasing utility function. However, this only proves that the relationship exists locally within each split. In theory, the increasing utility function also exists globally between splits. In which case, split 4 allows the function to be tested. All attribute levels, except price, are set at 40% of the number of kilometres in split 1. Assuming the same underlying implicit demand function exists in the two splits, respondents in split 4 should generally choose cheaper alternatives than respondents in split 1, resulting in WTP estimates being approximately 40% of that in split 1. As table 7.17 reveals, this is, however, not the case.

Table 7.17 Parameter estimates and calculated WTP in split 4

Parameter	Estimate	St. err.	P value	WTP
forest_min	1.2632	0.0927	‹0.0001	1191
forest_med	0.7481	0.0740	‹0.0001	705
wetland_min	0.8537	0.0882	‹0.0001	805
wetland_med	0.4788	0.0801	‹0.0001	451
heath_min	0.3601	0.0765	‹0.0001	339
heath_med	0.2663	0.0733	0.0003	251
price	-0.0011	0.0001	‹0.0001	
Std_1	1.4982	0.1703	‹0.0001	
N	1680			
Simulations	250			
LL(0)	1845.8			
LL(b)	1537.1			
Pseudo-R^2	0.167			

Note: Italicised values indicate non-significance at the 95% level. WTP figures are DKK per household per year.

Instead, it is shown that WTP estimates regarding the forest attribute are a lot higher than in split 1, and the remaining WTP estimates occupy the same level as in split 1.

There are a few probable explanations for this disturbing result. Split 3 reveals the existence of an anchoring effect caused by the applied price levels in the choice set example. As the price levels employed in the choice set example in split 4 are the same as in split 1, this might anchor the WTP estimates towards the same WTP levels in split 1.

Furthermore, consideration of the self-reported degree of importance that respondents attached to each of the attributes when making their choices in the choice sets (question 22) reveals a tendency for respondents in split 4 to attach more importance to the nature attributes in general and less importance to the price attribute than respondents in split 1. This, however, does not account for the very high WTP estimates for the protection of forest.

Another possible explanation is that respondents do not contemplate attribute levels as intended, namely as a quantitative continuous scale (1 km - 2 km -...- 10 km), but rather as qualitative categories ('good' – 'ok' – 'bad'). If this is the case, it would not make any difference to respondents whether, numerically, 4 or 10 kilometres of forest are protected, as long as it is the best possible level of protection.

Nevertheless, this does not explain the high forest WTP. One explanation could lie in the sociodemographic background of respondents in the two splits. In split 4, a larger proportion of respondents live in Funen and Jutland than in split 1. As the subgroup analysis in section 7.3.4 revealed, people living in these parts of the country show higher WTP for the protection of forest than people living in Zealand. Combining these findings provides a possible explanation for the high WTP for the protection of forest in split 4. Another reason could be that respondents in split 4 use forests more than respondents in split 1. However, a closer look at the answers to the questions regarding the respondent's use of forests (questions 1 and 2) reveals no such differences.

7.3.8 Split 5 – Non-use values plus reminder concerning annual payments

The basic idea with split 5 was to test the hypothesis that respondents, when choosing and thus stating a WTP, forget the fact that the price they are accepting for the chosen alternative is an annual payment and not just a one-off payment. A reminder concerning the annual payment was incorporated in the scenario. Otherwise, the questionnaire was identical to split 2. If WTP estimates in split 5 turn out to be lower than in split 2, this would indicate that respondents in split 2 had not fully perceived the price as an annual payment.

Table 7.18 Parameter estimates and calculated WTP in split 5

Parameter	Estimate	St. err.	P value	WTP
forest_min	0.9297	0.0803	‹0.0001	627
forest_med	0.5698	0.0701	‹0.0001	384
wetland_min	0.6312	0.0767	‹0.0001	426
wetland_med	0.2168	0.0731	0.0030	146
heath_min	0.1424	0.0723	0.0489	96
heath_med	0.0644	0.0678	0.3424	*43*
price	-0.0015	0.0001	‹0.0001	
Std_1	1.5449	0.2010	‹0.0001	
N	1872			
Simulations	250			
LL(0)	2056.8			
LL(b)	1787.4			
Pseudo-R^2	0.131			

Note: Italicised values indicate non-significance at the 95% level. WTP figures are DKK per household per year.

As table 7.18 shows, estimated WTP values in split 5 are not much different from split 2. Thus, it seems that respondents need *not* be reminded that they are dealing with an annual payment.

7.3.9 Split 6 (and 8) – Use values in Silkeborg based on Internet and postal samples

Splits 6 and 8 were intended to show whether or not respondents living in the Silkeborg area, actually affected by an ongoing motorway planning process, would exhibit preferences different from those of the national sample in split 1. It was expected *a priori* that people living in Silkeborg would state a higher WTP for protecting the areas of nature that they use from being encroached on by a new motorway, as they have been facing that exact threat for more than a decade. However, with reference to Ladenburg *et al.* (2005), the difference in preferences between local and national samples could be negative as well as positive.

Furthermore, splits 6 and 8 are intended to highlight possible sampling effects caused by the two different methods of sampling: Internet and postal. Theoretically speaking, no sampling effect should be present, and WTP estimates in the two splits should match as the questionnaires used are exactly identical.

Table 7.19 Parameter estimates and calculated WTP in split 6 (Internet sample)

Parameter	Estimate	St. err.	P value	WTP
forest_min	0.9782	0.1645	‹0.0001	720
forest_med	0.5809	0.1416	‹0.0001	428
wetland_min	0.6950	0.1499	‹0.0001	512
wetland_med	0.4468	0.1539	0.0037	329
heath_min	0.2676	0.1470	0.0687	*197*
heath_med	0.0265	0.1351	0.8446	*20*
Price	-0.0014	0.0002	‹0.0001	
Std_1	1.6297	0.4044	‹0.0001	
N	528			
Simulations	250			
LL(0)	580.2			
LL(b)	491.3			
Pseudo-R^2	0.153			

Note: Italicised values indicate non-significance at the 95% level. WTP figures are DKK per household per year.

WTP estimates from split 6, presented in table 7.19, are generally lower than in split 1. Contrary to expectation, this means that respondents living in the Silkeborg area have a lower WTP for protecting areas of nature from the encroachment by a new motorway than respondents in the national sample.

One explanation, partially supported by findings from the CVM analysis, could be that people in Silkeborg have been going through a long and complicated process in which

the negative and positive consequences of the motorway have been considered and discussed in public. Thus, respondents in the Silkeborg sample might be more familiar with the dilemma concerning the trade-off between the negative effects on nature and recreation and the negative effects on their own property or place of residence. A good number of respondents in the CVM samples commented that in an ideal world they would choose the Ringvej layout in order to protect the Gudenå valley from the Resendal layout.

However, they have had to compromise their ideals and moral standards and choose the Resendal layout, as the negative consequences of the Ringvej layout affected them too much in terms of, for instance, the expected noise where they live and their concern for property values. Thus, when asked to consider a generic stretch of new motorway affecting areas of nature that they use, it seems quite feasible that respondents in Silkeborg had the Resendal and Ringvej layouts in mind when answering the choice sets. This would explain the lower WTP estimates.

Another possible explanation could be differences in sociodemographic variables between the Silkeborg and the national sample. However, a closer look at the background variables reveals no big difference between the two splits.

Table 7.20 Parameter estimates and calculated WTP in split 8 (postal sample)

Parameter	Estimate	St. err.	P value	WTP
forest_min	1.2877	0.2284	‹0.0001	825
forest_med	0.8276	0.1708	‹0.0001	531
wetland_min	0.8296	0.2146	0.0001	532
wetland_med	0.5882	0.1809	0.0011	377
heath_min	0.2396	0.1724	0.1645	*154*
heath_med	0.4616	0.1810	0.0108	296
Price	-0.0016	0.0002	‹0.0001	
Std_1	2.1040	0.5311	‹0.0001	
N	406			
Simulations	250			
LL(0)	446.1			
LL(b)	376.4			
Pseudo-R^2	0.156			

Note: Italicised values indicate non-significance at the 95% level. WTP figures are DKK per household per year.

In comparing split 8 in table 7.20 to split 6, it seems that posting questionnaires yields WTP estimates slightly higher than using the Internet. Some of this difference

might be explained by differences in background variables. Split 8 has a much larger share of women in the sample than split 6, and as found in the subgroup analysis in section 7.3.4, women tend to elicit a larger WTP than men.

7.3.10 Split 7 (and 9) – Non-use values in Silkeborg based on Internet and postal samples

Splits 7 and 9 have the same purposes as splits 6 and 8, but were designed to be compared to split 2 in terms of non-use values only.

Table 7.21 Parameter estimates and calculated WTP in split 7 (Internet sample)

Parameter	Estimate	St. err.	P value	WTP
forest_min	1.5852	0.2038	‹0.0001	1137
forest_med	0.9315	0.1512	‹0.0001	668
wetland_min	1.1493	0.1981	‹0.0001	824
wetland_med	0.3315	0.1542	0.0315	238
heath_min	0.5978	0.1536	‹0.0001	429
heath_med	0.4278	0.1565	0.0063	307
Price	-0.0014	0.0002	‹0.0001	
Std_1	2.7348	0.4646	‹0.0001	
N	492			
Simulations	250			
LL(0)	544.6			
LL(b)	450.2			
Pseudo-R^2	0.173			

Note: Italicised values indicate non-significance at the 95% level. WTP figures are DKK per household per year.

Compared to split 2, WTP estimates from split 7 in table 7.21 are strikingly much higher. It does not make much sense that respondents in Silkeborg should have much higher non-use values than the national sample, and it is disturbing to note that the WTP estimates concerning only non-use values are higher than estimates covering both use and non-use values in split 6. A plausible explanation of this irregularity could be that asking respondents to imagine not being affected by the new stretch of motorway, when in reality they are affected, is too difficult a cognitive task for respondents to handle rationally.

Table 7.22 Parameter estimates and calculated WTP in split 9 (postal sample)

Parameter	Estimate	St. err.	P value	WTP
forest_min	1.0261	0.1667	‹0.0001	676
forest_med	0.8179	0.1537	‹0.0001	538
wetland_min	0.6867	0.1604	‹0.0001	452
wetland_med	0.3852	0.1532	0.0119	254
heath_min	0.4567	0.1571	0.0036	301
heath_med	0.1693	0.1509	0.2620	*111*
Price	-0.0015	0.0002	‹0.0001	
Std_1	2.2318	0.4758	‹0.0001	
N	480			
Simulations	250			
LL(0)	527.4			
LL(b)	455.1			
Pseudo-R^2	0.137			

Note: Italicised values indicate non-significance at the 95% level. WTP figures are DKK per household per year.

Looking at the results for split 9 in table 7.22, the picture is somewhat improved as WTP estimates are lower. Nevertheless, the estimates are not markedly lower than splits 6 and 8, as would be expected. All in all, it seems that respondents living in the Silkeborg area are not completely capable of imagining a scenario where they are not affected by the new stretch of motorway.

This result is quite interesting, as it indicates that, generally, it might be problematic to elicit existence value estimates from samples that are directly involved in a political process similar to this case.

7.4 Summary of WTP estimation based on the CE

As has been shown, the assumption of independency of irrelevant alternatives is largely violated in the CE data. To relax this assumption, a multinomial probit model is employed in the modelling and estimation of WTP.

Examining whether preferences differ within particular subgroups of the sample reveals that women tend to have a greater WTP than men; the higher the level of education the higher the WTP, whereas the level of income did not reveal the expected clear positive correlation with WTP. Furthermore, it is suggested that younger people have stronger preferences for the protection of forest than older people, whereas older people have stronger preferences for the protection of wetland than younger people. Finally, the subgroup analysis indicates that people living in Jutland or Funen have a

higher WTP than people living in Zealand, especially when considering the protection of forests.

The various splits examined in the CE study all produce different WTP estimates, ranging from 100 DKK to 1,100 DKK depending on the specific attribute, level and split. However, the splits all have one thing in common. The preference ordering is the same in all splits. The forest attribute is preferred over the wetland attribute, which, in turn, is preferred over the heath attribute. Converting the attribute levels to unit values (pr km) changes the picture somewhat; wetlands are now preferred over forest, and heath is still the least preferred. However, the conversion to unit values might be questionable, as an embedding effect seems evident.

Non-use values are estimated to account for approximately 60% of the total value, and respondents apparently bear in mind that they are asked to evaluate an annual payment and not just a one-off payment. The existence of an anchoring effect is confirmed in that a low set of prices initially introduced to respondents leads to a low WTP and vice versa. The existence of a sequencing effect with regard to the sequence of attributes is, however, rejected.

Results also show that people living in Silkeborg, who are affected by an ongoing motorway planning process, exhibit a lower WTP for protecting nature from encroachment by a new motorway than people not currently directly affected. However, it should be borne in mind that the problem concerning the Silkeborg motorway involves a lot of other issues besides the nature protection issue, such as the development of the city, alongside noise, pollution and property value issues, i.e. the NIMBY paradox. Furthermore, it is established that asking respondents to evaluate a hypothetical scenario, which is highly unrealistic to them, is a waste of resources.

Finally, the analyses revealed no large differences in preferences and WTP when comparing Internet sampling and ordinary postal sampling. Both sampling procedures show problems in their ability to represent the intended target population.

8 Layout for the Silkeborg motorway

In this section, the WTP estimates from the CVM and CE analyses described in the previous chapter are used to calculate the welfare economic difference in terms of loss of nature between the Resendal and Ringvej layouts. This is done in order to assess which layout should be preferred from a welfare economic point of view

8.1 Applying the CVM estimates

In table 8.1, the welfare economic value of choosing one layout over the other is calculated on the basis of the estimated WTP values from the non-parametric analysis of the open ended CVM.

Table 8.1 Calculation of the capitalised difference between the two layouts based on a non-parametric analysis of OE answers

	Layout	
	Resendal	Ringvej
Preferred by	79.5%	20.5%
Total number of households preferring layout	22,194	5,707
Estimated mean WTP/household/year (DKK)	1,318	1,428
Total aggregated WTP/year (DKK)	29,251,662	8,149,628
Capitalised WTP at 6% discount rate (DKK)	487,527,701	135,827,141
Difference: (Resendal – Ringvej) (DKK)	351,700,560	

Note: The total number of households in the municipalities of Silkeborg and Gjern is 27,901 (Danmarks Statistik 2005d)

A discount rate of 6% is applied to the calculations. This is the discount rate recommended by the Danish Ministry of Finance. For further discussion concerning the level of the discount rate, see Kjellingbro (2005).

The calculations suggest that, from a strictly welfare economic point of view, the Resendal layout is the superior layout with a capitalised value more than 350 million DKK larger than that of the Ringvej layout.

However, several other estimates of mean WTP were deduced in the previous sections. As these estimates are different from each other, inserting them in the above calculations might yield a different result and possibly change the overall conclusion concerning the superiority of the Resendal layout. To establish whether or not this is the case,

calculations identical to those performed in table 8.1 are carried out, and the results presented in table 8.2. Additionally, to check for sensitivity towards the choice of a 6% discount rate, the calculations are also performed using discount rates at 3% and 9% respectively.

Table 8.2 Difference between the two layouts based on the different mean WTP estimations (mill. DKK)

	Total WTP/year		Difference in capitalised value		
Based on WTP estimates from	Resendal	Ringvej	at 3%	at 6%	at 9%
Open Ended					
Non-parametric	29.3	8.1	703.4	351.7	234.5
Non-parametric – spike at 5000 DKK	23.1	6.3	559.4	279.7	186.5
Non-parametric – nature & recreation	14.3	6.4	265.1	132.5	88.4
Tobit model	15.6	8.3	244.2	122.1	81.4
Double Bounded Dichotomous Choice					
Non-parametric – conservative bids	18.5	5.4	436.2	218.1	145.4
Non-parametric – OE Follow-up	28.5	7.2	710.2	355.1	236.7
ML model	66.8	15.6	1,706.9	853.4	569.0
ML model – spike at 5000 DKK	29.0	8.7	675.7	337.8	225.2
ML model – spike at OE Follow-up	17.5	5.2	410.1	205.1	136.7
ML model – nature and recreation	32.4	13.3	635.6	317.7	211.8
ML model – spike OE + nature/recr.	9.9	3.8	204.4	102.2	68.1

None of the calculations changes the general conclusion that the Resendal layout is the superior layout, all else being equal. Even at a 9% discount rate, realising the Resendal layout instead of the Ringvej layout will yield a welfare economic profit of at least 68 million DKK according to the calculations.

It is interesting to note that the superiority of the Resendal layout is markedly weakened when using the WTP estimates attributed solely to concerns for nature and recreation. Nevertheless, it does not change the overall picture.

The calculated differences based on the ML model seem extremely high due to the above-mentioned problem of the 'missing' upper limit in the model. Categorising this as an outlier, table 8.2 strongly suggests that the welfare economic profit of realising the Resendal layout instead of the Ringvej layout will be between 100 and 350 million DKK applying a discount rate of 6%.

The above calculations are based on mean WTP values. Employing median WTP values instead does not change the picture significantly. The differences are generally slightly

smaller (60 to 320 million DKK at 6%), although the Resendal layout is still superior in all calculations.

8.2 Applying the CE estimates

Another approach to evaluating the two layouts is to utilise the results concerning a generic motorway from the CE study. This is done by converting the WTP estimates from the CE analysis to unit values, in this case 'WTP per kilometre', and transferring these unit values to the actual layouts proposed for the Silkeborg motorway. The resulting analysis of differences between the consequences of the two layouts, seen from a welfare economic point of view, is presented in table 8.3.

Table 8.3 Calculation of capitalised difference between the two layouts based on the transfer of 'WTP per km' estimates from split 1 in the CE study

	Metres through nature		WTP per km	Capitalised value of nature (mill. DKK)		
	Resendal	Ringvej	per year	Resendal	Ringvej	Difference (Rin – Res)
Marsh	560	720	157	40.7	52.4	11.7
Meadow	420	270	157	30.6	19.7	-10.9
Common pasture	260	300	68	8.2	9.5	1.3
Heath	70	380	68	2.2	12.1	9.8
Lake	620	590	157	45.1	43.0	-2.2
Woodland	3,800	4,900	91	161.2	207.8	46.7
Total	30,346	28,396		288.1	344.4	56.3

Note: The calculation of 'Metres through nature' is described in Appendix 1. 'WTP per km per year' is based on the minimum influence level WTP estimates from split 1 in the CE analysis. Marsh, meadow and lake are assigned the unit value deducted from the wetland_min attribute estimate; common pasture and heath are assigned the unit value from the heath_min attribute; and woodland is assigned the unit value from the forest_min attribute. The capitalised values are based on a total of 27,901 households in the municipalities of Silkeborg and Gjern, and a 6% discount rate.

The analysis shows that realising the Ringvej layout will have the highest welfare economic costs in terms of the value of nature affected, all things being equal. The capitalised value of the areas of nature encroached by the Ringvej layout is calculated to be close to 345 million DKK, whereas the corresponding calculated cost of the Resendal layout is some 56 million DKK lower. This suggests that the Resendal layout is the more favourable of the two layouts.

This analysis can be further extended by employing results from split 2 concerning non-use values. It is assumed that the relevant population, when considering non-use values connected with the two layouts, is the Danish population less the people in the municipalities of Silkeborg and Gjern. table 8.4 shows the results of this analysis.

Table 8.4 Calculation of the capitalised difference between the two layouts based on the transfer of 'WTP per km' estimates from split 2 in the CE study

	Metres through nature		WTP per km	Capitalised value of nature (mill. DKK)		
	Resendal	Ringvej	per year	Resendal	Ringvej	Difference (Rin – Res)
Marsh	560	720	89	2047.7	2632.8	585.1
Meadow	420	270	89	1535.8	987.3	-548.5
Common pasture	260	300	36	385.4	444.7	59.3
Heath	70	380	36	103.8	563.3	459.6
Lake	620	590	89	2267.1	2157.4	-109.7
Woodland	3,800	4,900	59	9185.3	11844.2	2658.9
Total	30,346	28,396		15525.2	18629.8	3104.6

Note: Calculations are based on a population of 2.47 million households.

Again, the Ringvej layout represents the largest value of nature, and the Resendal layout should be preferred, all else being equal. The actual numbers seem extremely high, and it could be argued that it is not realistic to suggest that every household in Denmark would attach non-use values to the area in question. This will be discussed further in chapter 9.

The calculation of unit values is somewhat simplified in the above analysis, and there is an argument for other approaches to this calculation. However, the chosen approach yields a quite conservative unit value, making the above calculated differences between the two layouts conservative estimates of the true values. An even more conservative approach would be to utilise split 3 instead of split 1 in table 8.3. Split 3 yielded lower WTP estimates due to the revealed anchoring effect. However, employing this approach does not change the general conclusion reached above; the Resendal layout still exhibits the lowest 'nature' value, but now at only 40 million DKK less than the Ringvej layout. Furthermore, raising the discount rate to 9% lowers the difference to about 25 million DKK.

In actual terms, using this benefit transfer approach favours realisation of the Resendal layout, whichever unit values are employed. This is due to the fact that this approach solely considers the cut-through length in each type of nature area, and the Ringvej layout passes through a lot more forest and heath than is the case with the Resendal layout. The only type of nature affected more by the Resendal layout is wetland. However, the difference between the two layouts regarding metres through wetland is no more than 20 metres. For this small difference to change the conclusion, the WTP estimates per km through wetland would have to be extremely much higher than the estimates of WTP per km through forest and heath.

However, benefit transfer does not take into account the fact that the Ringvej layout passes through 7 kilometres of residential area, whereas the Resendal layout entirely avoids such areas. Instead, it passes through 10 kilometres more arable land than the Ringvej layout.

Furthermore, the above approach does not take into account the fact that areas affected by the Ringvej layout are already to some extent affected by the existing ring road. It could be argued that the unit estimates from the CE analysis are not suitable for transfer to the Ringvej layout, as these estimates are based on a scenario considering a new motorway, whereas the Ringvej layout represents an upgrade of a main road to a motorway. It seems logical that the loss of nature associated with upgrading a road is less than when building a new road. In other words, using the CE estimates on the Ringvej layout is likely to overestimate the value of the loss of nature to a much larger extent than when using the estimates for the Resendal layout. Adopting this point of view, it seems quite possible that the superiority of the Resendal layout in the above analysis is not as unambiguous. In other words, the recommendation of the Resendal layout based on benefit transfer from the CE study should not be taken entirely at face value.

8.3 Summary

Employing estimates of WTP identified in the analysis of the CVM and CE data, and comparing the resulting welfare economic calculations, yields an answer to the question of which layout should be chosen for the Silkeborg motorway, when focusing on the value of nature from a welfare economic perspective. The Resendal layout is clearly the preferred layout, as this layout will minimise the welfare economic cost to society in terms of loss of nature. Depending on the method of calculation, the Resendal layout outperforms the Ringvej layout by a total value of at least 25 million DKK (the most conservative estimate) up to several hundred million DKK. In other words, choosing the Resendal layout gives a saving of at least 25 million DKK.

9 Discussion

The following chapter discusses the results of the preceding analysis. Results from the CVM are discussed firstly, followed by a discussion of the CE results and then, finally, the recommendations concerning the Silkeborg motorway based on the two methods are considered.

9.1 Results from the CVM study

Chapter 6 introduces a series of different WTP estimates. As mentioned previously, it is hard to determine which estimate is best, i.e. closest to the true WTP. However, chapter 8 showed that no matter which of the WTP estimates is used, the Resendal layout was superior in all cases with regard to aggregate WTP, and it would be tempting to conclude the study on this basis. Nevertheless, in order to validate the results, it is worth examining the extent to which these findings conform to previous comparable studies.

9.1.1 Open ended versus dichotomous choice

The WTP estimates generated by the DBDC analysis are generally somewhat higher than estimates from the OE analysis. This disparity is disturbing in that both approaches are, theoretically, based on approximately the same underlying preference function and, thus, the WTP estimates ought to be similar.

However, it is a common problem in valuation studies employing both OE and DC formats that the OE format consistently generates lower WTP estimates than the DC format. Brown *et al.* (1996) list eleven different CVM studies, each comprising both OE and DC formats. In all of these studies, the DC format yields WTP estimates that are between 1.12 to 4.78 times greater than the OE format. Four possible explanations for the consistent difference between WTP estimates from the two formats are presented below:

1. The DC format avoids providing incentives for the respondents to overstate or understate their true WTP, whereas the OE format only avoids incentives for overstatement and not understatement (Cameron 1988; Hoehn & Randall 1987). Looking at the number of protest bidders identified in this study, the above tendency seems obvious in that the OE format receives almost double the number of protest bids as the DBDC format. However, protesters are re-

moved in the analysed samples, so this explanation does not seem valid for the differences in WTP in this study.

2. The DC format is easier to answer as it avoids the difficult cognitive task of stating a precise maximum WTP amount (Mitchell & Carson 1989). If respondents find it very difficult to determine their precise maximum WTP in an OE question, the easy way out is to express a zero bid, even though they might have positive preferences for the good in question. Alternatively, respondents might simplify the task by adopting a conservative strategy, expressing a very low bid which might be a lot lower than the true maximum WTP.

   In this study, the existence of such a tendency cannot be ascertained. The number of zero bidders stating that their zero bid was due to the difficulty of the questions is very low in both formats. In addition, looking at the respondents' degree of certainty when stating their bids, reveals no differences in the two formats. Considering the respondents' knowledge of, and long time experience of, the motorway planning process in Silkeborg, it seems likely that the OE question is actually not a very hard cognitive task. Thus, the cognitive burden seems an unlikely explanation of the differences in WTP in this study.

3. If respondents are uncertain about their preferences they might find it difficult to state a precise estimate of maximum WTP. Instead, they might have a range or interval of plausible maximum WTP which they know they either exceed or fall under. But, within the boundaries of the range, they are not sure what they would pay (Gregory *et al.* 1995). In this context, the DC format is more likely to push respondents towards the upper end of the range of maximum WTP, whereas the OE allows respondents to state a bid amount with which they are more comfortable, probably closer to the midpoint of the range than to the upper limit. This seems to be a viable explanation of the differences in this study, especially when considering that about 20% of the respondents are not certain as to whether they would pay the stated WTP in reality.

4. The DC format does not necessarily allow respondents to express how favourable they view the good in question. If the bid level presented is higher than the true WTP, some respondents might feel obliged to answer 'yes' in

order to express a favourable impression of the good. The resulting WTP is not the WTP for the actual good in question but, instead, the respondents' WTP for moral satisfaction, also known as 'warm glow' bias (Kahneman & Knetsch 1992; Nunes & Schokkaert 2003). This phenomenon might very well explain some of the difference between the two formats in this study, especially with regard to the respondents in the DBDC sample which received the high end bid sets.

Having considered some reasons for the gap between WTP estimated in the two formats, the next question is, which of the two formats yields the WTP closest to the true WTP?

It has long been recognised that a hypothetical bias exists in non-market valuation. Hypothetical bias is when people misstate their actual preferences for a good when asked a hypothetical question. In a meta-analysis of a series of studies on stated WTP versus actual WTP, List & Gallet (2001) find an evident tendency for people to overstate their actual WTP in hypothetical situations. The magnitude of overstatement varies widely between studies with the average factor being 3.

Combining this with the fact that the OE format generates the lowest estimates of WTP would logically lead to the conclusion that the OE format yields WTP estimates closer to the true WTP than the DC format. However, Harrison & Rutström (2005) conduct a meta-analysis similar to that of List & Gallet and conclude that it is *not* possible to generalise as to which of the OE and DC formats is most flawed by hypothetical bias.

So there seems to be no clear answer to the question posed above. However, a conservative approach would favour the WTP estimates from the OE sample, as OE estimates are generally lower than DC estimates (Brown *et al.* 1996). Also, the OE format has an advantage in its simplicity. Respondents are asked directly about their maximum WTP and no assumptions have to be made when analysing it non-parametrically. This creates an appealing transparency in the estimated WTP values.

Furthermore, it would seem relevant from a conservative point of view to make use of the WTP estimates which are adjusted for the self-reported share of WTP attributed to protection of nature and recreational opportunities. Even though this adjustment entails a considerable amount of uncertainty due to the cognitive difficulty of the question, they are the only WTP estimates in the CVM study which, with some reservations

concerning the mentioned uncertainty, can be said to express only values related to nature.

9.1.2 Comparison with similar studies

As mentioned in chapter 3, the number of studies with similar focus is very limited. In a single bounded dichotomous choice CVM study Werneman (1997) deals with a new, 6 kilometre long road through "Fågelsången", which is a green area with recreational and environmental values located about 20 km north of Stockholm, Sweden. Werneman finds an average WTP of approximately 700 SEK[57] (~ 710 DKK[58]) per person per year in 20 years to have the road placed in a tunnel instead of above ground. This results in a total capitalised value of 460 million SEK (~ 465 million DKK in 2005 figures)[59] to avoid the road above ground. Even though this case in certain respects is different from the Silkeborg motorway, both regarding the evaluated scenario and the background of the respondents, it serves as grounds for comparison.

In the Silkeborg study, WTP per household was used and the estimated WTP, depending on the approach and preferred layout, ranged from 450 to 3200 DKK per household per year. Assuming an average of two persons in each household, Werneman's study yields a WTP of approximately 1,420 DKK for the tunnel solution, which is well within the range mentioned above. Werneman obtains a total capitalised value of 465 million DKK which is slightly higher than the corresponding capitalised value of realising the Resendal layout instead of the Ringvej layout, ranging from 100 to 350 million DKK.

This is probably due to the fact that, in Werneman's study, the adverse effects on nature is (supposedly) completely avoided by placing the road in a tunnel, whereas in this study, nature will be affected negatively, whichever layout is chosen. A further explanation can be found in the size of the population represented in the calculations. In Werneman's study, the population is almost double the size of the population in this study, thus raising the total value. Another difference is the extent to which issues of noise, traffic congestion and division of the city influence the WTP estimates. As established in chapter 6, these issues are quite prominent in this study, but it has not been possible to assess the influence of such issues in Werneman's study.

[57] Swedish Crowns.
[58] This figure is calculated on the basis of an exchange rate of 1 SEK ~ 0.87 DKK (in 1997) and then corrected for inflation from 1997 to 2005.
[59] Employing a 6% discount rate and a total population of 54400 people in the area.

Another related study is performed by Bamber & Khoury (1999). They use single bounded dichotomous CVM to estimate the values attached to the landscape affected by the Newbury bypass road in England. They estimate a mean WTP in the range of £4.42 to £6.69 per household per month for ten months per year over a five-year period. This equals a yearly WTP per household of £44.2 to £66.9, which, converted and corrected for inflation, equals an approximate range of 500 DKK to 750 DKK.

This is a bit lower than the range estimated in this survey, especially when considering the five-year payment period as opposed to the perpetual payment in this study. The source is rather uninformative about the scenario employed, so possible causes for this difference will not be investigated further. Bamber and Khoury continue calculating a range of total capitalised values from 110 to 175 million DKK for preserving the Newbury landscape[60]. This range is covered by the interval estimated in this study, mainly due to a much larger population in the Bamber & Khoury study.

The overall impression, when comparing with the two related studies presented above, is that the findings of this study are much in line with these studies. It is, however, not possible to determine whether or not this is actually due to similar preferences or simply due to coincidences.

9.1.3 Adjusting WTP according to follow-up questions

The estimated WTP values obviously cover more than just preferences for protecting the different areas of nature even though this was the primary aim of the study. This problem was realised prior to the collection of data in the focus group testing procedure. As an experiment, a follow-up question was incorporated in the questionnaire to try to clarify this problem; respondents were simply asked to consider the proportion of their stated WTP which they could actually ascribe solely to their preferences regarding nature. This information was then used to adjust the stated WTP of each individual respondent.

The approach seemed to work in the sense that estimates of mean WTP were reduced markedly by 30 to 50% depending on the specific layout chosen. However, these reduced estimates should be used with caution as the question must be recognised as cognitively very demanding. This is underlined by the fact that nearly 20% of the re-

[60] Using an 8% discount rate which was common practice in England in 1999.

spondents answered 'don't know' to this question. Furthermore, looking even closer at the answers to this question, there is a clear tendency to choose categorical levels such as '0%', '50%' or '100%'. This can be interpreted as a way of simplifying a very difficult cognitive task (Bateman *et al.* 1995). In other words, it is uncertain as to what extent this question actually reveals the true part of stated WTP ascribed to the protection of nature.

In the DBDC study, an open ended maximum WTP question was incorporated as a follow-up to the DBDC questions. This approach was inspired by Bateman *et al.* (1995), who introduced this as a sort of bidding game. The idea was to combine the advantages of OE and DC, i.e. elements of respondent control from the OE and elements of minimised uncertainty from the DC. However, at the same time, the imperfections of both approaches are combined, so the expected outcome is quite uncertain. In this study, anchoring of the OE follow-up in the preceding DC bids is found, when comparing to the regular open ended split sample. This is in accordance with the findings of Bateman *et al.* (1995). The applicability of the OE follow-up in terms of either a sort of independent OE in itself or a personalised upper truncation to be utilised in modelling and estimation of the DC would thus seem questionable However, as section 6.4.3 demonstrated, the underlying structure and determinants of preferences did not change considerably when the anchoring variable was introduced, which speaks in favour of the applicability of the OE follow-up bid.

Another question following up on the actual valuation questions, concerns the respondent's degree of experienced certainty when answering the valuation questions (question 16 in OE version). Respondents can be uncertain of their preferences due to their random determinants or due to the difficulty of the cognitive task.

The certainty follow-up question, in line with the recommendations of the NOAA panel (Arrow *et al.* 1993), allows for a conservative *calibration of WTP for self-reported certainty*. If the respondents are not sure that they would pay the stated WTP in reality, then, from a conservative point of view, the stated WTP cannot for sure be interpreted as an indicator of the true WTP, and stated WTP should, thus, be recoded to a zero bid in OE, or a 'yes' answer should be recoded as a 'no' answer in DC (Alberini *et al.* 2003; Li & Mattsson 1995; Samnaliev *et al.* 2005).

In table 9.1, the OE sample is recoded, resulting in slightly lower mean WTP estimates based on a non-parametric analysis. This tendency has also been identified in previ-

ous Danish valuation studies (Boiesen *et al.* 2005; Hasler *et al.* 2005; Ladenburg *et al.* 2005; Ladenburg & Martinsen 2004; Olsen & Lundhede 2005).

Table 9.1 Non-parametric analysis of OE CVM. Uncertain bids are recoded as zero bids

Layout	Respondents choosing layout	Mean WTP (DKK)	Median WTP (DKK)	95% CL for mean (DKK)
Resendal	385	1222	500	891 – 1553
Ringvej	99	1387	500	809 – 1965

Note: The WTP figures are per household per year.

Similar adjustments could be carried out in the remaining CVM analysis, but this has been omitted, as this would be quite extensive and it is strongly expected to show similar tendencies of lower WTP estimates when adjusting for uncertain respondents. Even though adjusting for uncertainty is in line with the NOAA panel's recommendations concerning conservative estimates, it does not necessarily mean that this approach yields estimates closer to the true WTP. On the contrary, interpreting an uncertain answer as the respondent actually saying 'I don't want to pay anything at all' is very questionable (Wang 1997).

9.2 Results from the CE study

In the CE study, focus is moved to the national level, where a generic motorway project is considered. The estimated values concern the following types of nature; forests, wetlands and heaths.

A series of different experimental splits were performed in the CE study. The following discussed the main results from split 1 as well as the results of these experiments.

9.2.1 Comparison with other Danish valuation studies

The types of nature valued in this CE study have, to a certain extent, been dealt with in previous Danish valuation studies. Table 9.2 provides a list of some of these related studies.

Table 9.2 Previous Danish valuation studies concerning forest, wetland and heath

Study	Type of nature	WTP	Valuation method
Dubgaard (1998)	Forest: Access to all Danish forests	128 DKK per person per year	CVM
Bjørner *et al.* (2000)	Forest: Access to Tokkekøb Hegn	233 – 261 DKK per household per year	CVM
Hansen (2005)	Wetland: Protection or restoration of, and access to, river valleys	1382 DKK per household per year (best possible alternative	CE
Boiesen *et al.* (2005)	Heath: Protecting more heath and moor	300 – 700 DKK per household per year	CE and CVM
Dubgaard (1996)	Forest, heath and wetland: Access to the Mols Bjerge area	44 – 71 DKK per person per year	CVM
Lundhede *et al.* (2005)	Wetland: Restoration of, and access to, Store Åmose	614 DKK per person per year (maximum restoration and access)	CE

None of the above-mentioned studies is directly comparable to this CE study, as different approaches have been employed. None of the previous studies has employed a scenario which focuses on the effect of a new motorway through countryside. Furthermore, all but one of the studies focuses solely on one single type of nature. Dubgaard (1996) implicitly deals with several types of nature in that the Mols Bjerge area covers a range of different types of nature. However, due to the fact that a CVM is employed, it is the area as such that is valued and not the different types of nature individually.

The previously mentioned tendency of WTP estimates from CE to be larger than estimates from CVM appear to be shown in table 9.2. This also seems to be the case when drawing a comparison to the estimates in this CE study. Dubgaard (1998) and Bjørner *et al.* (2000) (and to some extent Dubgaard (1996)) employ CVM to valuate access to forests. Although the WTP estimates from these surveys have not been adjusted for inflation, it is quite evident that they are lower than the estimated WTP at 460 to 912 DKK for protecting forest in split 1.

Whether this difference is due to the different methods of evaluation or the fact that the mentioned studies focus primarily on use values in terms of access to the forest or, more likely, a combination of these reasons, is not possible to determine for certain. However, a relatively large estimated share of the total value is attributed to non-use values in this study. This supports the assumption that the inclusion of non-use values in this study explains a significant part of the difference in WTP estimates.

Hansen's (2005) estimate of WTP to protect a generic river valley is more directly comparable to the wetland attribute in this study. The estimated WTP of 783 DKK to protect wetland from the new motorway is only just under half of the estimated WTP in Hansen (2005). Two plausible explanations for this difference emerge.

Firstly, Hansen's respondents only valuate wetland whereas, in this study, respondents valuate wetland in conjunction with forest and heath. Secondly, Hansen's scenario includes restoration, which is not considered in this study.

Equivalently, the same considerations apply to a similar study performed by Lundhede *et al.* (2005). Consequently, the lower WTP estimated in this study seems reasonable considering these differences. However, it could be argued that the sheer fact that, in this study, the areas of nature are threatened by encroachment of a very intrusive motorway might induce higher WTP than in the mentioned studies, where the scenarios do not involve as drastic a disturbance to nature.

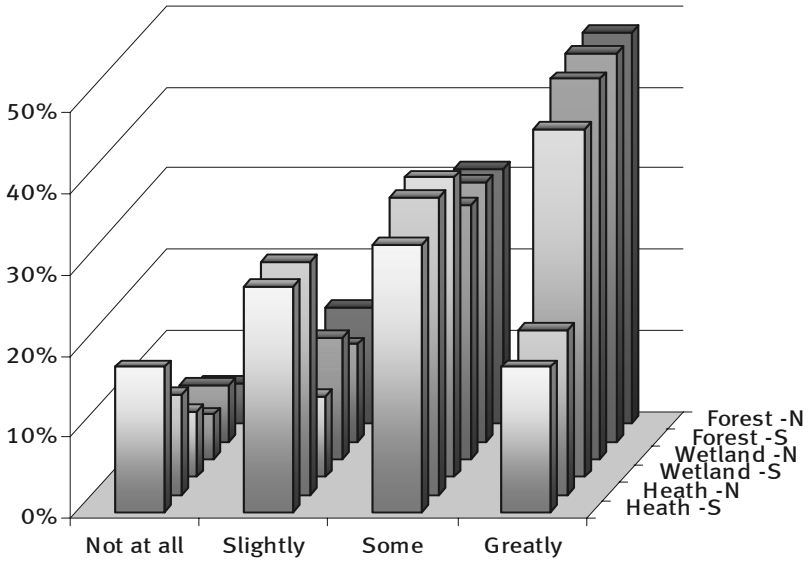
The estimated WTP for protecting heath at 341 DKK in table 7.7 seems reasonable when comparing to Boiesen *et al.*'s (2005) estimated 300 to 700 DKK. 341 DKK is in the lower end of this interval, which can be expected according to the argument applied to this study above, which looks at three types of nature simultaneously.

Ranking preferences for forest, wetland and heath based on the studies mentioned in table 9.2 suggests that wetland is preferred over heath which, in turn, is preferred over forest. This approach to ranking different types of nature is, however, very questionable in that the studies are not directly comparable. The present study provides a more viable ranking of the three types of nature as respondents value all three types of nature at the same time.

This ranking does prove to be different from the above. Heath is clearly the least preferred. Whether forest or wetland is the most preferred depends on the interpretation of the results. Looking at the attributes in the intended way, namely as quantitative variables, and converting estimated WTP to 'per km' estimates, shows wetland to be the most preferred. As briefly mentioned in chapter 7, it is, however, far from certain that respondents have actually perceived the attributes as a quantitative continuous scale and not a qualitative categorical scale.

Without a follow-up question aimed directly at exploring this matter, question 22 may serve as a clue towards providing an answer to this problem. In question 22, respondents are asked to state the general influence of each of the attributes on their choices in the choice sets. The answers to these questions ought to reflect the respondents' preference ranking with respect to the attributes. The answers are shown in figure 9.1.

Figure 9.1 Percentage distribution of answers to question 22: "To what degree did the attributes influence your choices from the various alternatives?"



Note: N denotes the national samples and S denotes the Silkeborg samples

The figure depicting the self-reported importance of the three types of environment underlying respondents' choices in the choice sets reveals that forest and wetland are almost equally important whereas heath is obviously less preferred. Differences between the national and the Silkeborg samples are minimal. This finding does not directly support the appropriateness of converting attribute levels to 'per km' values as the ranking based on 'per km' estimates clearly favours wetland over forest. The ranking based on WTP estimates at attribute level reflects the tendency in figure 9.1 to a larger extent, in that forest is only slightly preferred over wetland. Thus, it appears that the conversion to 'per km' values is indeed questionable.

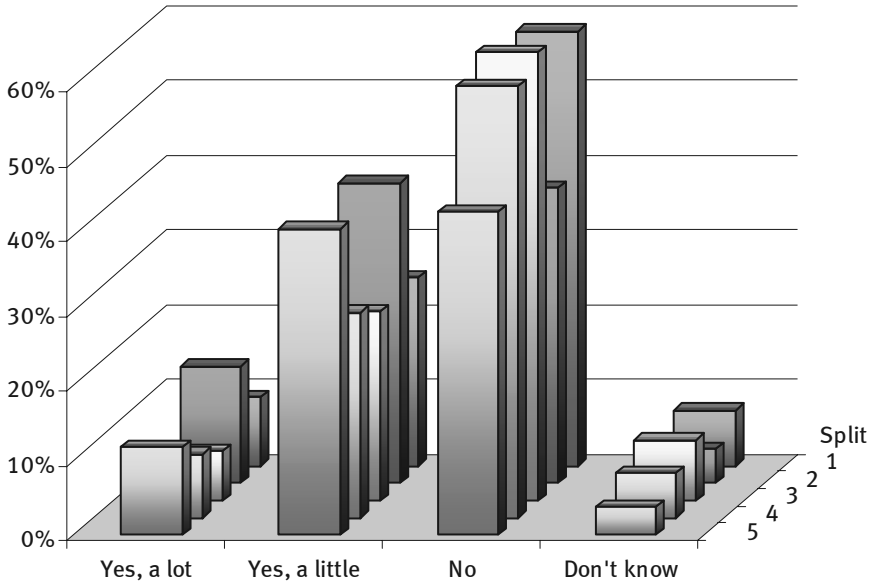
9.2.2 Use versus non-use values

Results from split 1 and split 2 indicate that non-use values account for approximately 60% of the total value. However, such an interpretation of non-use values associated with protecting forest, wetland and heath from motorway encroachment, warrants

some caution. Having answered the six CE questions, respondents in splits 1, 3 and 4, faced with a total value scenario, were asked if they believed that their WTP would change if instead they had been faced with only a non-use value scenario as specified in split 2.

Likewise, respondents in splits 2 and 5 were asked the opposite question. According to economic theory, the rational respondent would answer 'yes' to this question. However, as figure 9.2 shows, this is not the case in this study.

Figure 9.2 Percentage distribution of answers to question 21: "Would your WTP have been higher (lower) if instead you were asked to imagine that the new motorways *would* (would *not*) affect the areas that you use?"



Note: The Silkeborg splits show the same tendencies but are left out to simplify the graphical illustration.

As shown, on average half of the respondents state that they would not change their stated WTP if they had been evaluating the opposite type of scenario. If this is true, then deducing a 60% non-use value out of the total value on the basis of splits 1 and 2 is problematic. However, there is some evidence that respondents are not entirely truthful in their answers to question 21.

Firstly, the fact that there is a distinct difference between WTP in splits 1 and 2, suggests that most respondents *do* make a distinction between non-use and total values. However, this could be due solely to the roughly 45% in figure 9.2 stating a positive

answer. Secondly, it is particularly interesting to note that a striking difference between the non-use splits (2 and 5) and the total value splits (1, 3 and 4) is evident in figure 9.2. In the total value splits, about 60% answer no, whereas it is only 40% in the non-use value splits. This is probably due to psychological effects such as moral satisfaction, positive self-image and ethical righteousness (Johansson-Stenman & Svedsäter 2003).

In the total value splits, respondents are actually asked if they would pay less if they were not directly affected themselves. From a moral point of view, some respondents might find it hard to answer 'yes' to this question as it can be seen as a very selfish statement when you know that the motorway will instead affect somebody else. This type of altruistic behaviour has previously been recognised in environmental economics (Johansson 1992; Johansson-Stenman 1997).

In the non-use value splits, the question is less morally challenging as respondents are asked if they would pay more if they were more directly affected. This situation is not associated with other people being worse off, which explains the lower part of 'no' answers. However, 40% of the respondents in splits 2 and 5 still answer 'no', which poses a more serious problem. The correct theoretical interpretation of such a statement would be that the respondents gain no utility from 'using' the good in question; hence they will not use it at all.

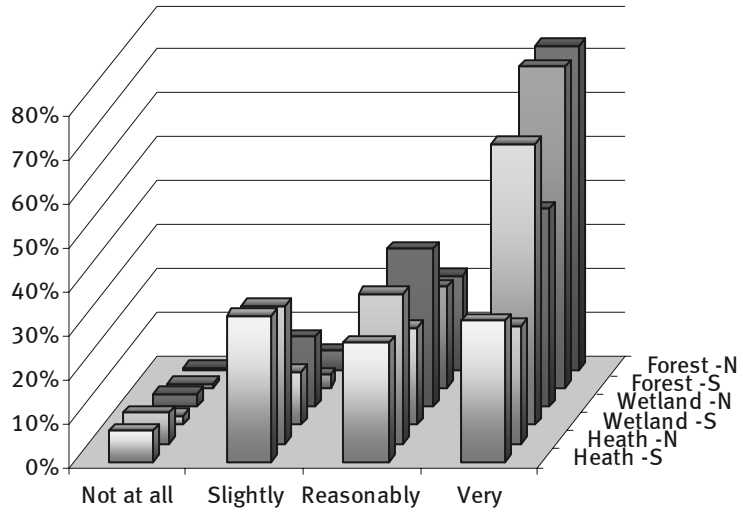
Knowing from the answers to question 2 that only 1 percent of the respondents have not visited nature within the past year, this interpretation seems very unlikely and invalid. Another explanation of the 40% 'no' answers in the non-use splits could be that these respondents do not actually state their true WTP for the specific combination of attributes offered. Instead, the stated WTP reflects a general *donation* towards the protection of nature – no matter what scenario is put forward, as long as it entails the protection of nature.

If this is the case, it will seriously affect the credibility of the analysis as the fundamental assumption of respondents trading off is not completely satisfied.

Despite the above reservations concerning non-use values constituting up to 60% of the total values, it still seems evident that non-use values *do* account for a large part of the total values. This is further backed up by comparing the answers to questions 22

and 1. Question 1 concerns the respondent's recreational experiences in different types of nature, i.e. use values only.

Figure 9.3 Percentage distribution of answers to question 1: "How important are the different types of nature for your recreational experiences?"



Note: N denotes the national samples and S denotes the Silkeborg samples

The answers are depicted in figure 9.3, where forest clearly shows the largest recreational value. It is interesting to note that wetland is apparently more important for the Silkeborg samples than for the national samples. This is probably due to the many wetland areas in Silkeborg.

In comparison to the answers to question 22 depicted in figure 9.1 which covers both use and non-use values underlying choices in the choice sets, it seems that wetland is associated with larger non-use values than forest. This is deduced from the fact that the two attributes are equally important in question 22. This is in accordance with the findings of Bhamber & Khoury (1999) and Bateman *et al.* (1993). Bateman *et al.* (1993) further state that the ratio of non-use value to total value is likely to vary according to the good under consideration. The more unique the good in question, the higher the non-use value part is of the total value.

Walsh *et al.* (1990) take a step further, in stating that goods with a reasonable amount of substitutes may exhibit roughly equivalent use and non-use values. It seems quite possible that people generally have more substitutes when considering forest than when considering wetland. This is due to the fact that Danish law ensures a high level

of accessibility to forest whereas wetland is generally less accessible. This also provides an explanation for the higher non-use values associated with wetland. Another explanation might simply be that wetland is generally more biodiverse than forest, and biodiversity is largely associated with non-use values.

Summing up, it is evident from the analyses that non-use values *do* constitute a part of the total value associated with the types of nature. Even though this study suggests a 60 to 40 ratio between non-use and use values, determining an exact magnitude and relationship between non-use and use values is a complicated task, involving several elements of uncertainty. Thus, further research in this area is needed.

9.2.3 Starting point bias or anchoring

Comparing splits 1 and 3, it is established that a starting point bias or anchoring effect is present. Considering the close methodological relationship between DC-CVM and CE, it is not surprising to find this effect in the CE as well as in the DC-CVM results. To the authors' knowledge, the number of previous studies testing anchoring effects in a CE context is limited to one; Hanley *et al.* (2005) investigate the sensitivity of WTP estimates to the vector of prices used in the CE experimental design, but find no significant impact of changing the price vector on estimates of WTP.

This would suggest that no anchoring is present, which is contradictory to the findings of this study. However, as Hanley *et al.* (2005) note, the mean WTP estimates are consistently lower when employing the lower price vector. Even though the difference is not found to be significant based on Likelihood Ratio tests, it might very well be significant in a policy context.

Considering the substantial uncertainty usually associated with exactly how the price attribute should be defined in terms of bid levels, and also taking into account the fact that the price attribute provides the key to converting parameter estimates of choice into welfare estimates, additional investigations into the area of anchoring effects in CE are warranted.

9.2.4 Embedding

It is often argued that CE largely avoids the embedding bias or effects of scope, which has been identified in CVM, due to the inherent experimental design and trade-offs between different levels of attributes, i.e. different amounts of attributes (Adamowicz *et al.* 1998; Foster & Mourato 2003; Hanley *et al.* 1998a). However, this study sug-

gests that this avoidance of embedding is only assured internally within each experimental design, but not externally when looking at different designs concerning the same attributes.

A substantial embedding effect is revealed when comparing splits 1 and 4. Estimates of WTP are not lower in split 4, even though the offered amount of nature protected is less. This supports the previously mentioned suspicion of respondents perceiving the km-values of the attribute levels as categorical values ('good' – 'ok' – 'bad') instead of as a continuous scale (0, 1, 2,..., 9, 10 km). The intention behind defining the attribute levels in terms of kilometres was to enable deduction of 'per km' estimates from the WTP estimates at attribute level, but if the attribute levels have not been correctly perceived by respondents, conversion of WTP estimates into 'per km' estimates for use in benefit transfer is rendered problematic.

It cannot, on the basis of just this one study, be concluded that CE in general is susceptible to this problem. The severity of the problem is probably context specific, but nevertheless caution is advisable when performing benefit transfer based on unit values deducted from CE.

9.2.5 Annual payments

In previous comparable CE studies, WTP estimates have often turned out to be, seemingly, very high when considering respondents' budgetary dispositions and the character of the good in question, especially when calculating capitalised values. It has already been determined that hypothetical WTP is generally overstated in valuation studies (Harrison & Rutström 2005; List & Gallet 2001).

Johansson-Stenman & Svedsäter (2003) find that one reason for the overestimation of benefits in CE is ethical beliefs and moral satisfaction closely related to the concept of 'warm glow' and 'yea-saying'. In this study, it was hypothesised that another explanation could be respondents not considering the price as an annual perpetual payment as intended, but rather as a one-off lump-sum payment.

Incorporating a reminder in split 5 concerning the annual payment did not, however, change the estimates of WTP markedly as compared to split 2. Given that respondents in split 5 have actually read the extra reminder, this supports the fact that respondents actually *do* see the price as an annual payment. Thus, misconception of the payment

vehicle in this regard is ruled out as an explanation of hypothetical WTP overstatements.

9.2.6 Are preferences the same when affected by current motorway planning?

It was expected beforehand that people in Silkeborg would exhibit stronger preferences for the different types of nature than the public in general. This hypothesis was based on the fact that people in Silkeborg are currently facing a new motorway, possibly affecting nature to a large degree. In other words, it was expected that respondents in Silkeborg would think of the specific Silkeborg motorway when asked to consider a generic motorway. This was further expected to generate higher estimates of WTP than for respondents at the national level (presumably) not thinking about a specific project.

However, the results showed that respondents in Silkeborg have a lower WTP than the public in general. This is probably mainly due to the fact that respondents in Silkeborg consider many other impacts, both negative and positive, than those affecting nature (noise, division of city etc.).

Furthermore, it is shown that respondents in Silkeborg do not respond rationally to the non-use value scenario. It is not surprising that asking respondents to imagine the motorway *not* affecting the areas of nature which they use, does not work, when, in fact, they *are* in a situation where they know for certain that this scenario is unrealistic.

9.2.7 Internet sampling or ordinary post?

Internet sampling has some obvious advantages over ordinary postal sampling in terms of cost efficiency, speed of collection and to some extent elimination of interviewer bias. However, due to the novelty of Internet sampling for valuation studies in Denmark, a split version of the CE questionnaire was employed via ordinary post to test for possible differences in representativeness and preferences due to mode of data collection.

In terms of the samples' ability to represent the intended local population in the Silkeborg area, there is not much difference between the two modes of collection. Both exhibit sampling bias in terms of oversampling of people from high income groups and people with academic education. Concerning the age distribution, there is, however, some difference. People over the age of 55 are underrepresented in the Internet sam-

ple, whereas these age groups are better represented in the postal sample. Considering the age specific preferences established in section 7.3.4.4, this difference between the two modes of sampling would expectedly offset higher WTP estimates for forest and lower WTP estimates for wetland in the Internet samples as compared to the postal samples.

There *is,* in fact, a small difference in WTP estimates in the two modes of sampling; WTP for forest is somewhat higher in the Internet samples than in the postal samples. However, regarding wetland, WTP estimates from the postal sample are *not* higher than in the Internet samples. Generally, differences in estimates of WTP, and thus in preferences, in the two modes of sampling are relatively small, which is in concurrence with recent findings from the USA (Berrens *et al.* 2003; Hui *et al.* 2004).

Therefore, it would seem that any reluctance towards using Internet sampling in valuation studies in Denmark can be relaxed. Still, more studies are warranted in this area of research to further validate the applicability of Internet sampling. Specifically, tests of the applicability of Internet samples when considering national samples are warranted in future studies. In this context, it is also worth mentioning that Internet sampling seems to offer new opportunities to improve sampling procedures in terms of stratified sampling to avoid sampling bias.

9.3 Recommendations concerning the new Silkeborg motorway

In chapter 8, results from the area specific CVM study in Silkeborg ,as well as the generic motorway investigations in the CE study at the national level, were used in combination in order to assess which one of the Silkeborg motorway layouts should be preferred when considering the loss of nature.

Both the results of the CVM and the CE (via benefit transfer) point towards realisation of the Resendal layout being preferred from a welfare economic point of view. No matter how unambiguous this conclusion might seem, a few words of caution are called for.

9.3.1 Shortcomings of the CVM

This study has, in principle[61], focused solely on the valuation of the non-marketed value of nature assuming that nothing else is affected.

In other words, only the benefit side associated with realising the most preferred layout is estimated. For society, i.e. politicians, to decide which layout should be realised, a regular cost-benefit analysis ought to be completed by comparing the estimated benefits in this study to the remaining costs and benefits. This would for instance be changes in travel time, rate of employment, number of traffic accidents, establishment and operating costs, emissions, barrier effects and so forth.

Even though this study points at the Resendal layout, the benefits of realising this layout might be outweighed by the remaining benefits and costs, thus rendering the Ringvej layout the most favourable to society.

The CVM study has some weaknesses, which deserve attention. Firstly, only people living in the Silkeborg area have been sampled. However, it is quite possible that people living outside this area would also attach some values to the affected areas of nature, especially considering the uniqueness of the Gudenå valley, which, according to Schulze *et al.* (1983), would warrant large non-use values on a national level. Had a national sample been employed in the CVM, it is likely that this would have led to different conclusions.

Secondly, it can be argued that the scenario put forward could have been more informative. More than 60% of the respondents living less than 500 metres from the Ringvej layout state that they expect the noise level at their residence to be much affected if the Ringvej layout is realised. However, the EIA concludes that the Ringvej layout will actually slightly lower the present noise level in the city, as it will be dug down and thus be subducted below surface level causing less noise nuisance than the present ring road.

Had people been properly informed of this, it might have changed their answers. It can be argued that this lack of information is not a problem for this CVM study in itself, as

[61] Respondents in Silkeborg have obviously included more aspects, such as noise and barrier effects, which might result in double counting if a cost-benefit analysis incorporating these effects in some other manner is conducted.

respondents' preferences are measured with minimal influence from the questionnaire. Had the scenario informed the respondents about the possible noise reduction, the respondents would not be representative of the population from which they were sampled, simply because the population is not informed about this. This lack of information regarding the consequences of the Ringvej layout would seem to be more of a general problem in the overall decisionmaking process in Silkeborg.

In relation to the stated WTP values for the two layouts, the information regarding the impact of noise might also have a significant effect. Results show that WTP *is,* in fact, influenced by noise. This relationship would also be expected on the basis of the findings of Bjørner *et al.* (2003), who establish that people are willing to pay to avoid noise nuisances from road traffic. If the respondents in the current study had been properly informed of the expected lower noise level in Silkeborg city as a consequence of the Ringvej layout, it is likely that WTP for the Resendal layout would have been lower.

Theoretically, this could lead to different conclusions regarding the recommendations of layout. In order to change the recommendation of layout from the Resendal layout to the Ringvej layout, the noise effect should account for a considerable share of the estimated WTP to ensure realisation of the Resendal layout. It is, however, neither within the scope, nor is it within the possibility, of this study to estimate the extent of such a noise effect. Hence, no further investigations into this area are made.

It could also be argued that the scenario does not put enough weight on the fact that the Resendal layout constitutes a completely new road through the landscape, whereas the Ringvej layout to a large degree merely replaces an already existing road. In other words, several of the adverse effects associated with the Ringvej layout are already present in terms of the existing ringroad. A more explicit reminder to respondents about this fact, would probably to some extent have reduced the WTP for the Resendal layout as well as the share of respondents choosing this layout.

Recognising, that it is not as much the magnitude of the WTP estimates, as it is the share of respondents choosing the Resendal layout, which is determining for the recommendation of the Resendal layout on the basis of the CVM analysis, the issue raised above is quite important. If respondents, when answering the questionnaire, have not considered the fact that a road already exists in the Ringvej layout, it would seem quite likely that a reminder of this fact would change the conclusion concerning the superiority of the Resendal layout. It is, unfortunately, not possible to examine to

what extent respondents in this survey have been aware of the existing ring road, so further investigations into this matter are omitted.

Another possible 'information effect' could arise from the fact that the scenarios are quite superficial with regard to the consequences of the two layouts for specific animal and plant species and communities. The previously conducted EIA surveys provide much more detailed and specific information concerning these issues. It could be argued that this is a weakness of this valuation study in the sense that respondents are not fully informed about consequences which might affect their preferences.

However, the aim of this study has not been to educate respondents and develop their preferences. On the contrary, the intention has been to affect respondents' preferences as little as possible with the questionnaire to ensure that the preferences of the sample still reflect the preferences of the targeted population in the Silkeborg area. This way, the results in this study reflect the preferences of the population based on the present population[62], and it has not been within the scope of this study to test the effect of educating respondents.

A third weakness in the CVM could be that the third possible layout, the so-called Combi layout, is not included. If a lot of people in Silkeborg had strong preferences beforehand for this layout, their answers to this questionnaire might be rendered useless as the scenario put forward would not apply to them. However, less than 1% of the respondents commented upon the lack of this alternative, so this problem can be cautiously interpreted as not being serious.

9.3.2 Shortcomings of the benefit transfer approach

Looking at the benefit transfer approach, based on unit estimates from the CE analysis on national level, an apparent important shortcoming of this approach is the fact that all areas of each specific type of nature are treated equally, i.e. attached the same value. Due to the use of a generic motorway in the scenario, the 'per km' estimates are principally interpreted as the values associated with locating a kilometre of motorway through an *average* Danish forest, wetland or heath, respectively.

It is, however, known from a number of studies that the value of two areas of the same type of nature might be valued very differently, depending on the specific attributes

[62] Momentarily disregarding the identified problems with representativeness.

(Aakerlund 2000; Bjørner *et al.* 2000; Boiesen *et al.* 2005; Bostedt & Mattsson 1995; Hanley *et al.* 1998b; Hanley & Ruffell 1993; Hansen 2005; Holgen *et al.* 2000; Mattsson & Li 1994; Olsen & Lundhede 2005; Scarpa *et al.* 2000; Willis *et al.* 2003) Some of the areas affected by the two proposed layouts in Silkeborg are, in fact, very different, not only from each other, but also from the average in Denmark. Even though the two layouts both run through approximately 1.6 km of wetland, it seems unrealistic to assume that the value is the same. This is due to the fact that the Ringvej layout is located almost precisely on the existing ring road. In other words, the areas affected by the Ringvej layout are already affected to some extent by the existing road.

The Resendal layout, on the contrary, is located through areas which as of yet have not been affected by a road. For instance, the wetland areas affected by the Resendal layout are mainly located in the quite unique Gudenå valley, whereas those affected by the Ringvej layout are mainly part of the lake Silkeborg Langsø in the western part of Silkeborg, areas which are already affected by the existing ring road.

Therefore, it would seem logical to assign higher values to the wetland areas of the Resendal layout than those of the Ringvej layout. Similarly, the main part of the forest encroached by the Ringvej layout is 'Nordskoven', which receives approximately 83,000 visits per year (Jensen 2003) and is part of the largest connected forest area in Denmark. Therefore, calculating the value of this area on the basis of a 'per km' estimate of the average Danish forest is likely to underestimate the true value of the affected area.

The forest areas affected by the Resendal layout are smaller and less visited areas, so it would seem more reasonable to assign the Resendal layout a lower 'per km' value than the Ringvej layout.

Finally, it can be argued that a shortcoming of this study is the fact that it does not take into account inherent values and symbolic values, as explained in chapter 2. As this problem is inherent in all economic valuation studies due to the anthropocentric approach, this discussion is outside the scope of this study and will not be elaborated on further.

The anthropocentric point of origin for the economic valuation carried out in this study is actually also a central cause for what might seem paradoxical; According to the carried out economic valuation in this study, the loss of nature values is greatest if

realising the Ringvej layout, whereas the Danish Road Directorate, as mentioned in Appendix 1, have reached the opposite conclusion, based on the previously performed EIAs (Vejdirektoratet 2002). This illustrates a main difference between the economic valuation approach and the EIA approach. Where the nature values in the EIA is based on qualitative descriptions of impacts on specific species and habitats determined by experts, e.g. biologists, the economic valuation approach describes the nature values in quantitative terms based on people's preferences. In other words, the EIA is to a large extent non-anthropocentric, whereas the economic valuation is purely anthropocentric. Thus, comparisons are difficult to make as the basis is not the same. Both methods have pros and cons, but, most importantly, both are capable of contributing with essential input to the decision making process, thus faciliting well-founded political decisions.

9.4 Sampling bias

The respondents in both the CVM and the CE have been found to be far from fully representative of the actual populations of the municipalities of Silkeborg and Gjern and the entire Danish population respectively.

The fact that all samples had a larger share of people in the higher income groups than expected causes some implications, in particular. In the CVM analyses and to some extent in the CE analysis, WTP was found to be dependent on household income; the higher the income, the higher the WTP. As expected, this indicates that nature is a non-inferior good. An exception was the lowest income group in the CE, which actually showed higher WTP than the other income groups. Even though it cannot be verified, this anomaly is probably caused by respondents in this specific income group not considering their budget restrictions realistically. In effect, this would mean that the WTP estimates based on this group are more influenced by strategic bidding and warm glow effects than estimates based on other groups. Another likely explanation of the high WTP estimates in the low income group is the relatively low number of observations in this group compared to the other income groups.

The overrepresentation of higher income groups in the samples, thus, implies that estimated WTP values overestimate the population's true WTP. This is important to remember when applying the estimates in further socioeconomic analysis, such as a cost-benefit analysis.

The sample is also skewed with regard to age-distribution and education-distribution, which, combined with the findings of the subgroup analyses, further supports the expectation of WTP estimates being overestimates of the true WTP.

However, this substantiated expectation of overestimation might not represent a serious problem in the case concerning the Silkeborg motorway, as two layouts are considered; not just one.

Both layouts are presumably equally flawed by the overestimation, meaning that the impact of the overestimation is reduced when making comparisons between them. This argument also applies to the benefit transfer of estimates from the CE.

Sociodemographic variables were not found to be determinants of respondents' initial choice of layout in the CVM. Therefore, the distribution of respondents choosing one or the other of the two layouts would probably not have changed, had the sample been more representative.

Recognising that the large share of respondents choosing the Resendal layout is a major determinant of the calculations pointing towards the Resendal layout, the overall conclusion concerning the choice of layout for the Silkeborg motorway is maintained, despite the overestimation of WTP due to the lack of representativeness in the samples.

Related to the sampling bias issue, the choice of people in Silkeborg and Gjern municipalities as the relevant target population, is open for discussion. The fact that a significantly larger share of respondents in Gjern municipality chose the Ringvej layout, suggests that, had a wider geographic area been used to determine the target population, then the Resendal layout would most likely be less superior. To determine whether this could actually change the overall conclusion, additional studies are needed.

10 Conclusion

The main focus of this study has been to provide a basis for the direct incorporation of the impact on nature in the decision-making and planning process of new motorways in Denmark. This has been accomplished by undertaking two economic valuation studies aimed at estimating monetary values for the loss of nature caused by the construction of motorways based on peoples' preferences for nature.

The results can serve as additional input for the cost-benefit analysis and Environmental Impact Assessments usually carried out to aid the political decision-making process when planning new motorways in Denmark.

Firstly, a Contingent Valuation Method study was carried out to estimate the values that people in the Silkeborg area attach to the impact on nature by the two possible layouts, the Resendal layout and the Ringvej layout, for the future Silkeborg motorway. Secondly, a national Choice Experiment study was completed in order to provide generic estimates of the preferences and values held by the public in general when considering the impact of placing a new motorway through areas of forest, wetland or heath as opposed to arable land.

10.1 The Contingent Valuation Method study

1,074 usable questionnaires were collected from the random sample of 2,000 people in the Silkeborg area. 76% of the respondents stated a preference for the Resendal layout, whereas the remaining 24% preferred the Ringvej layout. The choice of preferred layout was found to be dependent on the distance from the respondent's residence to the two layouts, and on the perceived influence of the two layouts on factors such as noise at place of residence, recreational opportunities, specific areas of nature and landscape appearance. The higher the perceived negative influence of a specific layout, the lower the probability of preference for this layout.

In accordance with the importance of the distance from the respondent's place of residence to the layouts, it is furthermore found that respondents living in Gjern municipality, which are not as directly affected as respondents in Silkeborg, have stronger preferences for the Ringvej layout than respondents living in Silkeborg municipality. In effect this means that 50% of the respondents from Gjern municipality prefer the Ringvej layout, whereas less than 20% of the respondents from Silkeborg municipality

would prefer this layout. Even though the samples in general cannot be said to be entirely representative of the intended population, namely people in Silkeborg and Gjern municipalities, these results are found to be directly extended to the population in Silkeborg and Gjern municipalities.

In a split sample employing an open ended elicitation format, respondents preferring the Resendal layout stated an average willingness to pay (WTP) of 1,318 DKK per household per year to ensure realisation of this layout, while those preferring the Ringvej layout stated an average WTP of 1,428 DKK per household per year to ensure realisation of their preferred layout. These figures are based on a non-parametric estimation procedure.

Certain refinements of the estimation procedure were carried out, resulting in modifications of the WTP estimates, as listed in table 10.1.

Table 10.1 Estimates of WTP per household per year based on the open ended sample

	Estimated mean WTP (DKK)	
Estimation procedure:	Resendal	Ringvej
Non-parametric	1318	1428
Non-parametric – uncertain bids recoded to zero	1222	1387
Non-parametric – upper spike at 5000 DKK	1040	1104
Non-parametric – exclusively nature and recreation	660	1023
Parametric – Tobit regression	707	1421

Note: The WTP figures are per household per year.

In the double bounded dichotomous choice sample, estimated WTP tended to be higher. Respondents preferring the Resendal layout had a mean WTP of 3,202 DKK whereas those preferring the Ringvej layout had a somewhat lower WTP at 2,213 DKK. However, different approaches to the estimation procedure yielded very different estimates, as presented in table 10.2.

Table 10.2 Estimates of WTP per household per year based on the double bounded dichotomous choice sample

	Estimated mean WTP (DKK)	
Estimation procedure:	Resendal	Ringvej
Non-parametric – based on the 2nd bid (conservative)	895	737
Non-parametric – based on the OE follow-up	1383	990
Parametric – Maximum likelihood interval regression	3202	2213
Parametric – upper spike at 5000 DKK	1388	1233
Parametric – upper spike at OE follow-up	838	735
Parametric – exclusively nature and recreation	1551	1887
Parametric – spike OE follow-up + exclusively nat./rec.	477	542

Note: The WTP figures are per household per year.

For respondents preferring the Resendal layout the different estimates of WTP in the CVM study range from 477 to 3202 DKK per household per year. Equivalently, WTP estimates of respondets preferring the Ringvej layout range from 542 to 2213 DKK per household per year. WTP estimates from both samples must be considered to be upper boundaries of the true WTP due to expected hypothetical bias and identified problems with the the sample's ability to represent the population in the Silkeborg area.

It also needs to be stressed that the estimated WTP values cover more than just values concerning nature affected by the two layouts, even though the intention was to focus solely on nature. To some extent, respondents seem to include factors such as noise, pollution and development of the city when determining their WTP. Asking people directly to state the proportion of WTP attributed solely to the protection of nature and recreational opportunities resulted in lower WTP estimates, especially for the Resendal layout. In other words, people choosing the Resendal layout based their WTP statements less on concerns for nature and more on concern for the factors described above than those choosing the Ringvej layout.

Determining which of the estimates in table 10.1 and table 10.2 that are closest to the true WTP values of people in the Silkeborg area, is an extremely difficult task, which is not attempted in this study. However, bearing in mind the substantiated suspicion of WTP estimates being overestimates of the true WTP, a precautionary and conservative approach suggests focusing on the lowest WTP estimates.

10.2 The Choice Experiment Study

2,923 usable questionnaires were collected using an Internet panel where 5,929 randomly chosen people, both nation-wide and in the Silkeborg area, were invited to par-

ticipate in the survey. A further 360 usable responses were collected through ordinary postal mail-out sent to a random sample of 600 people in the Silkeborg area.

Table 10.3 shows estimates of WTP to avoid different lengths of new motorway encroaching forest, wetland and heath. These WTP estimates express use values as well as non-use values.

Table 10.3 Estimates of WTP from the Choice Experiment study

Type of nature	Km protected from motorway encroachment	Estimated WTP (DKK) per household per year	WTP per km per household per year
Forest	10	912	91.2
	5	460	92.0
Wetland	5	783	156.6
	2.5	476	190.4
Heath	5	341	68.2
	2.5	*62*	*24.8*

NOTE: ITALICISED WTP FIGURES ARE NON-SIGNIFICANT AT THE 95% LEVEL

From the WTP per km estimates, it would seem that protection of wetland is preferred over forest which, in turn, is preferred over heath. However, there is some evidence that the 'per km' estimates can be questioned, which would imply that forest ranks higher than wetland in the average preference ranking.

Analyses indicate that approximately 60% of the estimated WTP is made up of non-use values. Furthermore, it is shown that an anchoring effect or a starting point bias exists, in that WTP estimates are sensitive to the initial price levels introduced in the questionnaire; the higher the initial price levels, the higher the WTP.

The Internet samples and the ordinary postal samples show substantively modest differences, both regarding the ability to represent the intended population and preferences for the three types of nature. Only the distribution of age markedly differs between the two modes of sampling. In conclusion, Internet sampling would seem a viable alternative to ordinary post as well as a promising area for future development of sampling procedures.

Finally, the results show that people living in Silkeborg, who are currently very much involved in a specific motorway planning process, in general exhibit slightly lower WTP than the national population. It is indicated that this lower WTP is brought about by a

more multi-faceted and thorough knowledge of the problem at hand. As a consequence, it turns out that people in Silkeborg are not cognitively able to handle the hypothetical scenario of not being directly affected by a new motorway.

10.3 Choice of layout for the Silkeborg motorway

Employing estimates of WTP identified in the analysis of the CVM and CE data, suggests an answer to the question of which layout should be chosen for the Silkeborg motorway, when focusing on the value of nature from a welfare economic perspective.

Based on the different samples, the Resendal layout is to be preferred, as this layout will minimise the welfare economic cost to society in terms of loss of nature.

Based on the results from the Contingent Valuation Method study, the total capitalised WTP to ensure realisation of the Resendal layout is 351 million DKK higher than that of the Ringvej layout. There is however some evidence that the valuation reflects more than just preferences regarding the impact on nature. A sensitivity analysis reveals that the general conclusion is quite solid. Using very concervative WTP estimates, which are adjusted for influences other than those related to impacts on nature, or the estimates which are most in favour of the Ringvej layout, the Resendal layout is still superior by more than 68 million DKK.

Applying the WTP estimates from the national Choice Experiment study in a benefit transfer to the Silkeborg motorway case, the same conclusion is reached. The total capitalised value associated with the areas of nature affected by the Resendal layout is 56 million DKK less than that of the Ringvej layout. In other words, realising the Resendal layout will entail a welfare economic saving of 56 million DKK to society. This conclusion, too, is relatively solid in a sensitivity analysis where the smallest difference between the two layouts is 25 million DKK in favour of the Resendal layout. However, this conclusion is subject to certain reservations. The transfer of unit value estimates from the generic case to the specific case is indeed questionable in some respects.

It should be noted that none of the samples in the analyses was able to fully represent the relevant target populations with regard to certain sociodemographic variables. Thus, all of the above estimates of WTP should be regarded as overestimates of the true WTP of the targeted population.

The recommendation of the Resendal layout in the current project should not stand alone. The conclusions of this report should be considered in conjunction with other analyses concerning more directly measurable economic costs and benefits as, for instance, establishment and operating costs, saved travel time etc. However, in this context it deserves attention that the estimates from this survey express more than just the values related to loss of nature. Respondents have to some extent included factors such as for instance noise, which is usually evaluated seperately in cost-benefit analyses of motorways. Thus, including the value estimates from the present study in cost-benefit analysis might cause double counting if no adjustments are made.

It has been beyond the scope of this study to conduct an all-inclusive cost-benefit analysis of the Silkeborg motorway case. However, the valuation surveys conducted provide a fairly strong indication that net benefits from choosing the Resendal layout substantially exceed the net benefits from choosing the Ringvej layout. Whether an all-inclusive weighing of all costs and benefits in economical terms will point towards the Resendal layout or the Ringvej layout is not determined in this survey.

Furthermore, decision-makers should remember that economic analyses are just one part of the basis for decision-making, and, as such, ought to be weighed against other non-economic analyses and motives outside the realm of welfare economic analysis. This way, decisions regarding the Silkeborg motorway and future motorways in Denmark can be made on a wide and well-informed basis.

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The authors are solely responsible for the report's contents and opinions expressed.

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Appendices

Appendix 1: Description of Silkeborg motorway layouts

The motorway at Silkeborg is one of several motorways in the planning process or construction phase in Denmark. This motorway is part of the stretch from Århus to Herning – a decision made in 1993. This final stage of the motorway is now a fact – however the final layout is still to be decided. The Silkeborg motorway has been chosen as a test case for carrying out the contingent valuation study in this report.

The nature around Silkeborg is characterised by a dramatic landscape formed by ice. The area includes Denmark's greatest coherent forest area of approximately 85 sq.km. Denmark's largest melt water valley, the Gudenå valley, is also part of this landscape. Altogether, the nature sites around Silkeborg are biologically, recreationally and culturally important sites.

For the final stretch two different layouts of the motorway have been suggested. The first proposal is *the Resendal layout* north of Silkeborg and the second is *the Ringvej layout* through Silkeborg city. This appendix will in short present the impacts on nature from the two main proposals, based on the environmental impact assessments (VVM – redegørelse) from the Danish Road Directorate (Vejdirektoratet 2002).

The Road Directorate is presently working on a possible third route – *the Combi layout*. However, we have not included this third proposed route in our valuation study, since the environmental impact assessment has yet to be completed for this proposal.

The Resendal layout

From west of Silkeborg at Funder, the Resendal layout runs north of Silkeborg passing through Låsby east of Silkeborg. This route cuts through a number of distinctive nature resorts in the dead ice area north of Silkeborg, as well as the Gudenå Valley itself.

After passing Funder Kirkeby, the Resendal layout runs north-east and follows the edge of *Hvinningdal* located west of Silkeborg. Hvinningdal is a spectacular valley to the side of the large Gudenå Valley. The area is special since the hilly landscape is a

habitat for a number of locally common and rare plants[63]. In addition, Hvinningdal is an important recreational area located close to the city. Although impacts from the motorway on Hvinningdal are few, it will cause a severe fragmentation of the large, interconnected heath and plantation areas.

The motorway continues through *Fladmosen*, which is designated a potential natural rehabilitation area. It is planned to run the motorway over a dam, so it will dominate visually and contribute with noise nuisance.

The Resendal layout runs cross Viborgvej to Resenbrovej. On this stretch, the motorway will pass close to the *Gubsø* marshland. Gubsø is a special landscape according to the VVM report. On the slopes to the marshland there is valuable common pasture, designated as a "poor nutrient" site. This type of environmental site is declining within Denmark. This area contains several rare plants, which makes it an area of botanical significance and attracts a number of specialised insects. The motorway will presumably destroy the common pasture, while the marshland of Gubsø area itself will remain.

The motorway will cut a corner off *Hulbo Marshland*, which will considerably decrease the recreational and landscape values and have a negative effect on the local amphibian population. At *Sejling bæk*, a common pasture will be partially destroyed and at *Nørreskov* a couple of ponds will be partially destroyed. However, these will be re-established.

The motorway runs across the *Gudenå Valley* on an elevated bridge. Thus, the river valley it self will only be affected by the bridge piers. On the 2.5 km long stretch, the motorway will pass the Sminge and Gødvad preservations. Due to the large difference in elevation between top and bottom of the river valley, there will be a large amount of excavation, which will affect the elevated, melt water ledges. At Grøndalsgård, there is a spring fen, which is a botanical area that is particularly worthy of preservation. The spring fen itself is nationally endangered. The area contains all Danish fen types with both extremely poor fens and extremely rich fens, all of which are equally endangered. According to the EIA study, the spring can be classified as being of the greatest botanical significance and botanically it is the most valuable location on the entire

[63] The term "locally common" species refers to species designated as R-species in the Red List (Rødlisten). That is, species with so few or few stocks that they are particularly sensitive to temporary manmade or natural fluctuations as well as carelessness" (Pihl & Stoltze 1998).

stretch of motorway. As a result of the necessary excavation and associated hydrological disturbances, the motorway will destroy the spring despite the fact that it only cuts across the edge of the spring. Thus, the endangered nature types, typical biotopic species and amphibians will disappear.

However, the greatest effect of the motorway on the Gudenå Valley is the effects on the landscape. The motorway will penetrate a large open connected area, which is almost untouched by technical installations. The number of recreational activities will decrease, including the Sminge and Gødvad preservations. The 25-metre-high bridge that the motorway passes over will not affect the number of species in the Gudenå Valley itself. The impact of the motorway in this area is, thus, limited to the visual and noise pollution.

Having passed the Gudenå valley, the motorway runs north of *Møllegård,* an old coppice wood with a natural woodland character. The motorway will be destructive to the natural woodland character of the locality. The motorway continues past *Bjarup Marshland* and *Linådalen,* which contain recreational interests, e.g. hunting and fishing. Highway 15 is already disruptive to the area but a motorway will increase the disruptive effects.

South of Voel, the motorway will affect a number of localities. In *Husmose* and the small area of marshland at *Thorupgård*, there is varied animal and plant populations including locally common species that will be greatly disturbed.

The Ringvej layout

The Ringvej layout starts at Bording and passes through Silkeborg. Natural impacts occur, in particular, in the dramatic landscape in Hvinningdal as well as in the large melt water valleys at Silkeborg Langsø and the Gudenå, including Nordskoven. The motorway will cross the valuable landscape near the existing main road 15.

The Ringvej layout runs further along *Silkeborg Langsø*, which is an important recreational area. As the road is markedly wider than the existing road, it will result in the reduction of marshland areas along the lake, some of which will potentially disappear. However, these actions are expected to be countered through the establishment of a new bank using the top soil from the old bank, in which the seed reserve is retained. On the south side of Silkeborg Langsø, there is an alder moor and reed-covered areas.

The motorway will greatly reduce the size of the area and will considerably change the composition of the vegetation.

The route runs through *Søholdt* in a south-easterly direction. Just north of Highway 15 lies *Gødvad Bakke* with recreational interests and locally common species. South of the road is a marshland with larger areas containing oligotrophic fens. These areas are endangered. A small area of common pasture will disappear, cutting off a corner of the oligotrophic fen. At the same time, some woodland areas will disappear, including several locally common species.

The Ringvej layout continues south-east and cuts through a section of *Hårup Sande and Nordskoven*. Both areas are included in Denmark's largest woodland area and have a significant recreational value. The woodland area has a varied birdlife and contains several locally common species. The motorway will be constructed on an embankment through the woodland and therefore constitutes a significant visual and physical barrier. The physical barrier is expected to be partially compensated due to a landscape bridge and a fauna bridge.

The Ringvej layout then crosses a part of *Linå Vesterskov*. The area contains both locally common species and rich wildlife, including badgers, fox, roe deer and red deer. Lesser populations of locally common species will disappear and wildlife will be affected by the motorway. The barrier effect will be minimal as a result of the landscape bridge.

Comparison of the two main proposals

The Resendal layout will have an impact on several more nature areas than the Ringvej layout. At the same time, the Danish Road Directorate has assessed the affected areas along the Resendal layout to be of greater value (Vejdirektoratet 2002).

Along the Resendal layout there are several species which Denmark has an international obligation to protect, and the number of endangered types of natureareas is higher along the Resendal layout. Both routes will run through EU habitat areas[64]. The Ringvej layout passes through the woodlands in the eastern corner of Nordskoven east

[64] The *EC Habitat Directive* concerns, in addition to designating habitat areas, the high-level protection of a number of animal and plant species, regardless of whether they exist within a protected area or outside such areas. The species are listed in Schedule IV of the Directive, and are known as 'Schedule IV species'.

of Silkeborg (EU habitat area no. 181). The Resendal layout will have an impact on the Gudenå valley and Gjern Bakker (EU habitat area no. 45).

The Ringvej layout follows the existing traffic corridor for some long stretches. This will reduce the harmful effects on nature to a certain extent. The Resendal layout passes through a landscape that is less influenced by large technical facilities. The motorway, thus, fragments vital, undisturbed nature areas and negatively impacts values relating to the landscape. To a certain extent, the planned fauna passages will compensate for the barrier effect.

Species from the EC Habitat Directive; Appendix V are found along both routes. *Interrupted Clubmoss* is, for example, found along the Ringvej layout and *Arnica* along the Resendal layout. Birds mentioned on the Red List which can be found in the area are believed to be migrating birds rather than breeding birds. According to the environmental impacts assessment they need not be given too much attention.

Besides the biological losses, the motorway will also result in a reduction in the recreational value of the area. Along the Resendal layout, this applies to e.g. areas of nature at the Gudenå Valley, while Nordskoven will be more adversely affected by the Ringvej layout.

From the value categories reviewed in chapter 2, the table below provides some examples of the natural resources that are expected to be lost around Silkeborg.

Table A.1. Examples of nature resources divided according to value category.

Values	*The Ringvej layout*	*The Resendal layout*
Direct usage value	Timber from Nordskoven Walks along Silkeborg Langsø and in Nordskoven	Agricultural crops Canoeing on the Gudenå Fishing in Bjarup Mose
Existence value	Biodiversity in Hvinningdal	Biodiversitet at Grønbjerg spring fen
Option Value	Possible areas of rehabilitation near *Hvinningdal*	Possible recreation values at the Gudenå river.

The Danish Road Directorate (Vejdirektoratet 2002) has stated that both the Resendal layout and the Ringvej layout are to be constructed as 4-lane motorways with a cross profile of 28 metres in open land. Architect Bjørn Hasløv from the Danish Nature Protection Board of Appeal has measured the length of the two routes and divided the

areas into categories according to the Danish Nature Protection Act §3 (marshland, meadow, common pasture, heath, beach meadow and lakes). Besides the categories from the Protection Act §3, areas with forest, cities and areas devoted to agriculture have been identified.

Figures A.1 illustrates the type of areas that are expected to be affected by the Resendal layout and the Ringvej layout. The data from the figure is presented in table A.2.

Figure A.1 Areas with woodland meadow, marsh, common pasture, heathland and wetland along the Resendal layout and the Ringvej layout.

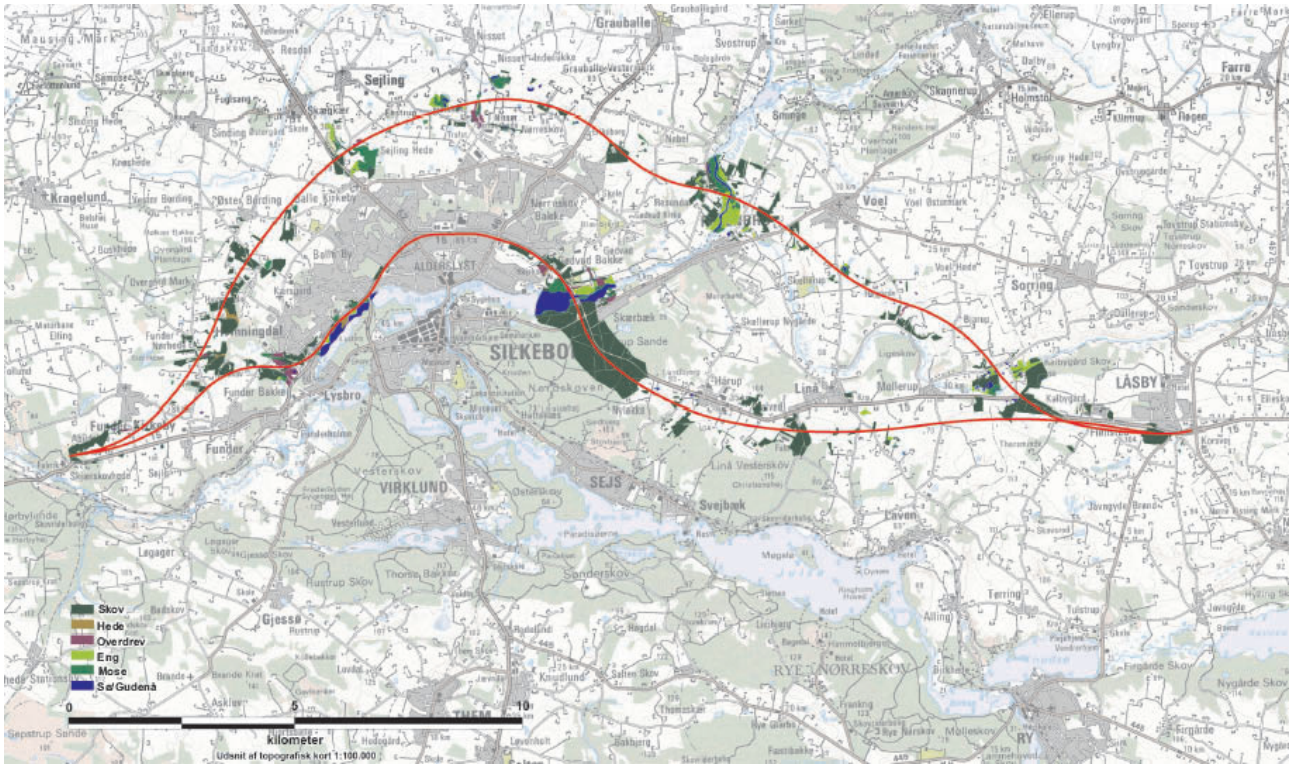

Table A.2. Affected area types for both the Resendal layout and the Ringvej layout according to the repair cost method

	The Resendal layout metres through nature	*The Ringvej layout metres through nature*
Marsh	560	720
Meadow	420	270
Common pasture	260	300
Heath	70	380
Lake	620	590
Woodland	3800	4900
Residential	-	7000
Arable land	24616	14236
Total	30346	28396

Note: Area type "arable land" is calculated as the remaining part of the total area when all other area types are identified.

Both routes are approximately 30 km long, and will affect all categories of nature areas. An important difference is that the Resendal layout does not pass through residential areas, but runs through open land with greater impact on arable land.

Appendix 2: OE CVM Questionnaire

Questionnaire

Location of the new motorway at Silkeborg

Help to increase the understanding of the people of Silkeborg and their attitudes towards concerns for nature in relation to the layout for the future motorway from Funder to Låsby

Win a gift voucher

(1 voucher at 2500 DKK and 5 vouchers at 500 DKK)

Contact:

Søren Bøye Olsen ☎ 3528 3643 ✉ sobo@kvl.dk

How to fill in the questionnaire

We would like to ask you to personally fill in the questionnaire, and not leave it to someone else in your household. It is important for the statistical analysis of the filled in questionnaires that it is the intended respondent who actually fills in the questionnaire.

Furthermore, we would like to ask you to answer in accordance with your spontaneous views. No replies are more correct than others – we are merely interested in your opinion.

Questions should be answered in chronological sequence.

Your answers will only be used for the intended research project, and will in no way be handed over to anyone else. In other words, we will ensure you that your answer will be treated confidentially.

Questions and comments

On the last page there is room for additional information or comments to the questionnaire. If you have questions or need guidance when answering the questionnaire, feel free to contact Søren Bøye Olsen on tel. 3528 3643 Monday to Friday from 9^{00} to 16^{00} or via e-mail: sobo@kvl.dk

Your experiences in nature

Below, we pose a series of questions concerning your experiences in nature. Think about your experiences in nature within the past year and especially try to recall your latest visit in nature. With 'visit' we think of actual trips, with the main purpose of experiencing nature.

Q.1: How important are the following types of nature for your recreational experiences in the Danish nature?

	Not imp.	Some imp.	Fairly imp.	Very imp.
Forest	❑	❑	❑	❑
Wetland (bog, stream, meadow, lake)	❑	❑	❑	❑
Heath or common (continuous grass)	❑	❑	❑	❑
Beach or coast	❑	❑	❑	❑
Arable land	❑	❑	❑	❑

Other important types of nature – type here: _____

Q.2: How often in the past year have you visited the following types of nature?

	0 times	1-5 times	6-10 times	11-20 times	More than 20 times
Forest	❑	❑	❑	❑	❑
Wetland (bog, stream, meadow, lake)	❑	❑	❑	❑	❑
Heath or common (continuous grass)	❑	❑	❑	❑	❑
Beach or coast	❑	❑	❑	❑	❑
Arable land	❑	❑	❑	❑	❑

Q.3: How long time did you spend on your last visit in nature?

(*tick one*)

Less than ½ hour	❑
½ to 1 hour	❑
1 to 3 hours	❑
3 to 5 hours	❑
More than 5 hours	❑

Q.4: How far is it from your residence to the nearest:

	Less than 1 km	1-5 km	5-10 km	10-20 km	More than 20 km
Forest	❑	❑	❑	❑	❑
Wetland (bog, stream, meadow, lake)	❑	❑	❑	❑	❑
Heath or common (continuous grass)	❑	❑	❑	❑	❑
Beach or coast	❑	❑	❑	❑	❑

Q.5: What have you done in your visits in nature within the past year?

(tick one or more)

Went for a walk ❑
Walked the dog ❑
Went for a run ❑
Went for a bike ride ❑
Went riding ❑
Took photos ❑
Picked berries, mushrooms, flowers etc. ❑
Experienced or studied nature ❑
Went fishing or hunting ❑
Watched animals ❑
Enjoyed silence ❑
Bathed / on the beach ❑
Other – Please type here: _____
_____

Q.6: How many times during the past year have you visited the following areas?

If necessary, look at the enclosed map

	0 times	1 to 5 times	6 to 10 times	More than 10 times
Nordskoven	❑	❑	❑	❑
Silkeborg Langsø	❑	❑	❑	❑
Gudenådalen	❑	❑	❑	❑

Your daily means of transportation

Q.7: Which of the following types of transportation do you use regularly?

(tick one or more)

Car ❑
Bus ❑
Train ❑
Bicycle ❑
Motorbike ❑
Other – please type here: _____

Q.8: Does your household own a car?

Yes ❑ → If yes, please type how many: _____
No ❑

Q.9: When driving a car, are you most often:

(tick one)

driver? ..... ❑
or
passenger? ..... ❑

Q.10: Do you notice the surrounding landscape when driving a car?

(tick one)

No ..... ❑ → *If no, continue to question 11*
Yes..... ❑

If yes, would you prefer rather to:

(tick one)

– Drive through nature than through city or arable land? ..... ❑
– Drive through city or arable land than nature? ..... ❑
– It's of no importance to me, which areas I drive through ..... ❑

Q.11: How many km do you on average drive in your car per day?

(tick one)

Less than 5 km ..... ❑
5 to 10 km ..... ❑
11 to 20 km ..... ❑
21 to 50 km ..... ❑
51 to 100 km ..... ❑
More than 100 km ..... ❑

Q.12: How far is it from your residence to the nearest motorway?

Please type the approximate distance: _____km

Q.13: How often do you drive on motorway?

(tick one)

Every day ..... ❑
Almost every day ..... ❑
Approximately a couple of times a week ..... ❑
Approximately a couple of times every 14 days ..... ❑
Approximately a couple of times a month ..... ❑
Approximately a couple of times every half year ..... ❑
More rarely ..... ❑
Never ..... ❑

Location of the motorway from Funder to Låsby

In 1993 the Danish Parliament decided to build a motorway between Herning and Århus. Even though major parts of this motorway is already finished, it has not yet been decided where exactly to locate the remaining stretch between Funder and Låsby.

Two possible layouts

After public hearings and EIAs (Environmental Impact Assessments), the Resendal layout and the Ringvej layout has appeared to be the two most realistic layout proposals. **See the enclosed map**!

The motorway will affect nature and recreation in the Silkeborg area

Even though the two layouts have been fitted into the open landscape in order to impact valuable areas of nature as little as possible, it cannot be avoided that there will be some adverse effects on humans, animals and plants.

Noise and visual impacts along a motorway can reduce the experience of landscape, nature and recreational areas. Furthermore, a motorway will constitute a barrier in the landscape, entailing changes in movement patterns for people and changes in dispersion patterns of animals and plants.

But the two layouts have different effects!

The Resendal layout and the Ringvej layout are expected to affect landscape, nature and recreation in the Silkeborg area in different ways. An outline is described in the table below:

Motorway in the Resendal layout	Motorway in the Ringvej layout
• In total 5.7 km through areas of nature: – 3.8 km through forests – 1.6 km through wetlands (lake, bog, meadow) – 0.3 km through heaths or commons • App. 2.5 km will encroach the Sminge og Gødvad Conservations in the Guden valley, of this app. 1.5 km on an elevated bridge across the valley. This will affect the opportunities for recreation.	• In total 7.2 km through areas of nature: – 4.9 km through forests – 1.6 km through wetlands (lake, bog, meadow) – 0.7 km through heaths or commons • App. 1.5 km alongside Silkeborg Langsø, which will affect recreational opportunities • App. 2 km will encroach Nordskoven, which also will affect recreational opportunities.

Q.14: In a referendum, which of the two layouts would you choose?

(tick only one)

Resendal layout ..... ❑

or

Ringvej layout ..... ❑

The layout you chose is expensive!

Imagine that the layout, which you chose in question 14, turns out to be so much more expensive to realise than the other layout, that it is not within the frame of the existing budget. Now imagine furthermore, that a proposal is put forward to raise the household income taxation in Denmark, and that this extra tax revenue is used solely to cover the extra expenses associated with realising your preferred layout.

Putting the proposal to the vote

In the next question we assume that the proposal of raising the tax is put to a referendum. If the proposal is decided on, the motorway will be built in the layout which you prefer instead of the other, cheaper layout.[65]

A lot of people overestimate

Similar surveys have shown that a lot of people tend to overestimate how much they in reality are willing to pay to protect nature. It is easy to forget that other opportunities for nature experiences might exist – for instance in areas not encroached by the motorway.

Thus, it is important to consider carefully, if you are willing to, and capable of, paying the specified amount in the question. Remember that en extra expense will affect your household's budget in terms of lower disposable income for other consumption like for instance food, clothes, travels, transportation, saving etc.

Q.15: What is the maximum amount that the proposal could cost your household in additional taxes every year, for you to still vote 'yes'?

Type amount here

"I would accept, that my household should pay a maximum of_____DKK in additional annual taxes to ensure that the motorway is realised in the layout, which I prefer."

[65] There are no actual plans to raise income taxation. We are merely interested in finding out, how important it is to you that the motorway realised in the layout which you prefer.

Q.16: How certain are you that you would be willing to, as well as capable of, paying the stated amount, if this scenario was carried out in reality?

Very certain ❑ Certain ❑ Don't know ❑ Uncertain ❑ Very uncertain ❑

Q.17: Did you state 0 DKK in question 15?

(tick one)

No ..... ❑ → *If no, continue to question 18*

Yes..... ❑

If yes, what is the main cause that you stated 0 DKK?

(tick one)

– It's of no importance to me, which layout is realised ..... ❑
– I don't want to pay additional taxes..... ❑
– I'm against the new motorway ..... ❑
– I can't afford to pay additional taxes..... ❑
– Other, please type here: _____ ❑

Q.18: To what extent did the following considerations affect your answers to questions 14 and 15?

	In no way	Little	Some	Very much
Animals and plants in the areas	❑	❑	❑	❑
My own recreational opportunities in the areas	❑	❑	❑	❑
Other people's opportunities for recreation in the areas	❑	❑	❑	❑
The opportunity of experiencing the areas of nature by driving on the motorway	❑	❑	❑	❑
Influence on landscape appearance	❑	❑	❑	❑
Influence on Silkeborg city	❑	❑	❑	❑
The motorway offers new means of transportation	❑	❑	❑	❑
Influence on the value of my property	❑	❑	❑	❑
This survey is my opportunity to affect the political process	❑	❑	❑	❑

Q.19: How large a share of the stated amount in question 15 would you assign to a desire for protection of nature and the recreational opportunities in the affected areas?

Please state the approximate share on the scale below:

❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑

0%------10%------20%------30%------40%------50%------60%------70%------80%------90%------100%--don't know

Q.20: How close are the two layouts to your residence?

Please state the shortest distance to each of the two layouts (look at the enclosed map):

	Less than 100 metres	100 – 500 m	500 – 1000 m	1 – 5 km	More than 5 km	Don't know
Resendal layout	❑	❑	❑	❑	❑	❑
Ringvej layout	❑	❑	❑	❑	❑	❑

Q.21: To what extent do you expect a motorway located in the Resendal layout or the Ringvej layout, respectively, will affect the following:

Please tick for both layouts:	Resendal layout			Ringvej layout		
	None	little	Much	None	little	Much
Your opportunities for nature experiences? .	❑	❑	❑	❑	❑	❑
Your opportunities for recreation?.....	❑	❑	❑	❑	❑	❑
The noise level at your residence?.....	❑	❑	❑	❑	❑	❑
The appearance of the Silkeborg landscape?	❑	❑	❑	❑	❑	❑
Your daily transport?.....	❑	❑	❑	❑	❑	❑
The specific affected areas?.....	❑	❑	❑	❑	❑	❑
Nature in Denmark in general?.....	❑	❑	❑	❑	❑	❑
Property values in your neighbourhood?	❑	❑	❑	❑	❑	❑

Your attitudes towards nature and motorways

Q.22: How would you characterise your own interest in nature and environmental issues in general?

(tick one)

Small..... ❑
Medium ..... ❑
Large ..... ❑
Don't know..... ❑

Q.23: To what extent do you expect that the future extension of the Danish network of motorways will affect:

	None	Little	Some	Very much	Don't know
Your opportunities for recreation in nature?	❑	❑	❑	❑	❑
Your transportation?	❑	❑	❑	❑	❑
Nature in Denmark in general?	❑	❑	❑	❑	❑

Q.24: What is your attitude towards:

	Very positive	Positive	Neutral	Negative	Very negative
Existing motorways in Denmark?	❑	❑	❑	❑	❑
Building of new motorways in Denmark?	❑	❑	❑	❑	❑

Q.25: Do you agree or disagree with the following statements?

	Strongly agree	Partly agree	Neither agree nor disagree	Partly disagree	Strongly disagree
Danish nature is threatened by human activity	❑	❑	❑	❑	❑
Concerns for nature should always be prioritised above concerns for infrastructure – no matter the costs	❑	❑	❑	❑	❑
Noise from a nearby motorway does not necessarily destroy a good experience in nature	❑	❑	❑	❑	❑
Motorways through areas of nature destroy the appearance of nature	❑	❑	❑	❑	❑
Of concern for the opportunities of future generations to experience nature, we should not extend the network of motorways	❑	❑	❑	❑	❑

Background questions

To be able to compare different sections of the population and their attitudes in the preceding questions, we would like you to answer a series of questions concerning your personal background. Furthermore, this information is intended to ensure that the respondents in the survey cover a wide section of the Danish population. *Remember, your answers will be treated confidentially*!

Q.26: In what year were you born? 19____

Q.27: Are you: Male? ❑ *or* Female? ❑

Q.28: How many persons live in your household?

Number of adults: _____ (yourself included) Number of children:_____(Under 15 years)

Q.29: What is your marital status?

(tick one)

Married or living in a relationship ❑
Single, separeted or divorced ❑
Widow or widower ❑

Q.30: In what size of city do you live?

(tick one)

Medium-sized city (10.000 – 99.999 inhabitants) ❑
Small city (1.000 – 9.999 inhabitants) ❑
Very small city (500 – 999 inhabitants) ❑
Village (200 – 499 inhabitants) ❑
Rural district ❑

Q.31: What is your education?

(tick one)

Primary school ❑
Vocational ❑
High school ❑
Short-term academic education (less than 3 years) ❑
Middle-term academic education (3 – 4 years) ❑
Long-term academic education (more than 4 years) ❑
Other (please state): _____

Q.32: What is the main occupation of you and your partner?

	Yourself *(tick one)*	Partner *(tick one)*
Independent/self-employed	❑	❑
Employed in the public sector	❑	❑
Employed in the private sector	❑	❑
Unemployed	❑	❑
Education	❑	❑
'Efterlønsmodtager', pensioner, early retirement	❑	❑
Other occupation	❑	❑

- please state here: _____

Q.33: What is your *personal* gross income?

Less than 50.000 DKK ❑
50.000 – 99.999 DKK ❑
100.000 – 149.999 DKK ❑
150.000 – 199.999 DKK ❑
200.000 – 249.999 DKK ❑
250.000 – 299.999 DKK ❑
300.000 – 349.999 DKK ❑
350.000 – 399.999 DKK ❑
400.000 – 449.999 DKK ❑
450.000 – 499.999 DKK ❑
500.000 DKK or more ❑

Q.34: What is your household gross income?

Less than 100.000 DKK..... ❑
100.000 – 149.999 DKK ..... ❑
150.000 – 199.999 DKK ..... ❑
200.000 – 249.999 DKK ..... ❑
250.000 – 299.999 DKK..... ❑
300.000 – 399.999 DKK..... ❑
400.000 – 499.999 DKK..... ❑
500.000 – 599.999 DKK..... ❑
600.000 – 699.999 DKK..... ❑
700.000 – 799.999 DKK..... ❑
800.000 DKK or more..... ❑

Q.35: Are you member of an environmental/'green' organisation?

Yes..... ❑
No ..... ❑
Don't know..... ❑

Last questions

Q.36: Please state your postal code here:

Q.37: If you wish to enter the draw for gift vouchers (1 voucher at 2500 DKK and 5 vouchers at 500 DKK), please enter your name and telephone number here:

Name: _____

Tel.no: _____

This information will solely be used for the draw.
Winners will be contacted directly.

If you have further comments or clarifications, please write them here:

Please fold the questionnaire along the centre line and mail it in the enclosed return envelope (postage is prepaid).

Thanks for your help!

Appendix 3: DBDC CVM Valuation questions

Q.15: If the proposal of placing the motorway in the layout that you prefer would cost your household 350 DKK in additional taxes each year, what would you vote?

(tick one)

YES..... ❑ → *Continue to question 16*

NO..... ❑ → *Continue to question 17*

Q.16: If the proposal instead would cost your household 550 DKK in additional taxes each year, what would you vote?

(please only answer if you answered 'yes' in question 15)

(tick one)

YES..... ❑ → *Continue to question 18*

NO..... ❑ → *Continue to question 18*

Q.17: If the proposal instead would cost your household 200 DKK in additional taxes each year, what would you vote?

(please only answer if you answered 'no' in question 15)

(tick one)

YES..... ❑ → *Continue to question 18*

NO..... ❑ → *Continue to question 18*

Q.18: What is the maximum amount that the proposal may cost your household in additional taxes each year, for you to vote 'yes'?

Write amount here:_____DKK

Appendix 4: Letter of introduction

DEN KGL. VETERINÆR- OG LANDBOHØJSKOLE

Name
Address
Postal code

Frederiksberg June 1st 2005
Reference no.: xxxx

Location of the new Silkeborg motorway

At the Royal Veterinary and Agricultural University we are currently conducting a survey to uncover the wishes and attitudes of the population with regards to consideration of nature when planning new motorways.

The survey focuses of the impact of new motorways on landscape, animals and plants, and opportunities for recreation and outdoor life in affected areas.

We have chosen to look closer at the upcoming choice of layout for the coming Silkeborg motorway and the importance of this for citizens in the area. We believe that the best possible way to do this, is by asking the citizens in the Silkeborg area themselves.

That is why we are sending the enclosed questionnaire to a total of 2000 randomly chosen persons in the Silkeborg area, including you. Participation is of course voluntary. It is however **of great importance for the quality of the survey that we receive as many replies as possible**, so we hope you will help us by spending the 15-20 minutes that it takes to fill in the questionnaire.

The results from this survey will achieve a better foundation for inclusion of the wishes and attitudes of the citizens in the Silkeborg area in the final choice of layout for the Silkeborg motorway. Further, future planning of new motorways in Denmark will benefit from the experiences from this survey in Silkeborg.

Please return the filled in questionnaire in the enclosed prepaid return envelope no later than Friday the 10th of June 2005. All returned questionnaires will enter a draw for **1 gift voucher of 2500 DKK** and **5 gift vouchers of 500 DKK**.

Thank you for your help!

Best regards

Head of research Alex Dubgaard

and

Research assistant Søren Bøye Olsen

Appendix 5: First reminder-letter

Location of the new Silkeborg motorway

About 10 days ago you received a questionnaire concerning your attitude to the location of the coming Silkeborg motorway. The questionnaire aims to ensure that the wishes and attitudes of the citizens in the area are heard, before it is finally decided precisely where to locate the motorway.

As we have not yet received your answer, we hereby allow ourselves to encourage you to fill in the questionnaire and return it in the enclosed prepaid return envelope. Participation is of course voluntary, but it is of great importance for the quality and the impact of the survey that we receive as many replies as possible. We would therefore very much like to receive an answer from you.

Remenber, that all returned questionnaires will enter a draw for 1 gift voucher of 2500 DKK and 5 gift vouchers of 500 DKK.

If you have returned the questionnaire recently, please disregard this letter. Have you lost the questionnaire, please call the phone number below our e-mail us, and we will send you a replacement questionnaire.

If you have questions or experience difficulties when filling in the questionnaire, please feel free to call the phone number below, Monday to Friday from 9.00 to 16.00, or write us an e-mail.

Thank you for your help!

Best regards

Head of research Alex Dubgaard

and

Research assistant Søren Bøye Olsen

Appendix 6: Second reminder-letter

Location of the new Silkeborg motorway

A couple of weeks ago we sent you a questionnaire concerning your attitude to the location of the coming Silkeborg motorway. The questionnaire is part of a larger research project, which aims to ensure that the wishes and attitudes of the citizens in the Silkeborg area are heard, before it is finally decided precisely where to locate the motorway between Funder and Låsby.

Unfortunately we have not received as many replies as hoped. As we have not yet received your reply, we allow ourselves to enclose a replacement questionnaire, which we would like you to fill in and return in the enclosed prepaid return envelope.

Participation is of course voluntary, but it is of great importance for the quality and the impact of the survey that we receive as many replies as possible, thus ensuring that all groups of people are represented in the survey. We would therefore very much like to receive an answer from you too.

If you have returned the questionnaire recently, please disregard this letter.

If you return the questionnaire no later than Monday the 27th of June, you can still join the draw for 1 gift voucher of 2500 DKK and 5 gift vouchers of 500 DKK.

If you have questions or experience difficulties when filling in the questionnaire, please feel free to call the phone number below, Monday to Friday from 9.00 to 16.00, or write us an e-mail.

Thank you for your help!

Best regards

Head of research Alex Dubgaard

and

Research assistant Søren Bøye Olsen

Appendix 7: CE questionnaire

Questionnaire

Concerns for nature when planning new motorways

Help to increase the understanding of people's wishes and attitudes in relation to concerns for nature when building new motorways

Win a gift voucher

(1 voucher at 2500 DKK and 5 vouchers at 500 DKK)

Contact:

Søren Bøye Olsen ☎ 3528 3643 ✉ sobo@kvl.dk

Introduction

New motorways are usually placed through arable land. However, for various reasons it is sometimes chosen to locate a motorway through areas of nature, as for instance forests, wetlands or heaths.

When a new motorway is planned, the effect on the environment is always assessed. In this way, concern for animals and plants in the affected areas of nature is to some extent exercised. It is, however, not possible to entirely avoid animals and plants being negatively affected.

It is more than just animals and plants, who are affected by a new motorway through areas of nature. Most Danish people use nature in their leisure time, for instance for hiking, fishing and so forth. Consequently, a new motorway through a nature area will possibly affect our opportunities for outdoor life negatively. On the other hand, people who drive on the motorway will have a beautiful view when driving on roads through areas of natural beauty.

Your experiences in nature

Below, we pose a series of questions concerning your experiences in nature. Think about your experiences in nature within the past year and especially try to recall your latest visit in nature. With 'visit' we think of actual trips, with the main purpose of experiencing nature.

Q.1: How important are the following types of nature for your recreational experiences in the Danish nature?

	Not imp.	Some imp.	Fairly imp.	Very imp.	Don't know
Forest	❑	❑	❑	❑	❑
Wetland (bog, stream, meadow, lake)	❑	❑	❑	❑	❑
Heath or common (continuous grass)	❑	❑	❑	❑	❑
Beach or coast	❑	❑	❑	❑	❑
Arable land	❑	❑	❑	❑	❑

Other important types of nature – type here: _____

Q.2: How often in the past year have you visited the following types of nature?

	0 times	1-5 times	6-10 times	11-20 times	More than 20 times	Don't know
Forest	❑	❑	❑	❑	❑	❑
Wetland (bog, stream, meadow, lake)	❑	❑	❑	❑	❑	❑
Heath or common (continuous grass)	❑	❑	❑	❑	❑	❑
Beach or coast	❑	❑	❑	❑	❑	❑
Arable land	❑	❑	❑	❑	❑	❑

Q.3: Which activities have you done on your visits in nature within the past year?

(tick one or more)

Went for a walk ❑
Walked the dog ❑
Went for a run ❑
Went for a bike ride ❑
Went riding ❑
Took photos ❑
Picked berries, mushrooms, flowers etc. ❑
Experienced or studied nature ❑
Went fishing or hunting ❑
Watched animals ❑
Enjoyed silence ❑
Bathed / on the beach ❑
Don't know ❑
Other – Please type here: _____

Q.4: Which activities did you do the *last* time you visited nature?

(tick one or more)

Went for a walk ❑
Walked the dog ❑
Went for a run ❑
Went for a bike ride ❑
Went riding ❑
Took photos ❑
Picked berries, mushrooms, flowers etc. ❑
Experienced or studied nature ❑
Went fishing or hunting ❑
Watched animals ❑
Enjoyed silence ❑
Bathed / on the beach ❑
Don't know ❑
Other – Please type here: _____

Q.5: How long time did you spend on your last visit in nature?

(tick one)

Less than ½ hour ❑
½ to 1 hour ❑
1 to 3 hours ❑
3 to 5 hours ❑
More than 5 hours ❑
Don't know ❑

Q.6: How far is it from your residence to the nearest:

	Less than 1 km	1-5 km	6-10 km	11-20 km	More than 20 km	Don't know
Forest	❑	❑	❑	❑	❑	❑
Wetland (bog, stream, meadow, lake)	❑	❑	❑	❑	❑	❑
Heath or common (continuous grass)	❑	❑	❑	❑	❑	❑
Beach or coast	❑	❑	❑	❑	❑	❑

Q.7: How far is it from your residence to the areas of the following types of nature, which you visit most often?

If you for one or more of the types of nature do not have a specific area, which you visit most often, please just tick 'don't know'.

Distance to *most often* visited:	Less than 1 km	1-5 km	6-10 km	11-20 km	More than 20 km	Don't know
Forest	❑	❑	❑	❑	❑	❑
Wetland (bog, stream, meadow, lake)	❑	❑	❑	❑	❑	❑
Heath or common (continuous grass)	❑	❑	❑	❑	❑	❑
Beach or coast	❑	❑	❑	❑	❑	❑

Your daily means of transportation

Q.8: Which of the following types of transportation do you use regularly?

(tick one or more)

Car ❑
Bus ❑
Train ❑
Bicycle ❑
Motorbike ❑
Don't know ❑
Other – please type here: _____

Q.9: Does your household own a car?

Yes ❑ → If yes, please type how many: _____
No ❑

Q.10: When driving a car, are you most often:

(tick one)

driver? ❑
or
passenger? ❑

Q.11: Do you notice the surrounding landscape when driving a car?

(tick one)

No ..... ❑ → *If no continue to question 12*
Don't know ..... ❑ → *If no continue to question 12*
Yes ..... ❑

↳ **If yes, would you prefer rather to:**

(tick one)

– Drive through nature than through city or arable land? ..... ❑
– Drive through city or arable land than nature? ..... ❑
– It's of no importance to me, which areas I drive through ..... ❑
– Don't know ..... ❑

Q.12: How many km per day do you on average drive in a car?

(tick one)

Less than 5 km ..... ❑
5 to 10 km ..... ❑
11 to 20 km ..... ❑
21 to 50 km ..... ❑
51 to 100 km ..... ❑
More than 100 km ..... ❑
Don't know ..... ❑

Q.13: How far is it from your residence to the nearest motorway?

Please type the approximate distance: _____km

Q.14: How often do you drive on motorway?

(tick one)

Every day ..... ❑
Almost every day ..... ❑
Approximately a couple of times a week ..... ❑
Approximately a couple of times every 14 days ..... ❑
Approximately a couple of times a month ..... ❑
Approximately a couple of times every half year ..... ❑
More rarely ..... ❑
Never ..... ❑
Don't know ..... ❑

Choose between alternative locations of a motorway through the landscape

To be able to answer the next questions,
it is important that you read the following passage thoroughly.

100 kilometres of new motorways
In the years to come, it is expected that car-traffic will rise and that the more motorways will be built. Now, imagine that 100 km of new motorways are to be built in Denmark during the next ten years.

Where?
When you answer the next questions, we would like you to further imagine that the new motorways are to be located in such a way that the nature areas which you visit most often will be affected.

Expected location in the landscape
In the following questions, we now assume that the location of the new motorways through the landscape is planned with no special concern for which type of area is being encroached. As a consequence, the 100 km of new motorways will pass through:

- ⇨ 10 km of forest
- ⇨ 5 km of wetland (e.g. bog, stream, meadow, lake)
- ⇨ 5 km of heat hor common (e.g. continuous grass)
- ⇨ 80 km arable land (e.g. grain, turnips, fallow, corn)

This distribution of kilometres equals the area distribution of the Danish landscape today. We label this location of the motorway 'Alternative 0'.

You can choose another location
In the next questions, you have the opportunity to choose alternative locations for the new motorways, where fewer km are located through nature areas and more km are instead placed through arable land.

But you have to pay to change the location
For instance, it can be expensive to position a motorway around a bog instead of placing it straight through it. In this survey we assume that the extra costs are covered by raising income taxation more than would otherwise be necessary. In each of the differing motorway alternatives in the following choice questions, you therefore also have to take into account an annual extra income tax, which you would have to pay. To your household, this tax will be an annual extra expense, implying less disposable income for other consumption[66].

[66] NB. There are no present plans to raise taxation on income. We are merely interested in finding out, how much it is worth to you, that greater considerations for nature are exercised in future motorway building.

Example

Here is an example of how the choice questions look. Think shortly about which of the three alternatives you would prefer?

Which of the following locations for the future motorways would you prefer?

	Alternative 0	Alternative 1	Alternative 2
Number of kilometres through:			
– Forest	10 km	5 km	0 km
– Wetland	5 km	0 km	5 km
– Heath/common	5 km	5 km	0 km
– Arable land	80 km	90 km	95 km
Annual extra payment	0 DKK	400 DKK	1100 DKK
I prefer …(tick one):	❑	❑	❑

For each alternative, think of all characteristics

As the example shows, it is not enough to just consider the trade-off between the number of km through different types of nature in the three alternatives. The tax payments have to be incorporated into this trade-off.

Most people overestimate

Similar surveys have revealed that a lot of people tend to overestimate how much they in reality would pay to protect nature. Often, it is forgotten that other opportunities for experiencing nature exist – for instance in the nature areas, which are not encroach by the motorway. In other words, it is important to remember, that even though some areas are influenced by the motorway, there will still be a lot of other areas of nature, which are unaffected.

Therefore, consider carefully whether you are willing to pay, and capable of paying, the given amount in the alternative you choose. Remember, that an extra expense will affect your household's disposable income for other consumption, as for instance food, clothes, transportation, travels, savings, etc.

Furthermore, please notice that the six choice questions are separate, isolated questions. The figures in the chosen alternatives are therefore not intended to be added up across the six questions.

You are now ready to make your choices on the following pages.

Have a good time!

Q.15: Which of the following locations for the future motorways would you prefer?

Remember to imagine that the nature areas which you visit most often, *will* be affected.

	Alternative 0	Alternative 1	Alternative 2
Number of kilometres through:			
– Forest	10 km	0 km	10 km
– Wetland	5 km	0 km	5 km
– Heath/common	5 km	5 km	2.5 km
– Arable land	80 km	95 km	82.5 km
Annual extra payment	0 DKK	200 DKK	100 DKK
I prefer …(tick one):	❑	❑	❑

Q.15A: How certain are you of your choice?

It's ok to be uncertain – Your reply will be no less valuable for that reason!

(*tick one*)

Very uncertain ❑
Uncertain ❑
Neither certain nor uncertain ❑
Certain ❑
Very certain ❑
Don't know ❑

Q.16: Which of the following locations for the future motorways would you prefer?

Remember to imagine that the nature areas which you visit most often, *will* be affected.

	Alternative 0	Alternative 1	Alternative 2
Number of kilometres through:			
– Forest	10 km	0 km	5 km
– Wetland	5 km	2.5 km	5 km
– Heath/common	5 km	2.5 km	0 km
– Arable land	80 km	95 km	90 km
Annual extra payment	0 DKK	1100 DKK	200 DKK
I prefer …(tick one):	❑	❑	❑

Q.16A: How certain are you of your choice?

It's ok to be uncertain – Your reply will be no less valuable for that reason!

(*tick one*)

Very uncertain ❑
Uncertain ❑
Neither certain nor uncertain ❑
Certain ❑
Very certain ❑
Don't know ❑

Q.17: Which of the following locations for the future motorways would you prefer?

Remember to imagine that the nature areas which you visit most often, *will* be affected.

	Alternative 0	Alternative 1	Alternative 2
Number of kilometres through:			
– Forest	10 km	5 km	0 km
– Wetland	5 km	2.5 km	0 km
– Heath/common	5 km	5 km	2.5 km
– Arable land	80 km	87.5 km	97.5 km
Annual extra payment	0 DKK	100 DKK	400 DKK
I prefer …(tick one):	❑	❑	❑

Q.17A: How certain are you of your choice?

It's ok to be uncertain – Your reply will be no less valuable for that reason!

(*tick one*)

Very uncertain ..... ❑
Uncertain..... ❑
Neither certain nor uncertain..... ❑
Certain ..... ❑
Very certain..... ❑
Don't know..... ❑

Q.18: Which of the following locations for the future motorways would you prefer?

Remember to imagine that the nature areas which you visit most often, *will* be affected.

	Alternative 0	Alternative 1	Alternative 2
Number of kilometres through:			
– Forest	10 km	10 km	0 km
– Wetland	5 km	0 km	5 km
– Heath/common	5 km	2.5 km	5 km
– Arable land	80 km	87.5 km	90 km
Annual extra payment	0 DKK	700 DKK	1600 DKK
I prefer …(tick one):	❑	❑	❑

Q.18A: How certain are you of your choice?

It's ok to be uncertain – Your reply will be no less valuable for that reason!

(*tick one*)

Very uncertain ..... ❑
Uncertain..... ❑
Neither certain nor uncertain..... ❑
Certain ..... ❑
Very certain..... ❑
Don't know..... ❑

Q.19: Which of the following locations for the future motorways would you prefer?

Remember to imagine that the nature areas which you visit most often, *will* be affected.

	Alternative 0	Alternative 1	Alternative 2
Number of kilometres through:			
– Forest	10 km	5 km	10 km
– Wetland	5 km	5 km	0 km
– Heath/common	5 km	0 km	5 km
– Arable land	80 km	90 km	85 km
Annual extra payment	0 DKK	400 DKK	1600 DKK
I prefer …(tick one):	❑	❑	❑

Q.19A: How certain are you of your choice?

It's ok to be uncertain – Your reply will be no less valuable for that reason!

(*tick one*)

Very uncertain ..... ❑
Uncertain..... ❑
Neither certain nor uncertain..... ❑
Certain ..... ❑
Very certain..... ❑
Don't know..... ❑

Q.20: Which of the following locations for the future motorways would you prefer?

Remember to imagine that the nature areas which you visit most often, *will* be affected.

	Alternative 0	Alternative 1	Alternative 2
Number of kilometres through:			
– Forest	10 km	0 km	10 km
– Wetland	5 km	0 km	2.5 km
– Heath/common	5 km	2.5 km	0 km
– Arable land	80 km	97.5 km	87.5 km
Annual extra payment	0 DKK	100 DKK	1100 DKK
I prefer …(tick one):	❑	❑	❑

Q.20A: How certain are you of your choice?

It's ok to be uncertain – Your reply will be no less valuable for that reason!

(*tick one*)

Very uncertain ..... ❑
Uncertain..... ❑
Neither certain nor uncertain..... ❑
Certain ..... ❑
Very certain..... ❑
Don't know..... ❑

Follow-up on your choices

Q.21: Do you think that your willingness to pay in the preceding questions would have been less, if instead you had been asked to imagine that the new motorways would *not* affect the areas of nature, which you visit most often?

(tick one)

Yes, a lot less ❑
Yes, somewhat less ❑
No ❑
Don't know ❑

Q.22: To what extent did the specific characteristics influence your choices between alternative locations of new motorways?

	None	Little	Some	Very much	Don't know
Number of km through forest	❑	❑	❑	❑	❑
Number of km through wetland	❑	❑	❑	❑	❑
Number of km through heath / common	❑	❑	❑	❑	❑
The annual extra taxpayment	❑	❑	❑	❑	❑

Q.23: Did you make your choices on the basis of all four characteristics?

(tick one)

Yes, I largely based my choices on all characteristics ❑
No, I only considered the characteristic, which I found to be most important ❑
Don't know ❑

Q.24: To what extent was your choices between alternative locations of new motorways base don the following considerations?

	None	Little	Some	Very much	Don't know
The motorway's influence on animals and plants in the nature areas	❑	❑	❑	❑	❑
The motorway's influence on recreational opportunities in the nature areas	❑	❑	❑	❑	❑
The opportunity to experience the nature areas from the motorway	❑	❑	❑	❑	❑

Q.25: Did you choose 'Alternative 0' in all six choice questions (Q15 to Q20)?

(tick one)

No ..... ❑ → *Continue to question 26*

Yes ..... ❑

→ **If yes, what was the primary cause for this?:** *(tick only one)*

The alternatives were to expensive considering the protection of nature ..... ❑
I can't afford to pay any more taxes ..... ❑
I pay enough taxes as it is ..... ❑
The questions were to difficult to answer ..... ❑
No more motorways should be built in Denmark ..... ❑
Special concerns for nature is unnecessary when building motorways ..... ❑
I like to have a view of natural beauty when driving ..... ❑
Don't know ..... ❑
Other – please type here: _____

Your attitudes towards nature and motorways

Q.26: How would you characterise your own interest in nature and environmental issues in general?

(tick one)

Small ..... ❑
Medium ..... ❑
Large ..... ❑
Don't know ..... ❑

Q.27: To what extent do you expect that the future extension of the Danish network of motorways will affect:

	None	Little	Some	Very much	Don't know
Your opportunities for recreation in nature?	❑	❑	❑	❑	❑
Your transportation?	❑	❑	❑	❑	❑
Nature in Denmark in general?	❑	❑	❑	❑	❑

Q.28: What is your attitude towards:

	Very positive	Positive	Neutral	Negative	Very negative	Don't know
Existing motorways in Denmark?	❑	❑	❑	❑	❑	❑
Building of new motorways in Denmark?	❑	❑	❑	❑	❑	❑

Q.29: Do you agree or disagree with the following statements?

	Strongly agree	Partly agree	Neither agree nor disagree	Partly dis-agree	Strongly disagree	Don't know
Danish nature is threatened by human activity	❑	❑	❑	❑	❑	❑
Danish nature must ensure diversity of plants and animals	❑	❑	❑	❑	❑	❑
Danish nature must meet the people's demand for outdoor life	❑	❑	❑	❑	❑	❑
Concerns for nature should always be prioritised above concerns for infrastructure – no matter the costs	❑	❑	❑	❑	❑	❑
Concerns for nature can justify a new motorway being more expensive than necessary	❑	❑	❑	❑	❑	❑
Noise from a nearby motorway does not necessarily destroy a good experience in nature	❑	❑	❑	❑	❑	❑
It's necessary to improve the Danish infrastructure with new motorways	❑	❑	❑	❑	❑	❑
Motorways through areas of nature destroy the appearance of nature	❑	❑	❑	❑	❑	❑
Of concern for the opportunities of future generations to experience nature, we should not extend the network of motorways	❑	❑	❑	❑	❑	❑

Q.30: Are there, or have there been, plans to build new motorways or similar project in close vicinity of your residence?

Yes ❑
No ❑
Don't know ❑

Q.31: Are you member of an environmental/'green' organisation?

Yes ❑
No ❑
Don't know ❑

Background questions

To be able to compare different sections of the population and their attitudes in the preceding questions, we would like you to answer a series of questions concerning your personal background. Furthermore, this information is intended to ensure that the respondents in the survey cover a wide section of the Danish population. *Remember, your answers will be treated confidentially*!

Q.32: In what year were you born? 19____

Q.33: Are you: Male? ..... ❑ *or* Female? ..... ❑

Q.34: How many persons live in your household?

Number of adults: _____ (yourself included) Number of children:_____(Under 15 years)

Q.35: What is your marital status?

(tick one)

Not married ..... ❑
Married ..... ❑
Living in relationship ..... ❑
Separeted or divorced ..... ❑
Widow or widower ..... ❑

Q.36: In what size of city do you live?

(tick one)

Greater Copenhagen ..... ❑
City with 50.001 - 500.000 inhabitants ..... ❑
City with 10.000 - 50.000 inhabitants ..... ❑
City with less than10.000 inhabitants ..... ❑
Rural district ..... ❑

Q.37: What is your length of schooling?

(tick one)

Primary school (7 years or shorter) ..... ❑
Primary school (8 or 9 years) ..... ❑
Primary school (10 years)..... ❑
High school..... ❑

Q.38: Besides school, have you...?

(tick one)

Basic vocational education ❑
Finished vocational training ❑
Academic education, short term (less than 3 years) ❑
Academic education, middle term (3-4 years) ❑
Academic education, long term (5 years or more) ❑
None ❑

Q.39: What is your main occupation?

(tick one)

Worker, unskilled (not semi-skilled) ❑
Worker, unskilled (semi-skilled) ❑
Worker, skilled ❑
Salaried worker or official, lower ❑
Salaried worker or official, higher ❑
Independent farmer ❑
Independent retailer or master artisan ❑
Independent, other ❑
Student ❑
Not working (unemployed, on leave, pensioner, etc.) ❑
Working at home ❑
Working for partner ❑

Q.40: Are you presently unemployed or on leave?

(tick one)

Currently unemployed ❑
Currently on leave ❑
None of the above ❑

Q.41: What is your *personal* gross income?

Less than 50.000 DKK ❑
50.000 – 99.999 DKK ❑
100.000 – 149.999 DKK ❑
150.000 – 199.999 DKK ❑
200.000 – 249.999 DKK ❑
250.000 – 299.999 DKK ❑
300.000 – 349.999 DKK ❑
350.000 – 399.999 DKK ❑
400.000 – 449.999 DKK ❑
450.000 – 499.999 DKK ❑
500.000 DKK or more ❑
Don't know/no answer ❑

Q.42: What is your household gross income?

Less than 100.000 DKK ❑	400.000 – 499.999 DKK ❑
100.000 – 149.999 DKK ❑	500.000 – 599.999 DKK ❑
150.000 – 199.999 DKK ❑	600.000 – 699.999 DKK ❑
200.000 – 249.999 DKK ❑	700.000 – 799.999 DKK ❑
250.000 – 299.999 DKK ❑	800.000 DKK or more ❑
300.000 – 399.999 DKK ❑	Don't know/no answer ❑

Last questions

Q.43: Please state your postal code here:

Q.44: If you wish to enter the draw for gift vouchers (1 voucher at 2500 DKK and 5 vouchers at 500 DKK), please enter your name and telephone number here:

Name: _____

Tel.no: _____

This information will solely be used for the draw.
Winners will be contacted directly.

If you have further comments or clarifications, please write them here:

Please fold the questionnaire along the centre line and mail it in the enclosed return envelope (postage is prepaid).

Thanks for your help!

Appendix 8: Subgroup analysis

Split 1

Subgroup	Forest _min	Forest _med	Wetland _min	Wetland _med	Heath _min	Heath _med	N	Pseudo-R^2
Male	839	362	678	449	381	*41*	846	0.14
Female	972	548	869	495	287	*78*	918	0.16
Edu1-2	767	551	652	540	395	*194*	528	0.17
Edu3-4	837	*142*	885	471	*130*	*51*	318	0.15
Edu5-6	1070	565	928	446	464	*62*	756	0.15
Inc0	1268	*224*	1047	537	*359*	*-148*	114	0.33
Inc1	771	532	596	477	*297*	*213*	294	0.13
Inc2	848	403	1093	560	429	*-3*	498	0.14
Inc3	978	536	646	440	330	*59*	720	0.15
Age18-34	1063	444	571	253	339	*71*	492	0.20
Age35-54	947	469	884	541	349	*72*	882	0.14
Age55-70	614	461	802	651	324	*70*	390	0.14
Zealand	819	400	796	464	338	*57*	1020	0.17
Funen	1276	*658*	*540*	*440*	*736*	*524*	78	0.18
Jutland	1112	601	834	531	348	*42*	666	0.13

Split 2

Subgroup	Forest _min	Forest _med	Wetland _min	Wetland _med	Heath _min	Heath _med	N	Pseudo-R^2
Male	577	344	531	251	184	*112*	900	0.15
Female	596	302	373	282	193	*106*	903	0.15
Edu1-2	408	209	499	321	*146*	*141*	552	0.16
Edu3-4	469	*166*	307	*200*	339	*158*	246	0.16
Edu5-6	762	480	451	255	185	*89*	853	0.16
Inc0	792	527	456	*45*	567	*156*	126	0.28
Inc1	690	323	531	312	*238*	*71*	300	0.16
Inc2	713	348	378	*368*	79	170	480	0.15
Inc3	454	298	450	245	154	*98*	744	0.15
Age18-34	585	390	369	*161*	314	*165*	480	0.17
Age35-54	612	339	433	296	126	*95*	978	0.15
Age55-70	541	206	603	391	*183*	*68*	348	0.15
Zealand	593	298	519	304	152	*111*	954	0.15
Funen	533	*294*	448	*82*	*222*	*221*	120	0.15
Jutland	578	353	340	260	211	*74*	732	0.16

Split 3

Subgroup	Forest _min	Forest _med	Wetland _min	Wetland _med	Heath _min	Heath _med	N	Pseudo-R^2
Male	831	431	600	383	282	190	978	0.14
Female	588	328	416	320	*93*	*-24*	732	0.20
Edu1-2	774	468	441	*302*	*331*	*230*	462	0.14
Edu3-4	672	433	*349*	*318*	*-75*	*-36*	258	0.20
Edu5-6	672	299	533	339	196	*41*	870	0.16
Inc0	1856	1508	1913	759	629	596	78	0.20
Inc1	517	*194*	448	402	344	*200*	240	0.18
Inc2	630	326	436	359	233	*72*	498	0.16
Inc3	768	400	519	358	*118*	*91*	738	0.16
Age18-34	780	407	238	186	*47*	*-87*	510	0.21
Age35-54	766	442	589	402	281	174	852	0.16
Age55-70	320	*124*	605	440	*136*	*130*	348	0.15
Zealand	748	358	499	346	154	*40*	879	0.15
Funen	530	*-29*	529	381	*-59*	*-240*	120	0.21
Jutland	619	419	420	289	237	142	720	0.16

Split 4

Subgroup	Forest _min	Forest _med	Wetland _min	Wetland _med	Heath _min	Heath _med	N	Pseudo-R^2
Male	1352	813	1063	572	538	334	774	0.15
Female	1107	657	650	377	206	203	906	0.19
Edu1-2	1091	787	697	460	451	337	522	0.15
Edu3-4	1052	484	702	405	*221*	*213*	258	0.15
Edu5-6	1335	695	1021	536	307	225	750	0.19
Inc0	1068	726	475	*25*	*155*	*290*	96	0.38
Inc1	1821	1032	815	598	632	531	300	0.20
Inc2	866	652	881	580	273	*224*	462	0.19
Inc3	1293	643	870	402	374	310	696	0.12
Age18-34	1465	814	794	477	437	267	534	0.23
Age35-54	1213	689	904	520	356	359	708	0.16
Age55-70	830	567	754	323	*198*	*57*	438	0.13
Zealand	1268	704	974	472	359	346	882	0.16
Funen	957	656	*334*	*207*	474	351	144	0.19
Jutland	1177	743	726	493	296	*132*	654	0.18

Split 5

Subgroup	Forest _min	Forest _med	Wetland _min	Wetland _med	Heath _min	Heath _med	N	Pseudo-R^2
Male	526	309	493	182	*102*	*-4*	930	0.11
Female	712	460	377	*114*	*91*	*87*	942	0.16
Edu1-2	767	444	535	*124*	*117*	*28*	582	0.13
Edu3-4	465	291	300	*147*	239	*149*	342	0.14
Edu5-6	556	334	417	209	*31*	*11*	780	0.13
Inc0	857	560	593	*266*	*1*	*-147*	108	0.20
Inc1	943	630	550	*177*	*174*	*136*	306	0.14
Inc2	615	313	534	231	*157*	*139*	474	0.17
Inc3	527	348	340	*125*	*90*	*33*	822	0.12
Age18-34	742	466	575	*98*	*185*	*-26*	522	0.16
Age35-54	643	424	358	188	*113*	*53*	876	0.15
Age55-70	473	210	401	*152*	*-15*	*115*	474	0.10
Zealand	788	462	477	187	*58*	*70*	846	0.14
Funen	*698*	*543*	*628*	234	267	-2	930	0.11
Jutland	464	296	331	*89*	*94*	*28*	942	0.16

Split 6

Subgroup	Forest _min	Forest _med	Wetland _min	Wetland _med	Heath _min	Heath _med	N	Pseudo-R^2
Male	742	357	400	334	*264*	*84*	246	0.15
Female	697	495	607	321	*134*	*-33*	282	0.27
Edu1-2	834	*330*	841	507	*193*	*-153*	144	0.14
Edu3-4	773	370	354	*262*	*30*	*-90*	156	0.21
Edu5-6	695	602	455	*247*	*259*	*264*	198	0.15
Inc0	-	-	-	-	-	-	12	-
Inc1	693	549	654	*551*	*493*	*300*	84	0.27
Inc2	439	*160*	502	*291*	*130*	*-62*	120	0.19
Inc3	836	552	352	*249*	*138*	*-55*	282	0.16
Age18-34	929	499	544	*237*	*0*	*38*	132	0.24
Age35-54	817	511	469	*281*	*264*	*41*	300	0.16
Age55-70	*-50*	*111*	*587*	*637*	*235*	*-112*	90	0.13

Split 7

Subgroup	Forest _min	Forest _med	Wetland _min	Wetland _med	Heath _min	Heath _med	N	Pseudo-R^2
Male	1718	733	1534	*386*	666	618	216	0.16
Female	845	600	453	*178*	254	*141*	276	0.20
Edu1-2	929	636	*397*	*229*	354	*301*	156	0.17
Edu3-4	1093	480	814	*1*	*302*	*340*	78	0.21
Edu5-6	1230	714	1103	*360*	696	*322*	234	0.19
Inc0	-	-	-	-	-	-	12	-
Inc1	*438*	*207*	*19*	*65*	*-23*	*-11*	66	0.11
Inc2	1404	456	1126	461	470	509	132	0.23
Inc3	1172	688	1089	*277*	539	*214*	252	0.18
Age18-34	1012	698	445	206	416	340	126	0.33
Age35-54	737	410	699	248	242	*132*	282	0.17
Age55-70	*7815*	*3365*	*5848*	*436*	*2462*	*2111*	84	0.15

Split 8

Subgroup	Forest _min	Forest _med	Wetland _min	Wetland _med	Heath _min	Heath _med	N	Pseudo-R^2
Male	672	*405*	883	664	*166*	*509*	156	0.13
Female	907	621	405	313	*179*	263	250	0.20
Edu1-2	805	570	636	*367*	*284*	567	72	0.40
Edu3-4	609	456	791	495	*126*	*325*	130	0.15
Edu5-6	908	585	*231*	*310*	*93*	*143*	198	0.15
Inc0	-	-	-	-	-	-	18	-
Inc1	*620*	*738*	*316*	*453*	*-161*	*254*	34	0.33
Inc2	582	534	772	721	*484*	*277*	90	0.19
Inc3	1059	606	354	*236*	114	382	264	0.18
Age18-34	*476*	*207*	*871*	*453*	*317*	*595*	18	0.41
Age35-54	195	566	556	*832*	531	637	108	0.09
Age55-70	975	556	480	295	*80*	238	280	0.22

Split 9

Subgroup	Forest _min	Forest _med	Wetland _min	Wetland _med	Heath _min	Heath _med	N	Pseudo-R^2
Male	559	432	464	*139*	378	*265*	246	0.14
Female	800	626	468	374	*230*	*-38*	234	0.15
Edu1-2	1627	1409	*419*	*115*	*609*	*612*	84	0.13
Edu3-4	524	272	428	*160*	*126*	*37*	174	0.17
Edu5-6	545	521	369	301	348	*12*	216	0.15
Inc0	-	-	-	-	-	-	-	
Inc1	-	-	-	-	-	-	48	-
Inc2	670	*197*	*336*	*213*	559	*244*	90	0.18
Inc3	718	658	454	*199*	274	*84*	342	0.14
Age18-34	-	-	-	-	-	-	12	-
Age35-54	*594*	951	960	*629*	*568*	*194*	132	0.11
Age55-70	735	464	352	*188*	254	*72*	336	0.17

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05

About the report

Motorways are comprehensive infrastructures with great impacts on the environment. Though highly important to society, impacts on nature are generally left out of the economic cost-benefit analyses when new motorways are planned. Instead the impacts are identified and presented in the environmental impact assessment – leaving the cost-benefit analyses incomplete whereby the results potentially can be misleading.

The purpose of this joint project between the Environmental Assessment Institute and The Royal Veterinary and Agricultural University, is to produce a set of value estimates for the welfare economic loss of nature associated with building new motorways. The estimates can be used in cost-benefit analyses in relation to future motorway projects in Denmark. Thereby impacts on nature will be handled in a consistent manner like all other impacts in the cost-benefit analyses.

About IMV

IMV is a policy analysis institute. The Institute's approach is socio-economic analyses of environmental issues. Forming critical, independent views on the basis of existing knowledge and communicating these to policy makers and public is the core objective of the Institute.

IMV was established in 2002. The Institute employs both environmental economists and natural scientists. In 2005 the Institute will turn special focus on environment and growth, on EU policy and on applicability of socio-economic methods.

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